

Environmental Impact Report

1 MW Geothermal Power Plant at Innamincka

27 August 2008

Geodynamics Pty Ltd



PREVIOUS
ENGINEERING
EXCELLENCE
AWARD WINNER
2006, 2005, 2004,
2003, 2002, 2001



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1. Introduction

1.1 Project background

1.1.1 Location

The 1 MW plant project is situated within the Innamincka Regional Reserve in northern South Australia and 12.3 km by road and about 7 km in a straight line from the town of Innamincka (Figure 1.1). The southern boundary of the Coongie Lakes Ramsar Wetland area is located 2.5 km northwest of the site. Relevant details are shown on Figure 1.2.

1.1.2 Objectives

The objective of the 1 MW pilot generating plant is to demonstrate the sustained performance of hot rock geothermal power generation.

1.1.3 Key project components

The projects comprises the following components:

- Construction of a small (1MW) pilot generating plant using the Habanero 1 and 3 wells.
- Use of the plant to generate power for the:
 - ▶ Site camp
 - ▶ ‘Innamincka Visitor Centre’ to be built in close proximity to the Habanero 1 well. (The Innamincka Visitor Centre will include the Turbine hall for the 1MW plant and is therefore a dependent project.)
 - ▶ Proposed Geodynamics site Warehouse proposed to be built between the Habanero 1 and 3 wells.
 - ▶ Innamincka township.
 - ▶ Potentially the Innamincka Cattle Station.¹
- Design and construct a power line from the 1MW Plant to the Innamincka town ship (and possibly to the Innamincka Cattle Station). This component of the project will be undertaken as a design, construct and management with all approvals being sought by the selected ‘electricity entity’ as defined in the *Electricity Act 1996*.

The proposed works are to be undertaken within the existing footprint of site works that were undertaken for drilling operations and were undertaken in accordance with the *Petroleum Act 2000* provisions (Plates 1.1 and 1.2).

¹ This is subject to negotiation with the Kidman Cattle Company.

1.2 Geodynamics Limited

1.2.1 Company background

Geodynamics Limited (Geodynamics) was formed in 2000 and listed on the Australian Stock Exchange (ASX) in September 2002 and has a market capitalisation (as of 30 April 2008) of \$328M.

Geodynamics vision is:

“Geodynamics will become a world leading geothermal energy company, supplying competitive zero carbon energy and base load power to the Australian market.”

The company has an outstanding resource and technology position, with potential to become a major player in Australia’s power generating industry. It currently has geothermal exploration licences covering more than 3,500 km². Its current focus is in the Cooper Basin in South Australia, where Geodynamics’ licence areas cover 1,962 km² and where the “hot rocks”:

- are known to exist, as proven by drilling and supporting geophysics
- are believed to be the hottest rocks of this type and at this depth in the world by measured temperatures at 3,500 m of 235°C increasing to 250°C at 4,300 m and projected to be between 280 to 290°C at 5,000 m
- are estimated by Geodynamics to contain an identified thermal resource of approximately 400,000 PJ
- have been assessed through preliminary testing and studies that suggest they contain energy to support power development of around 10,000 MW.

