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ENVIRONMENTAL IMPACT REPORT

Chowilla 1 Geothermal Exploration Drilling

GEL175

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1 Introduction

This document is an Environmental Impact Report (EIR), prepared in accordance with section 97 and regulation 10 of the *Petroleum Act 2000*. It has been prepared in conjunction with a Statement of Environmental Objectives (SEO).

This EIR and the SEO provide a risk assessment and basis for environmental compliance for drilling of a geothermal exploration drill hole by Eden Energy Ltd ("Eden") for the Renmark Geothermal Project. The proposed Chowilla 1 drill hole[1] will be located in Geothermal Exploration Licence (GEL) 175, on Chowilla Regional Reserve.

The Renmark Geothermal Project is located in GELs 175 and 176 on Chowilla Regional Reserve and Calperum Station, approximately 50 km northeast of Renmark. It is located over a distinct crustal heat flow anomaly, with high rock temperatures likely at depth, based on measurements from two nearby oil exploration wells. The Renmark Trough contains significant sedimentary accumulations beneath the Murray Basin. At the same time significant thermal refraction can be expected with lateral equilibration of the graben contacts, a combination providing enhanced values of heat flow and local hot spots associated with deep bounding fractures and high permeability zones.

The proposed drilling aims to assess the heatflow of the region and thereby the suitability of the area to host geothermal energy resources of commercial interest. Cores will be collected for thermal conductivity measurements and downhole temperature measurements will be undertaken to allow assessment of the heatflow in the area and an estimation of the likelihood of a geothermal resource being present. A more extensive programme may then be carried out dependent on the results of this drilling.

Although the proposed drilling differs from a petroleum exploration well in its purpose, small scale, limited depth, and the negligible probability of any petroleum discovery (given the proposed depth of investigation), the proposed drilling activity would be reasonably covered by the environmental objectives contained in a number of existing SEOs (e.g. *South Australia Cooper Basin Operators Statement of Environmental Objectives: Drilling and Well Operations* (Santos 2003) or the *Eden Energy Statement of Environmental Objectives: Geothermal Exploration Drilling* (Eden Energy 2005b)). However, the landforms and vegetation within GELs 175 and 176 are not directly comparable with the Cooper Basin and the assessment criteria contained in these SEOs are therefore not directly transferable to GELs 175 and 176.

Consequently, a new SEO that is focussed on this project and region has been prepared, based on this EIR. The submission of this new SEO will also trigger consultation on the EIR and SEO under the Petroleum Act processes. The new SEO is derived from existing drilling SEOs, with minor changes reflecting the differences of scale, site and location.

This EIR has utilised information contained in environmental reports prepared for other geothermal exploration programmes, in particular the *Environmental Impact Report - Witchelina Geothermal Energy Project: Proposed Hole WWD1 Re-Entry Programme GEL167* (Eden Energy 2005), which used information from reports prepared by Fatchen Environmental Pty Ltd.

[1] Note: The drill hole was referred to as Chowilla 2 in draft versions of this EIR, but was renamed following confirmation that the name Chowilla 1 was unused.

2 Proposed Activities

2.1 Location and access

2.1.1 Location

The proposed drilling location is on Chowilla Regional Reserve in GEL175, near the boundary with Calperum Station (and the boundary with GEL176). The location is shown in Figure 1.

The coordinates of the provisional drill hole location are: 479,800m E, 6266450m N (MGA Zone 54) (i.e. 33°44'30.51" S, 140°46'54.91" E).

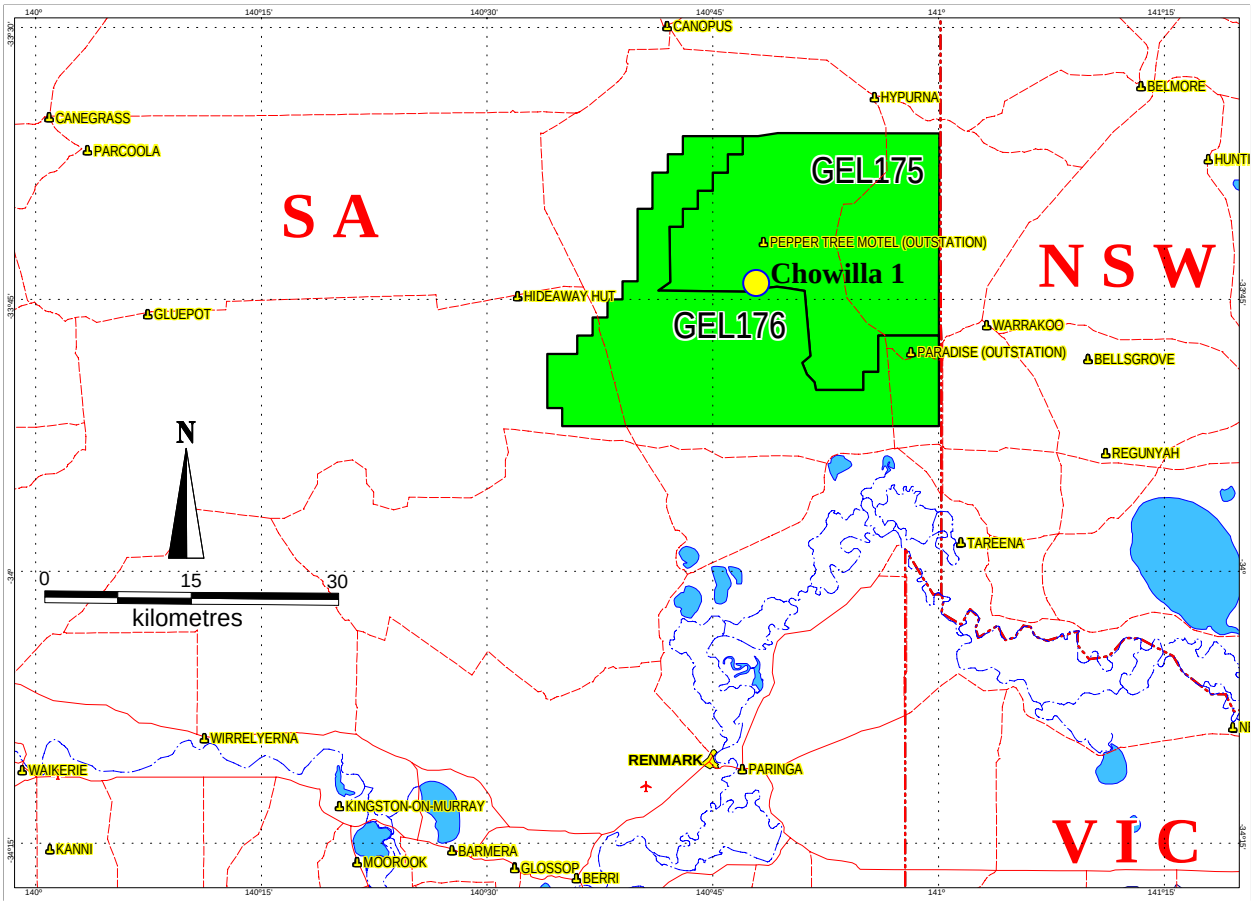

Figure 1: Location of Proposed Drill Hole

2.1.2 Access

Access to the site will utilise public roads and existing station tracks. Access from Renmark to Chowilla will be via the unsealed Main Wentworth Road. On Chowilla, access to the site will use the main track that runs north through Chowilla (and serves as a public access through Chowilla to Danggali Conservation Park). From this main track, access is proposed to follow a station track to the Chowilla shearing shed and finally via a track that travels westwards (for approximately 10 km) from the shearing shed to the site. There are alternative routes to the site that follow other station tracks that could be used, however this is the preferred route as it is the shortest in length.

The tracks to the shearing shed are in good condition and capable of carrying the truck-mounted drilling rig and support vehicles. The track to the drill site is overgrown in places, and will require clearing of shrubs that have regrown on the track and trimming of overhanging mallee branches to allow safe access. The track may be re-graded for some or all of its length, in areas where sandy conditions may pose difficulties for road trucks.

2.2 Drilling

2.2.1 Drilling operation

The rig that will be used for drilling has not been finalised, but will have capabilities to 650m depth for HQ core. A drilling rig (similar to the mud drilling rig that will be used) and a typical layout for drilling are shown in Plate 1.

Drilling will follow industry-accepted practice for water bore and diamond drilling. Procedures and operations will be defined in the contractor's Drilling Operations Manual (DOM).

Muds used will be non-toxic, and will comply with onshore drilling standards.

Based on the known geology of the area, the well design has been developed in consultation with DWLBC drilling personnel to manage the groundwater issues of the region. The three aquifer zones of the Murray basin will be drilled, cased and cemented separately to isolate and so prevent:

- contamination of aquifers through entry of pollutants from the surface
- interconnection between aquifers
- flow of pressurised water to the surface or into dry 'thief' zones
- degradation of natural hydrostatic conditions (maintain pre-drilling pressures)
- any physical hazard resulting from an open hole
- any environmental hazard resulting from an open hole which could become a trap for small animals or be hazardous to stock.

Plate 1: Photo of typical drill rig layout

2.2.2 Drilling period and parameters

Drilling is intended to commence in late October 2007. The overall duration for the drilling is expected to be in the order of 10 days/2 weeks. The generic drilling parameters are:

- Drilling date: Commence late October 2007 (provisional)
- Duration approximately 10 days/2 weeks
- Total depth 350-650m – final depth depends on thickness of Murray Basin & depth to the point at which core drilling can commence.
- Primary Objective: Drill hole to allow temperature measurements and assessment of geothermal gradient; collect core samples for thermal conductivity measurements, estimate heatflow at this location.
- Hole design:
  - 0-15m : 300mm mud rotary hole; 250mm casing
  - 15-100m : 9" mud rotary hole; 200mm PVC casing
  - 100-200m: 7" mud rotary hole; 150mm steel casing
  - 200-450m: 5" mud rotary hole; HW or 4" steel casing
  - 450-550m: HQ3 wireline core drilling – uncased

Given that the hole is only a short term observation hole, with a lifetime of approximately 1 year, materials used in the hole construction do not need to be stainless steel.

2.2.3 Drill site requirements

The drill site needs to be a level and firm pad approximately 20m by 30m for the rig and associated vehicles (see Figure 2). Minimal clearing of this area will be needed to remove tripping hazards and ensure a safe work area. There is no need for importation of borrow materials from elsewhere. The site is not subject to any more than local water run-on hazards.

Sumps will be needed for drilling fluid and to control any excess groundwater that may be encountered. Three unlined holes approximately 1.5 deep by 2m wide by 3m long will be used.