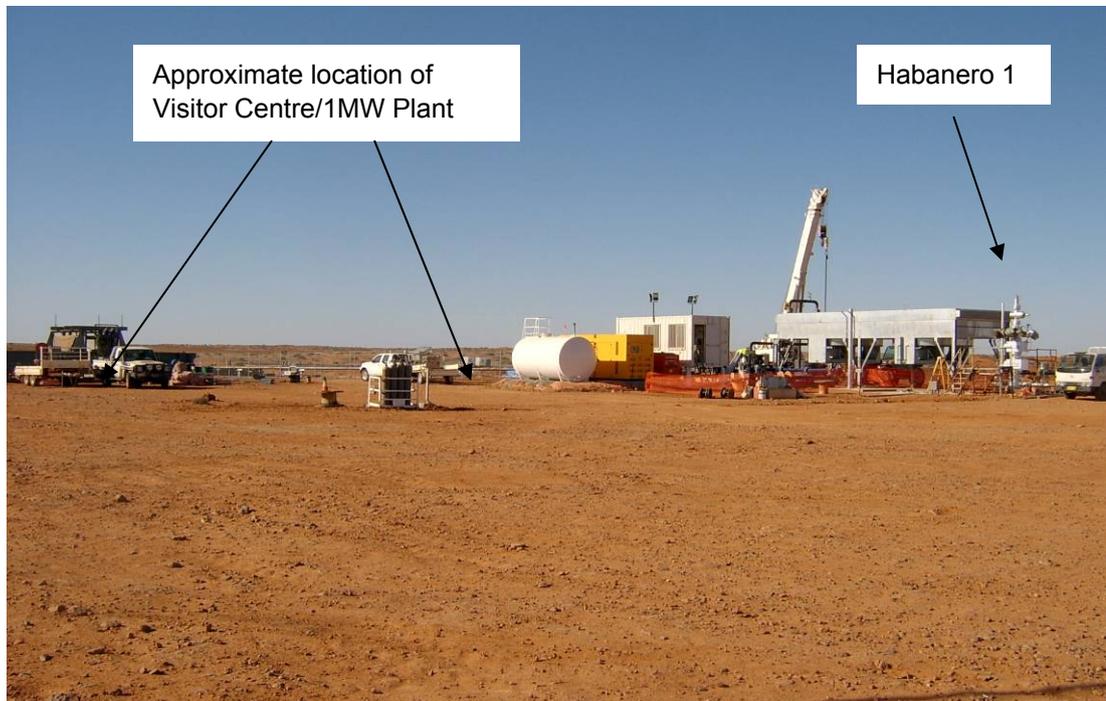