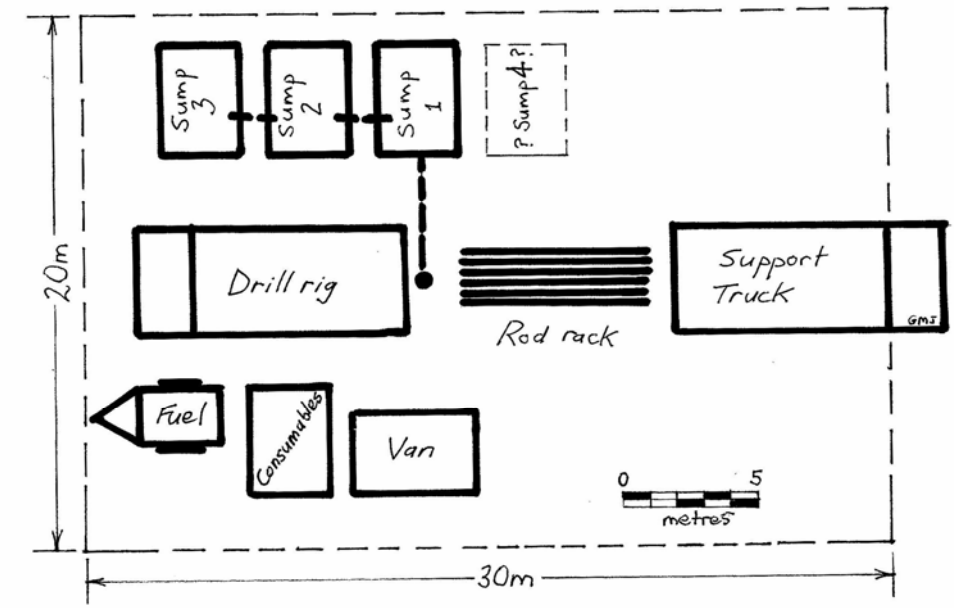

Figure 2: Typical site layout

Minimal earthworks are needed at the drill site – only sump excavation, the site is already clear and level. No soil will be imported to the site.

A very limited amount of fuel and chemicals will be held on site. These are likely to be stored in secure containers in a trailer or equivalent.

2.2.4 Accommodation

Accommodation for drill crews and Eden Energy personnel will be a combination of a towed on-site caravan located adjacent to the rig for active shift use and off-site formal accommodation at the Chowilla Shearing Shed quarters for off-shift accommodation. It is expected that four to six people will be on-site at various times during drilling.

2.2.5 Rubbish

Rubbish will be held on site in covered bins for later removal to disposal facilities (e.g. at Renmark or Berri). Some waste (e.g. drill cuttings and muds) will be buried in the drilling sumps.

2.2.6 Water supply

Water for drilling operations will either be obtained from a water well drilled on site (with appropriate approvals in place) or from the water reticulation system on Chowilla.

Drilling a temporary water supply hole on site is the preferred option. A bore will be drilled under DWLBC water bore permitting requirements (application in process).

If the Chowilla reticulation system is required, water would be preferably pumped through polypipe. The pipeline would be laid along existing corridors and best placement and extraction point would be decided upon in consultation with the pastoralist (discussions on this as a viable option have already occurred between the proponent and the pastoralist). In this case, an excavation may be required on site to hold the water. This would be approximately 5 m by 10 m and would be lined with polyethylene. This scenario would only occur should the proposed water bore fail to provide the expected water requirements. Notification of the need for the polypipe option would be provided to PIRSA should the need arise.

Potable water for personal use will be obtained from Chowilla Shearing Shed or from Renmark.

2.2.7 Responsibilities

Eden Energy's nominated representative(s) will be responsible for supervision of the initial site preparation, enforcement of vehicle movement limitations, cultural heritage issues, tidiness and cleanliness of the site and access, and supervision and documentation of remediation works. The drilling contractor will have responsibility for the actual drilling operation, reporting to Eden.

2.3 Transportation and other infrastructure

The proposed drilling does not require major road convoys or significant traffic movements.

Vehicular movements will use defined, pre-existing access. There will be no off track driving (short cuts etc) required nor permitted during this program. The rig and caravan moves in and out for the drill site would involve approximately four truckloads per move.

While drilling is underway, there would be daily movements of Eden Energy personnel from the accommodation at Chowilla Shearing Shed.

2.4 Downhole Temperature Logging

A suite of wireline logs including temperature will be collected downhole. The data will be collected both immediately following drilling and after 2-3 months when the downhole temperatures have equilibrated.

Logging will be from a light vehicle equipped with a winch & suitable logging tools.

2.5 Site Cleanup and Remediation

2.5.1 Suspension and abandonment

The present intention is to maintain the hole as an observation well for the immediate future, securely capped when not in use.

Following collection of all required data from the drill hole it is intended to abandon the hole in accordance with PIRSA requirements.

In summary, each aquifer will be separated by a cement grout plug and the hole will be backfilled to surface above the plugs. Alternatively, the entire hole will be cemented to the unconfined aquifer and then backfilled to surface.

The length of plug used will be dependent on aquifer pressure and thickness. The plug will extend through the aquifers back into the confining bed above, with a total minimum length of 20 m of grout. In an intermediate aquifer the plug should be emplaced from 15 m below the aquifer and extend upwards through the aquifer and to a distance of 15 m above the aquifer. Generally a minimum of 20m of cement should be positioned between aquifers.

Drill holes which penetrate artesian aquifers will be abandoned in such a way that the flow of water to surface or to other aquifers is prevented. The length of plug used to achieve this is dependent on the aquifer 'shut-in' pressure at surface. One metre of grout above top of aquifer will be used for every 7 kPa of head, with a minimum of 20 m of plug.

The top 0.5m of backfill will comprise native soil, and a soil mound will be left over the hole's position to allow for any subsidence.

Cement used for plugging or backfilling will be fresh, good quality cement and mixed as a neat slurry with not more than 30L of fresh water per 40 kilogram sack of cement, and be positively placed to reach the required position without contamination or dilution. Where approved, the expansion of standard grout by the addition of up to 10% API grade bentonite by weight of cement mixed with not more than 11 L of fresh water per kilogram of bentonite added may be used.

Grouting is achieved by pumping slurry of approved mix ratio and quality, through drill pipe or tremie line to the depth at which it is to be set. The equipment for mixing and placing grout must be adequate for the operation. The tremie line or grout pipe needs to be at the appropriate depth (i.e. at the bottom of the zone to be sealed) and drilling fluid or water pumped through it to ensure against any blockage, prior to the grout being pumped. It may be necessary to place a bridge plug or formation packer ahead of the grout to provide a seat for the plug. This can save large amounts of grout being lost to the formation. The chemical reactions that cause grout to set begin as soon as the slurry is prepared, so it is essential that the grout is emplaced while it is still fluid. The grout needs to be positioned in one continuous operation to provide an effective seal, and the bottom of the tremie line or grout pipe must remain below the surface of the slurry during grouting.

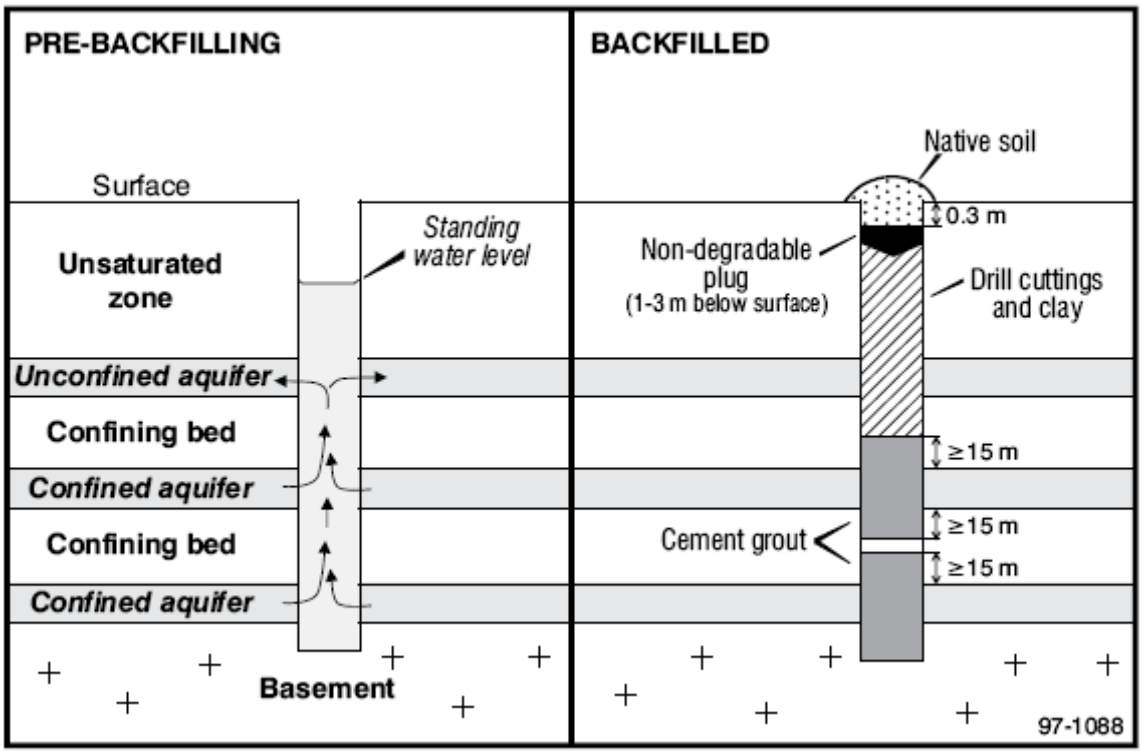

Figure 3: Backfilling of a drill hole penetrating multiple aquifers or artesian aquifers (arrows indicate flow direction)

Completion

The casing will be severed below ground level, and covered with a steel plate, to ensure maximum site safety and to allow future relocation with a metal detector.

2.5.2 Drill site

The sumps will be backfilled, but backfilling will be delayed until the sumps have largely dried. Stock will be excluded in the interim by temporary fencing. Soil originally from the sumps (which will be stockpiled separately from topsoil) will be used for backfill. Backfilling will be to slightly above original ground level, to allow for slumping.

All debris, including past drilling debris, will be removed to appropriate waste disposal or recycling.

Drill site will be scarified, and stockpiled and excess soil and plant debris loosely spread over the pad to speed natural revegetation.

2.5.3 Access

Access to the drill hole will be retained for the duration of the project, to allow its use as monitoring holes. In the event of the GEL areas being surrendered, the access will not be rehabilitated as it is an existing station track and will be retained for use in station management by the pastoral lessee.

3 Summary of Local Environment

The following section provides an overview of the environment within Eden Energy's Geothermal Exploration Licence area GEL175.

Information is also provided in this section on the environment in Eden's adjacent GEL176. Although the drilling location is within GEL175 and is not likely to have any direct effect on GEL176 (or on Calperum Station), many of the issues in the area (e.g. threatened species' habitat, impacts of fire) span across the GEL boundary and the environment of GEL176 is considered to be of some relevance.

Specific details relevant to the proposed drill hole location are provided in Section 4 of this document.

3.1 Climate

The region is characterised by hot, dry summers and mild winters. Rainfall is relatively low and predominantly occurs in winter and spring. Climate data for Renmark (Bureau of Meteorology 2007)) are provided in Table 1.

Table 1: Climate statistics for Renmark (site number 024016)

	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mean daily max. (°C)	32.5	32.1	28.8	24.2	19.7	16.8	16.2	18	20.9	24.4	27.8	30.3	24.3
Mean daily min. (°C)	16.7	16.6	14.2	10.8	8.2	5.9	5.1	6	8.2	10.7	13.2	15.1	10.9
Mean rainfall (mm)	15.8	19.3	14.1	18.2	24.8	24.6	23.1	25.3	28	28.3	21	18.2	259.2
Median monthly rainfall (mm)	8.9	7.6	8.4	12.3	18.5	21.2	20.2	22	22.1	21.8	14.8	11.9	252
Mean number of rain days (≥1 mm)	2.2	2	2	3.1	4.4	5	5.4	5.5	4.7	4.2	3.2	2.6	44.3

3.2 Land use

GEL 175 is wholly within Chowilla Regional Reserve. The adjacent GEL 176 lies across both Chowilla Regional Reserve and Calperum Station.

The principal land uses on Chowilla are pastoral grazing, conservation of natural and historic features and tourism. Tourist use of Chowilla is regarded as minimal and is confined mostly to recreational drivers using the main road through the reserve to Danggali Conservation Park, or on infrequent occasions as guests of the pastoral lessee or on a private tour of the property (DEH 2003). On the adjacent Calperum Station there is no pastoral activity and land use activities include conservation, tourism, education and recreation. Scientific research is also carried out, particularly on Calperum.

Both Chowilla and Calperum are part of the Riverland Biosphere Reserve (formerly Bookmark Biosphere). Further detail on Chowilla, Calperum and the Biosphere Reserve is provided below.

The closest town to the GELs is Renmark, which is located approximately 35 km south-west of GEL175 and 30 km south of GEL176 at the closest point. Renmark has a population of approximately 8,000 and is Australia's oldest irrigation settlement.

The GELs are within the South Australian Murray Darling Basin Natural Resources Management (NRM) Board region.

There is currently no registered native title claim over Chowilla Regional Reserve. Calperum Station is covered by the First People's of the River Murray & Mallee Region Native Title Claim (National Native Title Tribunal file no. SC98/3), which covers a large area of the Riverland.

Chowilla Regional Reserve

Chowilla Regional Reserve is jointly managed by the South Australian Department for Environment and Heritage and the lessees (Robertson Chowilla Pty Ltd). It was established as a reserve in 1993 and is managed under the *National Parks and Wildlife Act 1972*. Regional Reserves permit the utilisation of natural resources while conserving wildlife and natural or historic features of the land.

Calperum Station

Calperum Station is crown land owned by the SA Government, with the pastoral lease held by the Commonwealth Director of National Parks (i.e. the Commonwealth Department of the Environment and Water Resources) and is managed by the Australian Landscape Trust (ALT).

The Calperum pastoral lease management agreement framework is established in the Deed of Assignment between the Chicago Zoological Society and the Commonwealth. This trust provides for (among other uses) the use of the land for public education, as a model for the implementation of the UNESCO Biosphere Reserve Action Plan, from which interested and affected groups within the community (including recreational users, local government, pastoralists, miners, educators and health workers) can participate in and learn from a model programme for ecologically sustainable use of natural resources (TransGrid 2002).

Riverland Biosphere Reserve

The Riverland Biosphere Reserve is designated under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). It was formerly known as the Bookmark Biosphere Reserve, and includes Chowilla Regional Reserve, Calperum, Taylorville and Gluepot Stations (to the west of Chowilla), and Danggali Conservation Park (to the north of Chowilla).

Biosphere reserves are areas designated for inclusion in the World Network of Biosphere Reserves by the International Coordinating Council of the Man and the Biosphere (MAB) program of the United Nations Educational, Scientific and Cultural Organisation (UNESCO). Each biosphere reserve is intended to fulfil three complementary functions:

- a conservation function, to preserve genetic resources, species, ecosystems and landscapes
- a development function, to foster sustainable economic and human development
- a logistic support function, to support demonstration projects, environmental education and training, and research and monitoring related to local, national, and global, issues of conservation and sustainable development.

3.2.1 Roads and tracks

The closest main road to GEL175 is the unsealed Main Wentworth Road, which at its closest point is within 6 km of the southern boundary of GEL175 and 3 km of the southern boundary of GEL176. It is approximately 20 km south-east of the proposed drilling location.

A public access track crosses Chowilla and GEL175, travelling generally northwards from Main Wentworth Road to Hypurna (in Danggali Conservation Park). This forms the southern access to Danggali Conservation Park. There is a network of tracks throughout Chowilla Regional Reserve which are used for pastoral and reserve management but are not open to the public. A track network is also present in GEL176 on Calperum, although many of these have been closed in recent years. There is no public access across Calperum.

A number of old seismic lines also cross the region, although many of these are overgrown, particularly on Calperum Station.

3.3 Landform, soils and vegetation

3.3.1 Land systems

The project area is within the Murray Darling Depression IBRA region (Interim Biogeographic Regionalisation for Australia).

GEL 175 and 176 lie within the Canopus and Hypurna Environmental Associations (Laut *et al.* 1977). These cover 7490 km^2 and 340 km^2 respectively. Laut *et al.* (1977) characterise the landscapes in these environmental associations as:

- Canopus: a gently undulating plain with widespread easterly trending sand dunes and occasional claypans. Vegetative cover varies from mallee open scrub on the dunes and plains to low open bluebush shrubland on the pans.
- Hypurna: a very gently undulating alluvial plain with isolated areas of sand dunes. The alluvium has a vegetative cover of low woodland and the dunes have open mallee scrub.

Detailed land system descriptions were developed for the Chowilla Regional Reserve Management Plan (DENR 1995) and summarised in DEH (2003). These land systems have been incorporated into interim land system mapping across the state (DWLBC 2007). They are outlined in Table 2 and their locations are shown in Figure 4.

The mallee land systems of Lowan and Borehole are the most widespread across the GELs and are dominant in GEL176. A mosaic of all the listed land systems occurs on Chowilla in GEL175, with extensive areas of Sparks, Jack Halls and Hypurna occurring, particularly in the GELs eastern half.

Table 2: Land Systems in GEL175 and 176

Land System	Description (after DEH (2003) and DWLBC (2007))
Lowan	**Landform**: Sand dunes and narrow sandy swales. **Vegetation**: Mallee open scrub or low woodland. Beaked red mallee (*Eucalyptus socialis*) and grey mallee (*E. dumosa*) on lower dunes and sandy swales, ridge-fruited mallee (*E. incrassata)* on deeper sands. Wider interdune swales with red and white mallee (*E. oleosa* and *E. gracilis*) with sugarwood (*Myoporum platycarpum*) and bullock bush (*Alectryon oleifolius* ssp. *canescens*). Wide variety of shrub species including comb grevillea (*Grevillea huegelii*), spiny bitter-pea (*Daviesia benthamii* ssp *benthamii*), smooth wallaby bush (*Beyeria opaca*), narrow-leaved hopbush (*Dodonaea viscos*a ssp *angustissima*) and cassias (*Senna* spp.). Low shrubs such as shrubby pepper-cress (*Lepidium leptopetalum*), spiny goosefoot (*Rhagodia ulicina*) and bitter saltbush (*Atriplex stipitata*) are often found in dense stands on interdune swales. Porcupine grass (*Triodia scariosa*) on deeper sand dunes.
Bore Hole	As for Lowan land system, but sand dunes tend to be widely spaced and soils found on swales are usually sandy loams rather than sands.
Nanyah	**Landform**: Undulating sand plains **Vegetation**: Mallee woodland with black oak (*Casuarina cristata*) over spinebush (*Acacia nyssophila*), scotia bush (*Eremophila scoparia*), cassia, bluebush (*Maireana* spp.) and daisybush (*Olearia* spp.); flats and swamps of dense black oak woodland over nitrebush (*Nitraria billardierei)*, Australian boxthorn (*Lycium australe*) and spotted emubush (*Eremophila maculata* var *maculata*). Sandy rises with mallee over spinifex or mallee with tall shrubland.
Hypurna	**Landform**: Calcareous sandy plains. **Vegetation**: Black oak woodland with bullock bush and sugarwood. Diverse mix of shrub species including cassia species, thorny saltbush (*Rhagodia spinescens*), spiny fanflower (*Scaevola spinescens*), tarbush (*Eremophila glabra*) and pearl bluebush (*Maireana sedifolia*).

Land System	Description (after DEH (2003) and DWLBC (2007))
Sparks	**Landform**: Open plains and scattered low dunes. **Vegetation**: Scattered sugarwood and groves of bullock bush, with black oak, narrow-leaved hop bush (*Dodonaea viscosa* ssp. *angustissima*), and turpentine bush (*Eremophila sturtii*) common on low dunes. Largely annual ground storey vegetation with speargrass (*Austrostipa* sp.) and wallaby grass (*Austrodanthonia caespitosa)* forming dense stands after winter rains and scattered bitter saltbush, occasionally in dense stands, on calcareous loam soils of open plains
Jack Halls	**Landform**: Calcareous undulating plains and run-on depressions. **Vegetation**: Chenopod shrubland, typically low open-shrubland of pearl bluebush with other species including blackbush (*Maireana pyramidata*) and thorny saltbush. Overstorey limited to scattered sugarwood or groves of black oak.