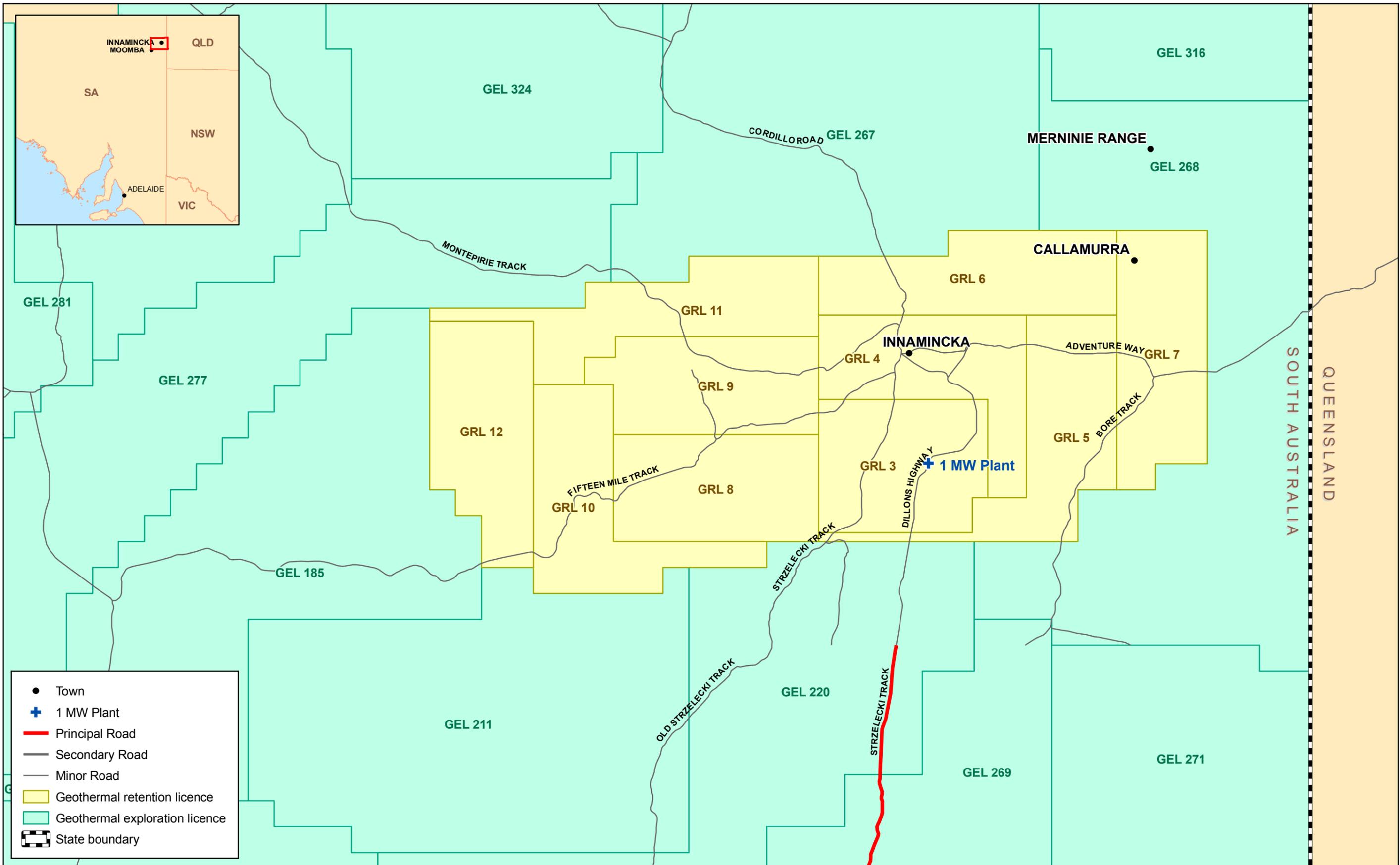