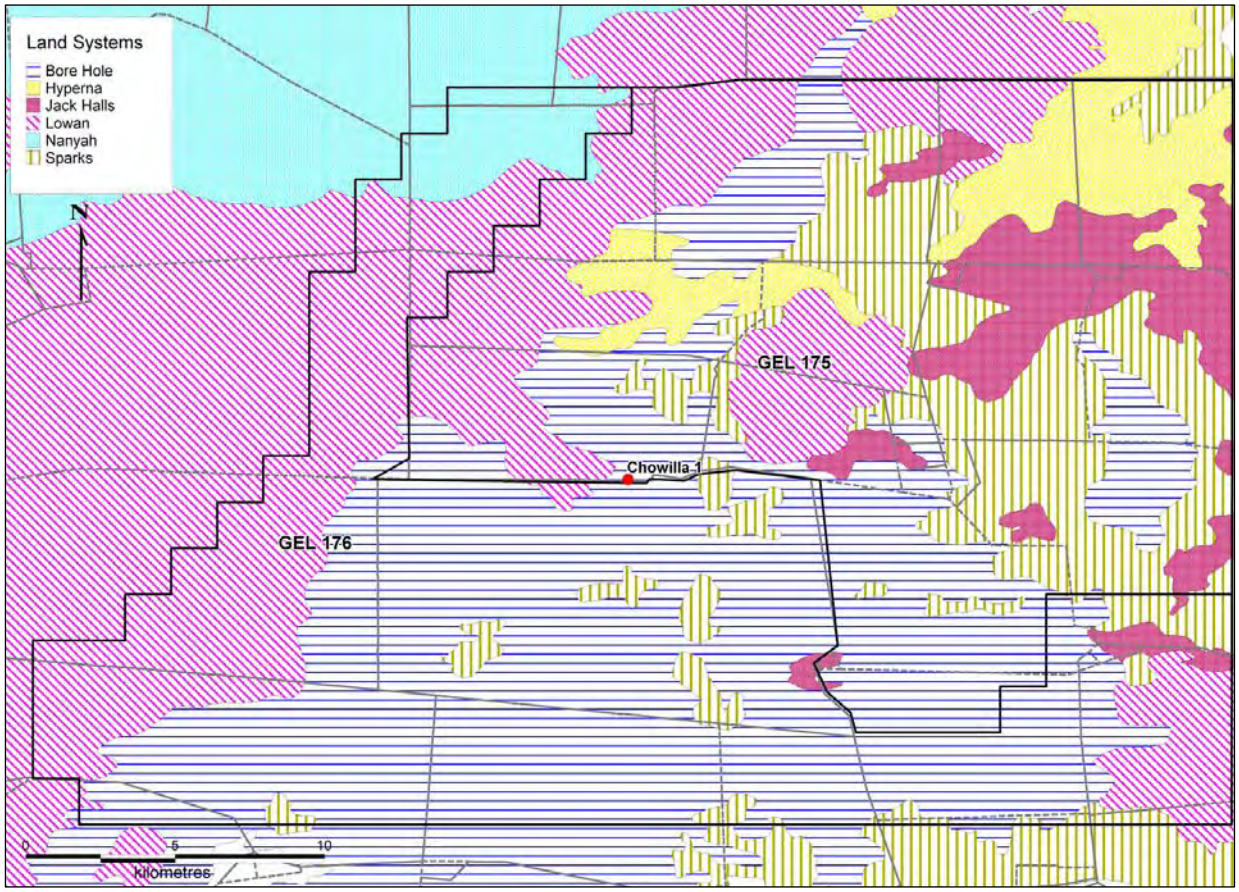

Figure 4: Land Systems in GEL175 and GEL176

3.3.2 Vegetation Condition and Significance

Chowilla has been grazed for over 120 years, and much of it has been subject to high grazing pressure (DEH 2003) and moderate to high levels of disturbance from continued grazing by stock, as well as goats, rabbits and kangaroos. Areas in close proximity to water sources in particular are quite degraded. Based on proximity to water sources, 55% of Chowilla Regional Reserve is subject to high or extreme grazing intensity. None of the reserve is ungrazed by stock and only 14% is subject to low grazing intensity (i.e. is more than 5 km from water) (DEH 2003).

The adjacent Calperum Station has not been grazed by stock since 1993 and vegetation is in much better condition than Chowilla Regional Reserve. East of the pipeline track (which passes generally north from Long Dam on the southern boundary of GEL176 to Canopus homestead on Danggali

Conservation Park) there are more tracks and dams and past grazing pressure may have been heavier than to the west of the track.

In general, the vegetation communities present are common and widespread. Kahrimanis *et al.* (2001) lists three threatened plant communities for the Riverland Biosphere area: *Eucalyptus cyanophylla* Open mallee, *Chenopodium nitrariaceum* Low shrubland and *Eragrostis australasica* Grassland, which are all limited in extent.

Although the vast majority of vegetation communities present are not listed as threatened, they are significant because they comprise a very large tract of old-growth vegetation (mainly mallee), which supports a number of rare and threatened species. Of particular note is that Calperum Station (along with neighbouring Gluepot Reserve and Taylorville Station) has been listed as critical habitat for the endangered Black-eared Miner under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*.

Much of the vegetation on Chowilla Regional Reserve (particularly the eastern half) could be considered to have lower conservation significance, as it is subject to high grazing pressure and much of it is not mallee (i.e. is not suitable habitat for the Black-eared Miner and many of the other threatened bird species in the region). There are some areas of mallee on Chowilla Regional Reserve that could support populations of the Black-eared Miner (e.g. in the north-west) but no studies have been carried out to confirm this (DEH 2003).

3.3.3 Fauna

The region, particularly the areas of old-growth mallee, supports a diverse array of bird species. Although no studies specific to Chowilla Regional Reserve have been carried out, around 200 species have been recorded in the adjacent Game Reserve. Around 20 of these are regarded as rare, vulnerable or endangered in South Australia (DEH 2003) and many of these (excluding those relying on close proximity to water) could be expected to occur in the Regional Reserve (DEH 2003). Approximately thirty rare or threatened bird species have been recorded within the broader region. Threatened birds are discussed further in section 3.4.1.

Terrestrial vertebrates present in the region include Red and Western Grey Kangaroos, small mammals such as Fat-tailed and Common Dunnarts, Southern Ningaui, Little Pied Bat and Greater Long-eared Bat. Both bat species are rated as vulnerable at state level. Introduced mammals present include house mice, rabbits, brown hares, foxes, cats and feral goats (which are increasing on Chowilla and contributing to overall grazing pressure; DEH 2003). A diverse reptile fauna is also present, with over 30 species expected to occur (DEH 2003).

3.4 Biophysical significance and sensitivity

There are a number of issues relevant to GEL175 and the broader region, including the presence of rare or threatened species. These are discussed in this section. However, it is noted that the site proposed for drilling has been selected to avoid most of these issues completely, as discussed in Section 4 and Section 5.

3.4.1 Rare or threatened species

Flora

No rare or threatened flora have been recorded within GELs 175 and 176 on DEH biological databases (DEH 2007). Two plant species of state conservation significance have been identified as occurring on Chowilla Regional Reserve (DEH 2003): Black Cotton-bush (*Maireana decalvans*) which is classed as Endangered in the state and the regionally Vulnerable Silky-head Lemon-grass (*Cymbopogon obtectus*).

A number of rare or threatened species have been recorded in the broader region and these species are listed in Appendix A. Threatened (i.e. Vulnerable or Endangered) plant species that are recorded in DEH biological databases (DEH 2007) at locations within 40 km of GELs 175 and 176 are discussed in Table 3. Many of these records are associated with the River Murray and are not likely to occur away from the river.

Table 3: **Threatened plant species recorded in the vicinity of the GELs**

Species	Common Name	Cwlth Status*	SA Status*	Likely in GELs	Comment
Acacia pendula	Weeping Myall		V	?	Occurs in river floodplains and on heavy clay soils (Cunningham *et al.* 1992). Two database records: south of GELs in Murray R. floodplain and on Danggali CP to the north of the GELs.
Acanthocladium dockeri	Spiny Everlasting	CE	E	-	Believed to be extinct from the region. Now known only from grasslands in the mid-north of SA (DEH 2005). Historic record (1910) near Murray R. at Overland Corner, 40 km SW of GELs.
Adiantum capillus-veneris	Dainty Maiden-hair		V	-	Fern associated with Murray R. Records are in near river areas
Austrostipa pilata	Prickly Spear-grass		V	-	One record near Murray R. and Vic. Border.
Callitriche umbonata	Water Starwort		V	-	Amphibious plant associated with Murray R. Records are in near river areas
Cuscuta tasmanica	Tasmanian Dodder		V	-	One historic record (1910) near Murray R. and Vic. Border.
Dianella porracea	Pale Flax-lily		V	?	Records are in near river areas.
Lepidium pseudotasmanicum	Shade Peppercress		V	?	Records are in near river areas
Maireana decalvans	Black Cotton-bush		E	?	Found in heavy clays that are seasonally waterlogged and/or in grasslands, bladder saltbush and open woodland communities (DEH 2003). Three database records: one south of GELs near Murray R. and two on Danggali CP to the north of the GELs.
Myriophyllum crispatum	Upright Milfoil		V	-	Aquatic plant associated with Murray R. Records are in near river areas
Ranunculus sessiliflorus var. *pilulifer*	Annual Buttercup		V	-	Habitat: "moist situations on a variety of soils" (Cunningham *et al.* 1992). One record (1990) near river / Overland Corner.

*Conservation status: CE – Critically Endangered, E – Endangered, V – Vulnerable

The EPBC Act on-line database predicted that three nationally Vulnerable species may be present in the region: *Solanum karsense* (Menindee Nightshade), *Austrostipa nullanulla* (Club Spear-grass) and *Swainsona pyrophila* (Yellow Swainson-pea). These three species are all very unlikely to be present. Menindee Nightshade and Club Spear-grass have not been recorded in the search area for the DEH biological database search (which was a rectangle 50 km from the boundaries of the GELs). The only record for Yellow Swainson-pea in DEH databases in the search area is 50 km south-west of GEL176 and its habitat (gypseous lunettes and kopi rises) is not present in the GELs.

Fauna

There are a number of vertebrate species known or likely to be present on Chowilla or Calperum that are threatened at the national level. These include the endangered Black-eared Miner (*Manorina melanotis*), the Red-lored Whistler (*Pachycephala rufogularis*), Malleefowl (*Leipoa ocellata*), Regent Parrot (*Polytelis anthopeplus*) and Greater Long-eared Bat (*Nyctophilus timoriensis*). These species inhabit the large tracts of intact vegetation in the area, particularly the old-growth mallee woodland. Further information on these species is provided in Table 4.

More than forty vertebrate species that are rare or threatened at state level occur in the region (DEH 2003, DEH-Cwlth 2006b, Baker-Gabb 2003, DEH 2007) including:

- Birds such as the Vulnerable species Blue-winged Parrot (*Neophema chrysostoma*), Major Mitchell's Cockatoo (*Cacatua leadbeateri*), Striated Grasswren (*Amytornis striatus*), Chestnut Quail-thrush (*Cinclosoma castanotus*), Crested Shrike Tit (*Falcunculus frontatus*), Black-chinned Honeyeater (*Melithreptus gularis*), Diamond Firetail (*Stagonopleura guttata*) and Painted Button Quail (*Turnix varia*) and a number of Rare species
- The Vulnerable Little Pied Bat (*Chalinolobus picatus*)
- Reptiles including the Rare Olive Snake Lizard (*Delma inornata*) and the Rare snakes Bandy-bandy (*Vermicella annulata*) and Bardick (*Echiopsis curta*)
- A number of species more closely associated with river and wetland habitats (and therefore not likely to occur in the GELs) such as the magpie goose (*Anseranus semipalmata*), Freckled Duck (*Stictonetta naevosa*), Australasian Bittern (*Botaurus poiciloptilus*), White-bellied Sea-eagle (*Haliaeetus leucogaster*), Latham's Snipe (*Gallinago hardwickii*) and Broad-shelled Tortoise (*Chelodina expansa*).

Appendix A lists all threatened fauna species that are recorded in DEH biological databases (DEH 2007) at locations within 40 km of GELs 175 and 176.

Table 4: **Nationally threatened fauna species recorded in the vicinity of the GELs**

Species	Cwlth Status*	SA Status*	Database Records in GELs	Comment
Birds				
Leipoa ocellata (Malleefowl)	V, M	V	✓	Widely distributed across Calperum and Chowilla in mallee.
Manorina melanotis (Black-eared Miner)	E, M	E	✓	Known colonies on Calperum in old-growth mallee. No records on Chowilla.
Pachycephala rufogularis (Red-lored Whistler)	V	V	-	Wide-ranging and mobile species that inhabits mallee woodland (DEH 2006a). Numerous records on Calperum west (and some south) of GEL176
Polytelis anthopeplus monarchoides (Regent Parrot (eastern))	V	V	-	Nests in large trees near river, forages in mallee (DEH 2006b). Numerous records to the west of GEL176 on Calperum and to the south associated with the Murray R.
Mammals				
Nyctophilus timoriensis (South-eastern form) (Eastern Long-eared Bat)	V	V	-	Roosts in tree hollows and under loose bark (Strahan 1998). Threatened by the destruction of roosting sites, particularly old-growth trees (DEH 2003). Scattered records in Calperum and Danggali CP, expected but not confirmed in Chowilla (DEH 2003).

*Conservation status: E – Endangered, V – Vulnerable. M – listed as migratory species.

Black-eared Miner

The nationally endangered Black-eared Miner (*Manorina melanotis*) is a key threatened species in the region. Some of the largest known populations of this species occur on Calperum and neighbouring stations to the west and they constitute more than 80% of the known colonies of this species (DEH-C'wlth 2006b). The species has not been recorded on Chowilla, although suitable habitat occurs in the north-west (DEH 2003). Known colonies are present within GEL176 on Calperum in the south west corner of GEL 176 (Baker-Gabb 2003, DEH 2007). One colony has also been reported just north of the GELs, on the boundary between Calperum and Chowilla (Baker-Gabb 2003).

The Black-eared Miner is dependent on old growth mallee that has been unburnt for more than 40 years, although younger mallee may provide occasional foraging habitat (Baker-Gabb 2003). Threats to the species include habitat clearing and fragmentation, habitat degradation by grazing, hybridisation with Yellow-throated Miners and fire (and consequent loss of old-growth mallee habitat).

Habitat fragmentation by clearing or degradation by grazing and the introduction of permanent water sources is a major concern (Baker-Gabb 2003). Such actions not only result in a loss of habitat, but such disturbances (particularly creation of permanent water) create habitats suitable for the Yellow-throated Miner. This in turn promotes hybridisation and loss of genetically "pure" Black-eared Miner populations. Fire is also a major concern as a very large fire could wipe out most of the species' habitat.

Calperum Station, along with neighbouring Gluepot Reserve and Taylorville Station has been declared as critical habitat for the Black-eared Miner under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, as discussed in section 3.4.2.

3.4.2 EPBC Act matters

The GELs encompass a number of matters protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Results of an online database search (DEH-Cwlth 2006) for a rectangle including all of GEL175 and 176 returned the following matters relevant to the GELs:

- Threatened Species: see discussion above
- Commonwealth Lands: Calperum Station
- Commonwealth Heritage Places: Calperum Station
- Places on the Register of the National Estate: Calperum Station and Bookmark Block
- Critical Habitat: Calperum Station as Black-eared Miner habitat.

These are discussed further below.

Several additional EPBC Act matters that are outside the GELs and would not be affected by geothermal exploration activity within the GELs were also returned by the online search, including:

- Ramsar wetlands associated with the River Murray
- Threatened Ecological Community - Buloke Woodlands of the Riverina and Murray-Darling Depression Bioregions (not present in the GELs).
- Several threatened species and listed marine or migratory species that have not been recorded within the region and/or rely on habitats (e.g. riverine habitats) not present within the GELs.

Critical habitat

Calperum Station (north and west of Main Wentworth Road), along with Gluepot Reserve and Taylorville Station have been declared under the EPBC Act as critical habitat for the Black-eared Miner. The critical habitat register entry states that:

- Current and future actions within the listed properties should be undertaken in a way that will not significantly damage Critical Habitat for the Black-eared Miner.

- Whether or not an action is likely to significantly damage critical habitat will depend on the nature and magnitude of potential impacts as well as the particular area of the mosaic in which the action will occur. In general, actions are more likely to lead to significant damage if they occur within the most important areas of open mallee bushland. Actions within disturbed areas of the properties of little or no direct relevance to the survival of the species would generally be unlikely to cause significant damage to critical habitat.

Other Matters

Calperum Station is Commonwealth land as it leased to the Commonwealth. It is also listed as a Commonwealth Heritage Place and on the Register of the National Estate (RNE) in its own right and as part of the Bookmark Block. Any actions taken on Calperum that are likely to have a significant impact on the environment would require Commonwealth approval under the EPBC Act.

EPBC Act referral and approval

If a project is likely to impact matters of "national environmental significance" it must be referred under the EPBC Act for a determination as to whether it requires approval. In the context of geothermal exploration, a proposal would require approval if it is likely to:

- significantly impact a threatened species on Chowilla or Calperum
- adversely effect Black-eared Miner critical habitat on Calperum
- significantly impact the environment on Calperum (as it is Commonwealth land, is listed as a Commonwealth Heritage Place and is listed on the RNE).

Eden Energy has undertaken an assessment of the proposed drilling in GEL175 and, given that it is located on Chowilla in an area of very open chenopod shrubland and is unlikely to impact any listed threatened species (see Section 5.2), is of the opinion that it will not adversely affect matters of "national environmental significance" and will not require Commonwealth approval.

3.5 Water

3.5.1 Surface Water

There are few natural surface water features in the GELs. There are no defined drainage channels. In most land systems there is little or no runoff, and rainfall either infiltrates or results in localised pooling when infiltration rates are exceeded. In some land systems (e.g. Nanyah) flats and swamps receive localised runoff.

Permanent stock water points on Chowilla are provided by a network of concrete tanks feeding 51 water troughs through a pipeline system over 200 km in length. There are also some 15 dams present, of various sizes and ability to catch and hold water (DEH 2003). Strategic closure of water sources on Calperum has been carried out over recent years to reduce their impact.

3.5.2 Groundwater

The GELs lie within the Murray Basin, which is a saucer shaped Tertiary basin covering an area of 300 000 km^2 which extends approximately 850 km east to west and 750 km north to south. The majority of the western Murray Basin is shallow but the basin deepens towards the tri-state corner (and the area of the GELs) where two deep northeast trending troughs (Renmark and Tararra) are located (Rammers *et al.* 2005).

The aquifers likely to be encountered in the GELs during drilling to the depths described in this EIR are in the Tertiary sequence of the Murray Basin. The Tertiary can be split into three phases (Rammers *et al.* 2005):

- Pliocene Marine to fresh water silts and sands (Bookpurnong beds and Loxton sands)

- Marine Limestone of Oligocene to Miocene age (Ettrick Formation, Gambier Limestone, Mannum Formation, Morgan Limestone and Pata Limestone).
- Predominantly freshwater Paleocene to Eocene sands (Renmark Beds).

The depth to the basal unit of the Renmark Group (the Warina formation) ranges from 235 to 511 m below ground surface in the Renmark region (Rammers *et al.* 2005). Information on these Tertiary aquifers is sparse and there is no well information north of Renmark (Rammers *et al.* 2005).

3.6 Heritage

Many Aboriginal heritage sites are known near the Murray River. DEH (2003) reports that limited detailed Aboriginal heritage survey work has been undertaken on Chowilla Regional Reserve and no sites have been identified or recorded on Chowilla. However, it is considered that there is a strong likelihood of sites such as stone artefact scatters and hearths occurring, particularly on dune crests near ephemeral water sources such as soaks or swamps (DEH 2003).

Non-indigenous heritage features and structures present in the region are derived from colonial exploration, settlement and pastoral occupation (DEH 2003). Features located on Chowilla include a wool shed and associated yards, shearers quarters, the Paradise Out-station building, fence lines and pipelines with water tanks (DEH 2003).

4 Description of Drilling Site and Access

4.1 Drill site

The drill site is located in South Borehole Paddock in the western part of Chowilla Regional Reserve, approximately 100m from the fence-line of the southern boundary with Calperum. Photographs of the site are shown in Plate 2.

4.1.1 Topography, Soils and Drainage

The site is located on almost level ground. There is a very slight slope away from the drill site to the south and east. A low sandy rise is present north-west of the site. Soils at the site are a red sandy clay loam.

There are no drainage features present at the site. Several shallow depressions approximately 30 cm deep and 10-20m in diameter are present 100 – 200 m to the east of the site. These would pond local drainage for short periods after rainfall.

Plate 2: Proposed drill site, facing (clockwise from top left): north, east, south and west

4.1.2 Vegetation

The site is located in the Borehole land system, in an area of low discontinuous sand dunes where the three main vegetation types are mallee over shrub, mallee over *Triodia* and chenopod shrubland.