PLATE 1.1
Proposed plant site located in foreground



- Town
- ⊕ 1 MW Plant
- Principal Road
- Secondary Road
- Minor Road
- Geothermal retention licence
- Geothermal exploration licence
- ▬ State boundary

1:250,000 at A3

0 5 10
Kilometres

Data Source: DEH, PIRSA, Geoscience Australia

Coord. Sys.: GDA94 MGA54

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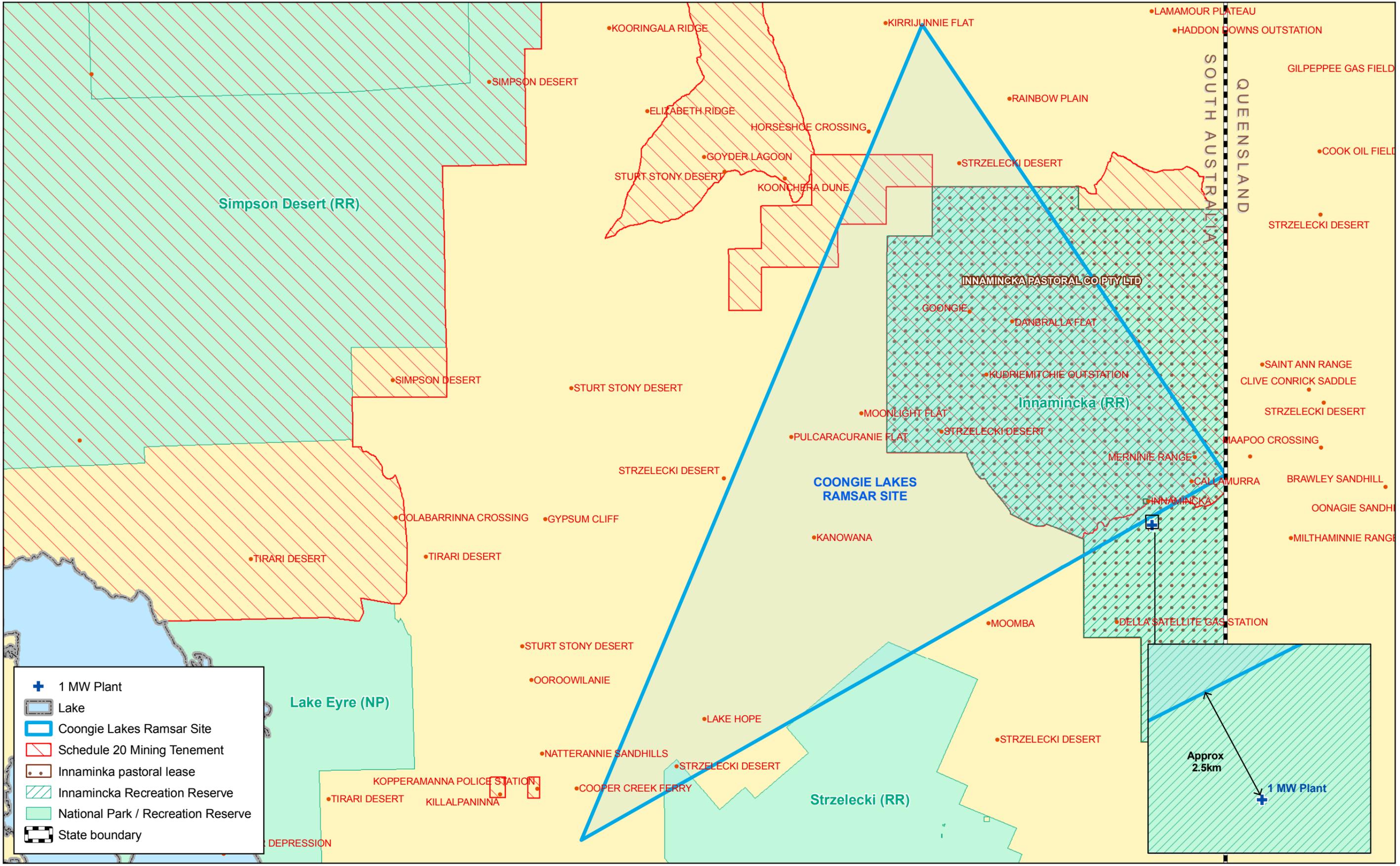
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Innaminka 1 MW Geothermal Power Plant
Location plan
Figure 1.1



- + 1 MW Plant
- Lake
- Coongie Lakes Ramsar Site
- Schedule 20 Mining Tenement
- Innamincka pastoral lease
- Innamincka Recreation Reserve
- National Park / Recreation Reserve
- State boundary



1:1,150,000 at A3 ↑

0 20 40
Kilometres

Data Source: DEH, PIRSA,
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Innaminka 1 MW Geothermal Power Plant
Regional Setting
Figure 1.2