The site is located in chenopod shrubland, which occurs in areas clear of mallee such as the area surrounding the site. Common chenopods in this shrubland include *Maireana eriocladа, M. brevifolia, M. pentatropis, Atriplex stipitata, Enchylaena tomentosa, Sclerolaena obliquicuspis, Eriochiton sclerolaenoides, and Chenopodium desertorium*. At the site itself, the following species were recorded:

- Shrubs: *Enchylaena tomentosa, Sclerolaena obliquicuspis, Atriplex stipitata, Senna artemisiodes filifolia, Chenopodium desertorum* subsp.
- Herbaceous species: *Oxalis perennans, Calotis cuneifolia, Brachyscome lineariloba?, Senecio* spp.

The predominant vegetation type in the broader area is mallee (*Eucalyptus dumosa* and *E. socialis* on low dunes and sandy swales, *E. oleosa* and *E. gracilis* with *Myoporum platycarpum* and *Alectryon oleifolius* on wider swales and *E. incrassata* on dune crests) over understorey shrubs including *Zygophyllum apiculatum, Z. aurantiacum, Eremophila glabra, E. scoparia, Westringia rigida, Dodonaea viscosa, Senna artemisioides, Acacia ligulata, A. nyssophylla, A. colletioides, Grevillea huegelli, Beyeria lechenaultii and B. opaca* and with *Triodia irritans* complex in deeper sand on dune slopes.

No rare or threatened plant species or plant population of notable importance were located at the proposed drilling site during an inspection carried out by Stephen Milne and Alex Coombe in July 2007.

4.1.3 Fauna

The site does not represent unusual or significant habitat, and is not likely to be of importance to any of the rare or threatened fauna species discussed in Section 3.4.1.

In particular, the site is outside the known range of the Black-eared Miner in the area, and is not located in its habitat type (mallee woodland). Therefore, this species is not likely to occur at or near the site. Other threatened species dependent on mallee (e.g. Malleefowl, Red-lored Whistler, Eastern Long-eared Bat) could potentially occur in the vicinity, however the site does not represent suitable (or important) habitat for these species.

4.1.4 Land Use

The area is used for livestock (sheep) grazing. The site shows evidence of grazing and sheep trails but is not in close proximity to any watering points.

There are no residences near the site – the closest house is the Pepper Tree Motel Outstation, which located 5 km to the north on Chowilla and is unoccupied. The Chowilla homestead is approximately 30 km south of the site.

The site is not in an area that is likely to be visited by tourists or the general public.

4.1.5 Heritage

The landform in which the site is located is not one that is typically considered as being of high sensitivity for Aboriginal heritage. No evidence of Aboriginal heritage material was noted during the site inspections. It is considered unlikely that any sites of Aboriginal heritage significance will be affected by the proposed drilling. However, Eden plans to consult the Riverland Aboriginal

Community Heritage Association and plans to carry out an inspection of the site (subject to agreement between the parties) to confirm that there will be no impacts to Aboriginal heritage significance.

There are no sites of European heritage at or near the drill site.

4.2 Access

As described in Section 2.1.2, the site will be accessed by diverting off the north-south public access road at the Chowilla shearing shed turnoff, and following station tracks for approximately 10 km westwards to the site.

The station tracks that will be used to access the site predominantly traverse mallee. They have been previously cleared and graded, but in some places shrubs have regrown on the track. While still navigable with a four-wheel drive, vegetation growing on the tracks will need to be cleared in these areas to allow truck access to the site. Plate 3 shows examples of the condition of the existing tracks.

The shrubs that have regenerated on the track and will require clearing are predominantly Cassia (*Senna artemisioides*) with some Narrow-leaved Hopbush (*Dodonaea viscosa*). These are very common and are regarded as 'increaser species' which tend to increase in numbers in response to disturbance such as track building and grazing. Some mallee eucalypts have also grown branches and trunks that overhang the track. These branches will also need to be lopped (using chainsaws where possible) to allow access. No tree hollows or other significant habitat features were noted in these overhanging branches.

Plate 3: Examples of station tracks showing occasional overhanging mallee and areas of dense shrub regrowth

5 Environmental Risks and Management

The overall level of environmental risk posed by the drilling operation is considered to be low. The following sections provide a brief discussion of key environmental risks and management strategies.

Table 5 contains a summary of possible risks and their management in relation to the environmental objectives for the drilling operation (as defined by the SEO).

5.1 Downhole risks

Contamination of aquifers and cross-aquifer contamination can occur in a drilled hole. As indicated in section 2.2.1, the well design has been developed in consultation with DWLBC drilling personnel to manage the groundwater issues of the region. The three aquifer zones of the Murray basin will be drilled, cased and cemented separately to isolate and so prevent aquifer contamination and cross-flow. Muds used will be non-toxic, and will comply with onshore drilling standards.

5.2 Risks to the biophysical environment

5.2.1 Drainage and soils

There are no significant drainage features at the drill site or on the access tracks to be used and thus the proposed drilling represents minimal risk to surface drainage.

Minimal earthworks will be required for drill site preparation and the site will be reinstated following completion. There is a risk that soil profiles at the site could be altered, inhibiting regeneration. However, respreading of stockpiled topsoil and vegetation over the backfilled sumps will minimise this risk. Compacted areas will be lightly ripped where necessary.

Fuel and chemicals used at the site represent a risk of soil contamination if improperly handled and stored. Leaking fuel and hydraulic hoses also represent a soil contamination risk. Appropriate handling and storage of these materials and inspection and maintenance of equipment will ensure that these risks are minimised. If a spill were to occur, it would be cleaned up and given the nature of the terrain and drainage, would be unlikely to result in significant or widespread effects.

The adoption of safe driving practices, including low speeds and no off track driving, will also help prevent impacts to the soils or drainage of the area.

5.2.2 Flora and fauna

The principal risks to flora and fauna posed by drilling activities relate to the clearance of vegetation for access tracks and drill sites, vehicle movements on tracks, disturbance due to noise and habitat degradation by wildfire.

The drilling site has been selected in an area with low, open vegetation and no trees present, and the access track is an existing station track (albeit requiring some maintenance). Consequently, very little vegetation clearance is required for the proposed drilling site or access. Access to the drill site along the existing tracks will be undertaken at speeds appropriate to minimise the risk of impacts to fauna from vehicle movements.

In addition to being very limited in area, the vegetation that is proposed to be cleared does not constitute significant habitat. It is not likely to support or be important to any of the rare or threatened plant or animal species in the region. In particular, there will be no new clearance of mallee, which may provide habitat to a number of threatened bird species. Although the station track will be re-cleared where it is overgrown, this will not create significant habitat fragmentation. Even bird species

that are sensitive to clearance of wide easements (such as the endangered Black-eared Miner) are not thought to be threatened by fire access tracks approximately 5m wide (Baker-Gabb 2003).

The noise from drilling may disturb fauna in the vicinity (e.g. within a few hundred metres of the site). However, the area of potential impact is a very small proportion of the available habitat in the area, and drilling will only occur for a short period of time. Consequently, no significant impact is expected as a result of disturbance or temporary displacement of fauna. It is noted that there are no records of the endangered Black-eared Miner near the site and no known colonies in the area.

Wildfire from drilling has the potential to cause significant impact to large areas of mallee habitat and therefore impact numerous rare or threatened species. Consequently, fire prevention measures will be required to ensure that this does not occur. The fuel loads at the site are unlikely to be able to support a wildfire, however site preparation will ensure that it is clear of flammable material. Similarly, preparation of the access will ensure that flammable material is cleared off the track. Fire control equipment appropriate to the season and weather conditions will be present on site during drilling. The pastoral lessee and DEH will be consulted regarding fire management if drilling occurs during the fire danger season. Requirements of the *Fire and Emergency Services Act 2005* will be complied with.

5.3 Risks to the cultural environment

Risks posed to Aboriginal cultural heritage by drilling mainly concern the potential for damage to sites in the creation of access and the drilling pads. In this case, the access already exists, and the drill pad is not in an area of heritage sensitivity, as discussed in Section 3.6. As a consequence, the proposed drilling poses no significant risk to Aboriginal cultural heritage. There will be no off track driving permitted.

The activities pose no risk to non-indigenous cultural aspects.

5.4 Risks to landholders and the community

There will be a very small incremental impact on public roads, primarily due to movement of personnel on a daily basis and rig moves in and out. Most personnel moves will be confined to tracks that are not used by the public. The station track used for access will be repaired before the start of drilling and is expected to be in a better condition following drilling than it is currently. Any station road damage will be made good.

Discussions have been held with the pastoral lessee regarding drilling, and the program has been planned to minimise disturbance to station operations. Drilling will be carried out after shearing, to avoid disruption to shearing.

All access surfaces will generate some dust. Dusting will be of relatively short-term duration. The adoption of safe driving practices and including low vehicle speeds along access tracks will also go someway to ameliorating the impacts associated with dust generation.

The proposed drilling will not have a significant impact on the conservation values of Chowilla Regional Reserve or the Riverland Biosphere, primarily due to the selection of a site where impacts are not significant and the use of existing station tracks for access.

5.5 Summary of risks, management and environmental objectives

A Statement of Environmental Objectives has been developed in conjunction with this EIR. Table 5 provides a summary of possible risks and their management in relation to the environmental objectives for the drilling operation (as defined by the SEO).

Table 5: Risks, impacts and management in relation to environmental objectives

Environmental objective	Main sources of risk	Possible impact	Avoidance, management, mitigation
1. Avoid disturbance to sites of Aboriginal and non-indigenous heritage significance	Access and pad construction, vehicle and people movement	Intrusion or physical site damage to areas of Aboriginal and European heritage significance	Access uses existing station tracks; minimal pad construction. Unlikely that any sites of Aboriginal heritage significance will be affected by the proposed drilling - landform is not typically considered as being of high sensitivity for Aboriginal heritage and no evidence of Aboriginal heritage material was noted during the site inspections. Riverland Aboriginal Community Heritage Association are planned to be consulted and an inspection of the site is planned (subject to agreement between the parties) to confirm that there will be no impacts to Aboriginal heritage significance. Control of vehicle and personnel movement off drill site and defined access. No sites of significant non-indigenous heritage near drilling site.
2. Minimise disturbance to native vegetation and native fauna	Access and pad construction; fires	Direct physical impact on high biological or wilderness value areas; fires started at pad	Site is grazed, open chenopod shrubland on an active pastoral lease and is not a high biological or wilderness value area. Fire fighting equipment appropriate to the season and conditions available on site. Emergency response plan in place. Fire inductions. Fuel loads at drill site not sufficient to support a wildfire. Site will be kept clear of flammable material. Consultation with DEH if drilling carried out in fire danger period. Compliance with *Fire and Emergency Services Act 2005.*
	Access and pad construction or upgrade; fires	Physical damage to soils, vegetation and habitat; wildfire	Existing tracks and other roads used to minimise impact. Drill pad and shrub regrowth on access will require minimal clearing. Consideration will be given to adopting methods to minimise disturbance along access tracks (e.g. rolling or use of a raised blade to flatten any vegetation rather than grading the full track width). Subsequent rehabilitation of pad can speed revegetation. Surface soil and debris will be stockpiled from scraped areas (sumps, pits) for later use in rehabilitation. Post-operations rehabilitation works at drill site. See procedures to limit risks of fires above.
	Access and pad construction	Impact to or physical removal of rare, vulnerable or endangered species	No rare or threatened plant species detected at site or recorded in vicinity. Minimal vegetation clearance and location of site in open area will result in no significant habitat disturbance for rare or threatened fauna species. Some threatened bird species may occur in the vicinity but the site does not represent habitat of significance / importance. Many species of significance are less common on Chowilla or not