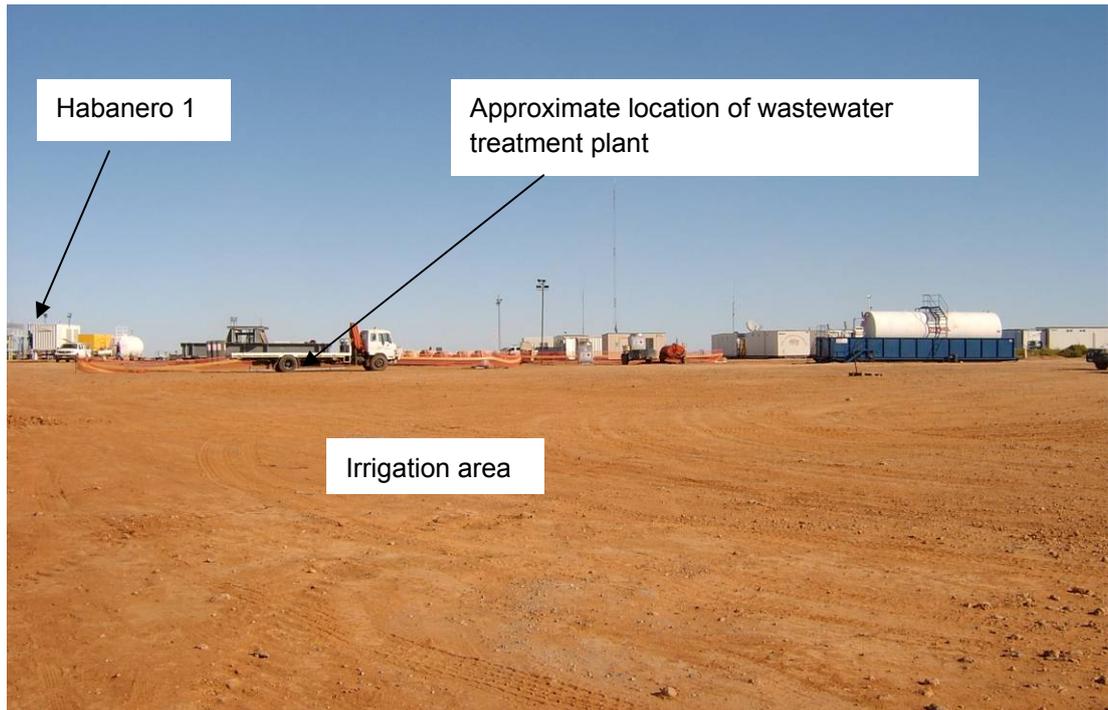


PLATE 1.2
Proposed wastewater treatment plant and subsurface irrigation area

To date Geodynamics has successfully drilled three wells to depths greater than 4,000 m. The company has been working to a three stage plan:

- Proof of concept stage – this has evolved to comprise three wells, Habanero 1–3, with fracture stimulation and an “open” circulation test between two wells (Habanero 1 and 3).
- Establishing a pilot plant – Geodynamics received a \$5M grant from the Australian Government’s Renewable Energy Demonstration Initiative (REDI) program. The pilot programme involves two components, a “closed loop” circulation test, followed by the establishment of a 1 MW power generation module between Habanero 1 and 3 (this project).
- Commercialisation of the project will occur in two stages, an initial 50 MW power generation plant increasing to 500 MW by 2016

The 50 MW plant is expected to be based on nine wells (Habanero 1–9) occupying a small footprint and expected to generate equivalent power for 50,000 homes. The 500 MW power plant is expected to be based on 81 wells and ten 50 MW units.

1.2.2 Power generation from fractured hot rocks

The concept involves injecting water in a well to a depth where the rock is at the required high temperature (at least 250°C). The water (geofluid) passes through the fracture system in the rock and extracts heat from the rock mass. The heated geofluid is then drawn to the surface through adjacent wells.

At the surface the heat in the geofluid is transferred to a secondary working fluid via a heat exchanger where it expands and is passed through a turbine generator. The geofluid is then returned to the fracture system in a closed loop, as is the secondary fluid.

Downstream of the turbine generator, air coolers are used to condense the secondary fluid, so there are no water losses. The concept is indicated in Figure 1.3.

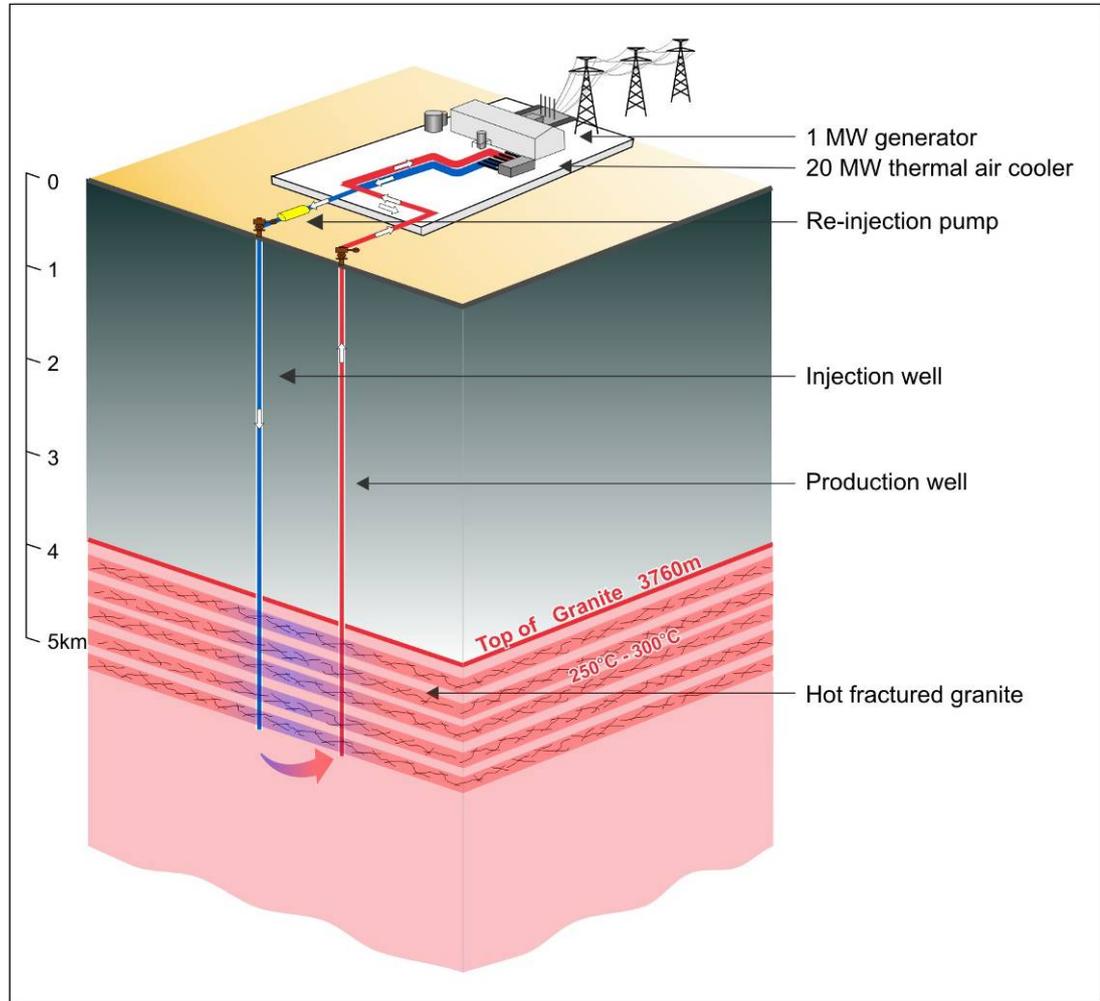


FIGURE 1.3
Geothermal power generation process (Geodynamic 2007)

1.2.3 Land ownership

The proposed 1 MW plant is situated within the Innamincka Regional Reserve under the care and control of the Minister for Environment and Heritage. In addition the Innamincka Pastoral Company holds a lease over the area for pastoral activities such as cattle grazing. The site is also within Geothermal Retention Licence GRL 3. Relevant details are shown on Figure 1.1.

1.3 Structure of this document

1.3.1 Structure

This EIR has been structured in the following manner:

Section 1	Introduction Provides an overview of the project and outlines the purpose and structure of the EIR.
Section 2	Legislative Requirements Provides details on the legislative requirements associate with the project. Details applicable legislation and relevance to the project.
Section 3	Stakeholder Consultation Provides an overview of the stakeholder consultation undertaken to date.
Section 4	Description of Land and Environment Provides an overview of the existing land and environment in which the project is located. This section is supported by various specialist sub consultants' reports that are contained in the document Appendices.
Section 5	Description of Operations Provides a description of the proposed operations.
Section 6	Environmental Impact Assessment (EIA) Discusses the environmental impacts associated with the 1 MW project. The impact assessment process is based on risk assessment procedures.
Section 7	Environmental Management Details the environmental management to be undertaken during the pilot plant operation.
Section 8	Rehabilitation and Closure Plan Provides an overview of rehabilitation and closure should the project not proceed to commercial development
Section 9	Management Systems
Section 10	Bibliography



2. Legislative requirements

Geothermal activity in South Australia is primarily governed by the *Petroleum Act 2000* and Regulations. In addition to the primary approval and regulation of geothermal projects via the Petroleum Act, there are a number of additional South Australian and Commonwealth Acts and regulatory processes that affect operational activities associated with the project.