Environmental objective	Main sources of risk	Possible impact	Avoidance, management, mitigation
			present compared to the adjacent Calperum. Noise may cause some short term disturbance to fauna but will affect an insignificant proportion of available habitat. Conduct of activities in accordance with requirements for operating in a Regional Reserve: no domestic pets or firearms to be brought into the reserve, no collection of firewood from within the reserve, no removal of flora or fauna without a permit, managing injured fauna or relocating fauna to be done in consultation with the District Ranger, and appropriate speeds along tracks to be observed.
3. Prevent the introduction or spread of weeds and undertake control measures where required	Importation of pest plants on vehicles or machinery	Establishment of further alien species in the locality	Requirement for contractor/other vehicles to be clean prior to entering district. Wash downs required where vehicles or equipment are coming from an area of known weed infestation. Alien introduction due to drilling operation is a low incremental risk, given the long-term pastoral use of the region.
4. Minimise impacts to soil	Access and pad construction	Accelerated soil erosion Soil compaction or inversion resulting in poor regeneration of vegetation Visual impact of pad construction	Vehicle movements are relatively light (road truck-mounted drilling rigs) and will utilise existing tracks. Clearing of vegetation regrowth will be required and tracks may be re-graded in some areas where sandy conditions may cause difficulties for road trucks. The site will need some minor clearing of native shrubs. Later rehabilitation of the drill pad will be undertaken, but station access track will be left in place. The size of the drill site will be minimised. Where excavations are required (e.g. sumps) surface scrapings of soil and plant material will be stockpiled for later re-spreading. Following drilling, rehabilitation (e.g. light scarification) of wheel marks and scraped areas will be undertaken. The sumps will be allowed to dry following completion of drilling and will then be filled in. The construction of the sump will leave a shallow ramp into the sump to provide escape for any fauna which may fall into the sumps. Movement on tracks and surfaces will not be undertaken under wet conditions to avoid bogging and deep rutting. If any borrow is needed it will be taken from existing pits.
	Escape of drilling muds from sumps	Impaired regeneration of vegetation Visual impact	Sumps to have sufficient capacity to hold muds and cuttings If sumps overflow, light scarification and respreading of cleared vegetation to blend site with surrounds and encourage regeneration.
	Vehicle and plant refuelling, drilling operations.	Pollution through local fuel tank or filling point spills	All rig refuelling will be from a fuel trailer. Any refuel areas' contaminated soil to be removed from site and disposed of at a licensed facility. Drilling fluids to be disposed of in sump at end of drilling. Non-toxic Muds will be used.

Environmental objective	Main sources of risk	Possible impact	Avoidance, management, mitigation
			Drip trays will be used for refuelling and under any parts of the drill rig that represent a leak or spill hazard. Fuel and hydraulic hoses will be checked for signs of wear
5. Minimise loss of aquifer pressures and avoid aquifer contamination	Drilling	Contamination of aquifers beyond the drill hole.	Use of controlled water loss/low solids drilling muds. Non-toxic muds used.
	Missing or inadequate casing or plugging post drilling.	Contamination of higher quality groundwater with lower-quality waters (salinity, trace elements).	Casing design to prevent aquifer mixing or flow to surface. Cementing and plugging on abandonment to appropriate PIRSA and DWLBC standards.
6. Minimise disturbance to drainage patterns and avoid contamination of surface waters and shallow groundwater resources	Access and pad construction	Flow interception, downstream shifts; erosion	No significant drainage features present. Drainage in all cases is mostly local (sheet flow or ponding) and any interception by drill site or access will be minor to negligible. Rehabilitation of site as described in (4) above.
	Vehicle and plant refuelling, drilling operations.	Pollution through local fuel tank or filling point spills	No significant drainage features present. Measures outlined in (4) above regarding prevention of soil contamination will mitigate potential contamination of local drainage.
	Escape of drilling muds from sumps	Mud or chippings contamination of surface and surface waters	No significant surface drainage features are present. Groundwater will be contained in sumps and release of groundwater beyond area of drilling activity will be avoided.
7. Minimise risks to the safety of the public, employees and other third parties	Access risks, drill site risks	Creation of new public risks: public using access road; public access to site during drilling.	Minor incremental risk due to increase of traffic for drilling. Relatively small number of truck loads for rig moves. Observation of speed limits and safe speeds on access tracks. Where appropriate, signage at site and access to indicate restricted access. The site is not accessible to the public or public view. It is not visible from any public roads or station tracks. Visitors are unlikely to pass the site as there is no through access to any notable destinations. Liaison with DEH and pastoral lessee regarding movements.
	Wildfire from drill site, campfires	Public safety risk, damage to vegetation and pastoral infrastructure (also OH&S	See (2) above.

Environmental objective	Main sources of risk	Possible impact	Avoidance, management, mitigation
		considerations not covered in this EIR)	
8. Minimise disturbance to stakeholders and associated infrastructure	Vehicle movements; drilling	Interference with stock or station activities	Drilling site is not close to a stock water point. Drill site is temporary: activity would be sufficient to deter stock from pad but unlikely to otherwise affect stock. Drilling scheduled to avoid shearing. Liaison maintained with pastoral lessee.
	Access and pad construction or upgrade; Stock and fauna access to sumps / water Fires at drilling site	Impacts to conservation values of Regional Reserve Physical damage to soils, vegetation and habitat; wildfire Visual impact of disturbance at drill site	See (2), (4) and (6) above. No significant impact on Regional Reserve, due to use of existing station track for access (requiring only minor clearing and or grading) and selection of site in open area with little vegetation. Sumps temporarily fenced following drilling (subject to discussions with the pastoral lessee and the District Ranger) and water well not left as permanent water source. Risk to stock / fauna and potential for increased grazing pressure or increased abundance of feral species is minimal. Active rehabilitation of site on abandonment. The site is not accessible to the public or public view. It is not visible from any public roads or station tracks. Visitors are unlikely to pass the site as there is no through access to any notable destination.
9. Minimise the impact on the environment of waste storage, handling and disposal	Disposal of wastes while drilling	Creation of wastes: sewerage, litter, overflow and spillage	Wastes on site confined by bins/skips. Disposal eventually to licensed waste disposal facility. Minor non-toxic wastes, chippings and muds disposed in drill sump. Litter cleanup during and post-drilling. No sewage systems on site – accommodation and ablution facilities at Chowilla shearing shed.
10. Remediate and rehabilitate operational areas to agreed standards	Post-drilling	Drill site permanently left in place with visual impact, changed soil surfaces, colour contrasts	Cleanup, sumps and pits filled, facilities removed. Some scarification may be used to alleviate compacted surfaces. Topsoil stockpiled from excavated areas respread. Rehabilitation/abandonment plans for surface activities will be developed in consultation with pastoral lessee and DEH.

6 Environmental Management Framework

6.1 Responsibilities, inductions and training

Induction, responsibilities and reporting requirements for Eden Energy's representatives and the contractors will be given as indicated in the Eden Energy Operations Manual. Eden Energy will use contractors for all operations; contractors' operating manuals, particularly drilling operations manuals, and responsibilities will be documented in Eden Energy's DOM or associated documents.

An induction briefing is provided to contractors and employees. Contractors subsequently are responsible for their employees' inductions, and will be required to have in place appropriate induction procedures and materials.

For general environmental aspects, Eden Energy's nominated representative will be responsible for supervision of the initial site preparation, enforcement of vehicular movement limitations, tidiness and cleanliness of the site and access, supervision of remediation works, and general documentation of operations. An on-site induction will be carried out which refers to these aspects as well as the Statement of Environmental Objectives and responsibilities under the Petroleum Act.

6.2 Emergency response

An Emergency Response Plan, specific to the site, will be developed and will be applied by Eden Energy Ltd and its contractors.

6.3 Evaluation and Monitoring

6.3.1 Subsurface

In the process of drilling, continuous reports will be produced, including an evaluation component in relation to environmental as well as other risks.

Such evaluations are provided in both the daily drilling reports and in the Final Well Reports, which cover all aspects of subsurface operations including environmental. Drilling and event logs are maintained and reported in the daily well reports and in the Final Well Report.

6.3.2 Surface

For general environmental monitoring and evaluation, the SEO (based on the Cooper Basin Drilling SEO) will be applied. Following the initial inspections of the site pre-operations, the main continuous monitoring tool is photographic, with photographs taken at all stages of development. File records are held of any archaeological and environmental inspections.

6.4 Reporting

6.4.1 Serious and reportable incidents

Serious and reportable incidents under Section 85 (1) of the Petroleum Act are listed in the SEO.

Reporting formats and procedures will be provided, or where a subcontractor provides services, specified in Eden Energy's Emergency Response Plan for this operation.

6.5 Consultation

Consultation, including meetings and telephone calls, has been carried out with the lessees of Chowilla (the Robertsons) and DEH in Berri. Several discussions with DEH personnel in Berri and Adelaide have been held during preparation of this report. The Riverland Aboriginal Community Heritage Association will be consulted regarding heritage issues.

Formal notices of entry have also been provided to the Robertsons and DEH.

7 References

Baker-Gabb, D. (2003). Recovery Plan for the Black-eared Miner *Manorina melanotis* 2002 – 2006: Conservation of old-growth dependent mallee fauna. Department for Environment and Heritage, Adelaide.

Bureau of Meteorology (2007). Climate Data Online. Accessed in April 2007 at www.bom.gov.au/climate/averages.

Cunningham, G.M., Mulham, W.E., Milthorpe, P.L. and Leigh, J.H. (1992). *Plants of Western New South Wales.* Inkata Press, Melbourne.

DEH (2003). *A Review of Chowilla Regional Reserve 1993 – 2003*. Department for Environment and Heritage, Adelaide.