2.1 South Australian Legislation

2.1.1 Petroleum Act 2000

2.1.1.1 Environmental Impact Report

The primary legislation governing the proposal is the *Petroleum Act 2000* and *Petroleum Regulations 2000*. The key objectives of the legislation are:

- To protect the natural, cultural, heritage and social aspects of the environment from risks associated with activities governed by the Act.
- To provide for constructive consultation with stakeholders, including effective reporting of industry performance to other stakeholders.
- To provide security of title for petroleum, geothermal energy, and other resources governed by the Act.

The Act and Regulations are objective based rather than prescriptive. An objective based regulatory approach principally seeks to ensure that industry effectively manages its activities by complying with performance standards that are cooperatively developed by the licensee, the regulatory authority and the community.

Section 96 of Part 12 of the Petroleum Act indicates that a licensee must not carry out regulated activities unless a statement of environmental objectives (SEO) is in force for the relevant activities. The SEO must:

- be prepared on the basis of the Environmental Impact Report (EIR)
- include the environmental objectives to be achieved
- the measurement criteria for measuring the achievement of objectives
- be developed in consultation with relevant stakeholders e.g. landowners, other agencies (DEH, DWLBC, EPA); and
- be either regional or site specific.

In accordance with Section 97 the EIR must:

- Take into account cultural, amenity and other values of Aboriginal and other Australians in so far as those values are relevant to the assessment.
- Take into account risks inherent in the regulated activities to the health and safety of the public.
- Contain sufficient information to make possible an informed assessment of the likely impact of the activities on the environment.

In accordance with Regulation 10, the EIR must include:

- A description of the regulated activities to be carried out under the licence (including their location).
- A description of the specific site features of the environment that can be reasonably be expected to be affected by the activities, with particular reference to the physical and biological aspects of the environment and existing land uses.
- An assessment of the cultural values of Aboriginal and other Australians which could be reasonably foreseen to be affected by the activities in the area of the licence, and the public health and safety risks inherent in those activities (insofar as these matters are relevant in the particular circumstances).
- A description of the reasonably foreseeable events associated with the activity that could pose a threat to the relevant environment, including:
 - ▶ events during the construction stage (if any), the operational stage and the abandonment stage
 - ▶ events due to atypical circumstances (including human error, equipment failure or emissions, or discharges above normal operating levels)
 - ▶ information on the estimated frequency of these events
 - ▶ an explanation of the basis on which these events and frequencies have been predicted
 - ▶ an assessment of the potential consequences of these events on the environment, including:
 - the extent to which consequences can be managed or addressed
 - the action proposed to be taken to manage or address these consequences
 - the anticipated duration of these consequences
 - an explanation of the basis on which these consequences have been predicted
 - a list of all owners of the relevant land
 - information on any consultation that has occurred with the owner of the relevant land, any Aboriginal groups or representatives, any agency or instrumentality of the Crown, or any other interested person or parties, including specific details about relevant issues that have been raised and any response to those issues, but not including confidential information.
 - ▶ events due to atypical circumstances (including human error, equipment failure or emissions, or discharges above normal operating levels)
 - ▶ information on the estimated frequency of these events
 - ▶ an explanation of the basis on which these events and frequencies have been predicted.

2.1.1.2 Assessment process

An initial review of the EIR and Draft SOE is undertaken by PIRSA to determine the Impact Category of the project as either:

- Low Impact – requires internal Government Consultation

- Medium Impact – requires Public Consultation
- High Impact – Referred for Environmental Impact Statement (EIS) assessment under Part 8 of the *Development Act 1993*.

On the basis of the work undertaken to date Geodynamics is of the view that the proposed 1MW geothermal energy power plant and associated infrastructure is of low impact.