DEH (2005). Spiny Daisy, *Acanthocladium dockeri.* Threatened Flora Fact Sheet FIS 2319.05 10/05. Department for Environment and Heritage, Clare.

DEH (2006a). Red-lored Whistler *Pachycephala rufogularis*. Threatened Species of the South Australian Murray-Darling Basin Fact Sheet FIS 2542.06/Red-lored Whistler 7/06. Department for Environment and Heritage, Murraylands Region.

DEH (2006b). Regent Parrot (Eastern sub-species) *Polytelis anthopeplus monarchoides.* Threatened Species of the South Australian Murray-Darling Basin Fact Sheet FIS 2542.06/Regent Parrot 7/06. Department for Environment and Heritage, Murraylands Region.

DEH (2007). Biological Databases of South Australia search results. Department for Environment and Heritage, Adelaide.

DEH-Cwlth (2006). EPBC Act Protected Matters Search Tool. http://www.deh.gov.au/erin/ert/epbc/index.html. Searched 31 March 2006. Department of the Environment and Heritage, Canberra (now the Department of the Environment and Water Resources).

DENR (1995). *Chowilla Regional Reserve and Chowilla Game Reserve Management Plan.* Department for Environment and Natural Resources, Adelaide.

DEH-Cwlth (2006b). Australian Heritage Database listing for Murray Mallee - Bookmark Block, Main Wentworth Rd, Renmark, SA. Place ID 101590. Department of the Environment and Heritage, Canberra.

Rammers, N., Hill, T. and Yan, W. (2005). *Regional Disposal Strategy – Renmark Group Deep Injection: Phase 1 Desktop Study.* Department of Water, Land and Biodiversity Conservation. DWLBC Report 2005/29.

DWLBC (2007). South Australian Land System Mapping. GIS data obtained from the Department of Water, Land and Biodversity Conservation.

Eden Energy (2005a). *Environmental Impact Report Witchelina Geothermal Energy Project: Proposed Hole WWD1 Re-Entry Programme GEL167,* November 2005.

Eden Energy (2005b). *Statement of Environmental Objectives: Geothermal Exploration Drilling,* December 2005.

Kahrimanis, M.J., Carruthers, S., Oppermann, A. and Inns, R. (2001). *Biodiversity Plan for the South Australian Murray-Darling Basin*. Department for Environment and Heritage, Adelaide.

Santos (November 2003). *South Australia Cooper Basin Operators Statement of Environmental Objectives: Drilling and Well Operations.* Santos Ltd, Adelaide.

TransGrid (2002). Proposed South Australia – New South Wales Interconnector (SNI) Environmental Impact Statement. TransGrid, Sydney.

Appendix A: Rare or Threatened Species Recorded in Region

The following tables list all rare or threatened species recorded in the Biological Databases of South Australia (DEH 2007) at locations within 40 km of GELs 175 and 176.

A portion of the 40 km search buffer overlaps the River Murray and near-river habitats that are not present within the GELs. Where species have only been recorded in these areas (i.e. they likely to rely on river or near-river habitats and are unlikely to be present in the habitats present in the GELs) this is indicated in the tables.

Several rare or threatened fauna species have been recorded in the GELs and these are indicated in Table A2. There are no rare or threatened flora species records within GELs 175 and 176 in the DEH databases.

Conservation status in Tables A and A2 is based on the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the South Australian *National Parks and Wildlife Act 1972* listings. Abbreviations are as follows:

Abbreviations for Conservation Status Listings		
Category	**Cwlth (EPBC Act)**	**SA (NPW Act)**
Critically Endangered	CE	-
Endangered	EN	E
Vulnerable	VU	V
Rare	-	R

Table A1: Rare or Threatened Plant Species Recorded in Biological Databases of South Australia (DEH 2007) within 40 km of GELs 175 and 176

Species	Common Name	Cwlth Status	SA Status	Comment
Acacia pendula	Weeping Myall		V	
Acanthocladium dockeri	Spiny Everlasting	CE	E	
Adiantum capillus-veneris	Dainty Maiden-hair		V	Records are in near river areas
Brachyscome basaltica var. gracilis	Swamp Daisy		R	
Austrostipa pilata	Prickly Spear-grass		V	Records are in near river areas
Brachycome parvula var. lissocarpa (NC)	Coast Daisy		R	Records are in near river areas
Callitriche sonderi	Matted Water Starwort		R	Records are in near river areas
Callitriche umbonata	Water Starwort		V	Records are in near river areas
Calocephalus sonderi	Pale Beauty-heads		R	
Calotis scapigera	Tufted Burr-daisy		R	
Choretrum glomeratum var. chrysanthum	Yellow-flower Sour-bush		R	
Christella dentata	Soft Shield-fern		R	
Corynotheca licrota	Sand Lily		R	

Species	Common Name	Cwlth Status	SA Status	Comment
Crassula peduncularis	Purple Crassula		R	Records are in near river areas
Cuscuta tasmanica	Tasmanian Dodder		V	Records are in near river areas
Cyperus nervulosus			R	Records are in near river areas
Daviesia benthamii ssp. humilis	Mallee Bitter-pea		R	
Dianella porracea	Pale Flax-lily		V	
Diplachne parviflora (NC)	Small-flower Beetle-grass		R	Records are in near river areas
Elatine gratioloides	Waterwort		R	Records are in near river areas
Eragrostis infecunda	Barren Cane-grass		R	Records are in near river areas
Eragrostis lacunaria	Purple Love-grass		R	
Eremophila polyclada	Twiggy Emubush		R	Records are in near river areas
Exocarpos strictus	Pale-fruit Cherry		R	
Frankenia cupularis			R	
Geijera parviflora	Wilga		R	
Goodenia heteromera	Spreading Goodenia		R	
Hakea tephrosperma	Hooked Needlewood		R	
Hyalosperma stoveae	Dwarf Sunray		R	
Lepidium pseudotasmanicum	Shade Peppercress		V	Records are in near river areas
Lythrum salicaria	Purple Loosestrife		R	
Maireana decalvans	Black Cotton-bush		E	
Maireana pentagona	Slender Fissure-plant		R	
Maireana rohrlachii	Rohrlach's Bluebush		R	
Maireana suaedifolia	Lax Bluebush		R	
Muehlenbeckia horrida ssp. *horrida*	Spiny Lignum		R	Records are in near river areas
Myoporum parvifolium	Creeping Boobialla		R	
Myriophyllum crispatum	Upright Milfoil		V	Records are in near river areas
Myriophyllum papillosum	Robust Milfoil		R	Records are in near river areas
Nymphoides crenata	Wavy Marshwort		R	Records are in near river areas
Ophioglossum polyphyllum	Large Adder's-tongue		R	
Orobanche cernua var. australiana	Australian Broomrape		R	Records are in near river areas
Osteocarpum acropterum var. deminutum	Wingless Bonefruit		R	
Picris squarrosa	Squat Picris		R	Records are in near river areas
Pratia concolor	Poison Pratia		R	
Ranunculus sessiliflorus var. *pilulifer*	Annual Buttercup		V	
Rorippa laciniata	Jagged Bitter-cress		R	Records are in near river areas
Sclerolaena muricata var. villosa	Five-spine Bindyi		R	Records are in near river areas
Zannichellia palustris			R	Records are in near river areas

Table A2: Rare or Threatened Fauna Recorded in Biological Databases of South Australia (DEH 2007) within 40 km of GELs 175 and 176

Species	Common Name	Cwlth Status	SA Status	Recorded in GELs	Comment
Birds					
Acanthiza iredalei	Slender-billed Thornbill	VU	V		Closest record on Gluepot Reserve, 40km west of GEL176
Alcedo azurea	Azure Kingfisher		E		Records are in near-river areas
Amytornis striatus	Striated Grasswren		V		
Anas rhynchotis	Australasian Shoveler		R		
Ardea intermedia	Intermediate Egret		R		
Biziura lobata	Musk Duck		R		Records are in near-river areas
Burhinus grallarius	Bush Stone-curlew		V		Records are in near-river areas
Cacatua leadbeateri	Major Mitchell's Cockatoo		V	✓	
Chlamydera maculata	Spotted Bowerbird		EX		
Cinclosoma castanotus	Chestnut Quail-thrush		R	✓	
Climacteris affinis	White-browed Treecreeper		R	✓	
Coracina papuensis	White-bellied Cuckoo-shrike		R		
Coturnix ypsilophora	Brown Quail		V		Records are in near-river areas
Entomyzon cyanotis	Blue-faced Honeyeater		R		
Falco hypoleucos	Grey Falcon		R		Records are in near-river areas
Falco peregrinus	Peregrine Falcon		R		
Falcunculus frontatus	Crested Shrike-tit		V		
Gerygone fusca	Western Gerygone		R		Records are in near-river areas
Haliaeetus leucogaster	White-bellied Sea-Eagle		V		Records are in near-river areas
Leipoa ocellata	Malleefowl	VU	V	✓	
Manorina flavigula melanotis	Black-eared Miner	EN	E	✓	
Melithreptus gularis	Black-chinned Honeyeater		V		
Neophema chrysostoma	Blue-winged Parrot		V		
Neophema splendida	Scarlet-chested Parrot		R		
Pachycephala rufogularis	Red-lored Whistler	VU	V		
Philemon citreogularis	Little Friarbird		R		
Plectorhyncha lanceolata	Striped Honeyeater		R	✓	
Plegadis falcinellus	Glossy Ibis		R		Records are in near-river areas
Podiceps cristatus	Great Crested Grebe		R		Records are in near-river areas

Species	Common Name	Cwlth Status	SA Status	Recorded in GELs	Comment
Polytelis anthopeplus	Regent Parrot	VU	V		
Pyrrholaemus brunneus	Redthroat		R	✓	
Stagonopleura guttata	Diamond Firetail		V		
Stictonetta naevosa	Freckled Duck		V		Records are in near-river areas
Turnix pyrrhothorax	Red-chested Button-quail		R		
Turnix varia	Painted Button-quail		V		
Mammals					
Acrobates pygmaeus	Feathertail Glider		E		Records are in near-river areas
Chalinolobus picatus	Little Pied Bat		V		
Nyctophilus timoriensis	Greater Long-eared Bat	VU	V		
Phascolarctos cinereus	Koala		R		Records are in near-river areas
Amphibians					
Litoria raniformis	Golden Bell Frog	VU	V		
Reptiles					
Chelodina expansa	Broad-shelled Tortoise		V		Records are in near-river areas
Delma inornata	Olive Snake-lizard		R		
Echiopsis curta	Bardick		R		
Varanus varius	Tree Goanna		R		Records are in near-river areas
Vermicella annulata	Common Bandy-Bandy		R		