2.1.2 Native Title (South Australia) Act 1994

The project area is subject to native title claims by the Yandruwandha/Yawarrawarrka Native Title Claimants. Work Area Clearances (WAC) were obtained for all previous activities.

Legal opinion provided to Geodynamics has indicated that Geothermal Titles do not trigger the *Native Title Act 1993* (Commonwealth) “Right to Negotiate”. In South Australia Crown Law advice provided to PIRSA indicated that circulation of water through an underground heat exchanger is a heat transfer process rather than a mining or substance extraction process. Native Title claimants in South Australia have accepted this ruling and geothermal tenement owners have been working harmoniously with claimants.

Geodynamics has entered into an agreement with the traditional owner to obtain clearance for activities that are proposed at the site. This agreement was signed on 13 February 2004.

2.1.3 Environment Protection Act 1993

The *Environment Protection Act 1993* (EP Act) provides for the protection of the environment and it is administered by the Environment Protection Authority (EPA).

2.1.3.1 General environmental duty

Geodynamics has a ‘general environmental duty’ under the EP Act (Section 25) to not undertake an activity that pollutes, or might pollute, the environment unless it takes all reasonable and practicable measures to prevent or minimise any resulting environmental harm.

In determining what measures are required to be taken, consideration must be given to:

- the nature of the pollution or potential pollution, and the sensitivity of the receiving environment
- the financial implications of the various measures that might be taken as those implications relate to the class of persons undertaking activities of the same or a similar kind
- the current state of technical knowledge and likelihood of successful application of the various measures that might be taken.

2.1.3.2 Authorisations

Approvals, which are administered by the EPA, are required for activities which are classified as a prescribed activity of environmental significance under Schedule 1 of the EP Act. Authorisations for prescribed activities under the EP Act take the form of a Works Approval, Licence or Exemption.

The EPA has advised that authorisations or licences will not be required for the proposed 1 MW geothermal plant. PIRSA has advised that the EPA will be consulted regarding the application.

2.1.4 Development Act 1993

The *Development Act 1993* and associated Regulations set out the procedures by which different forms of “development” are assessed in South Australia. Development includes, land division, change of land use, the erection of structures and prescribed operations that are undertaken under the *Petroleum Act 2000*.

The site is within the “Land Not Within Council Area (Far North)” Development Plan area. Normally the Development Assessment Commission would be the relevant planning authority for the granting of development approval. However, the Development Act has special provisions relating to the *Petroleum Act 2000*.

In most cases the Development Act does not apply to activities undertaken under the Mines Acts (which includes the *Petroleum Act 2000*). Section 75 of the Development Act provides for applications for tenements to be referred to the Minister for Urban Development and Planning in certain cases:

- There is a mandatory referral for tenements that fall within Schedule 20 areas. In other cases the Minister for the *Petroleum Act 2000* may refer the application for comment.
- If the Minister responsible for the *Petroleum Act 2000* is of the opinion that the proposed operations are of major social, economic or environmental importance. Under this scenario the assessment process would follow the Major Developments process in the Development Act and there would be the need to prepare an Environmental Impact Statement or Public Environmental Report.

2.1.5 Natural Resources Management Act 2004

The abstraction and use of groundwater will be governed by the *Natural Resources Management Act 2004* (NRM Act), which promotes sustainable and integrated management of the State's natural resources and provides for their protection. This act brings together three Acts, the *Animal and Plant Control (Agricultural Protection and Other Purposes) Act 1986*, *Soil Conservation and Land Care Act 1989* and *Water Resources Act 1997* and is administered by the Department of Water, Land and Biodiversity Conservation (DWLBC).

2.1.5.1 Groundwater

The Geodynamics project is located in the Far North Prescribed Wells Area (FNPWA). The FNPWA incorporates the portion of the GAB which lies within South Australia and some immediately adjacent areas. The FNPWA has been set up to primarily achieve responsible use of the GAB resources in South Australia.

Approval (in the form of a licence and water allocation) is required for abstraction and use of groundwater for the project. Geodynamics made an application as an existing user (Reference 41029) in September 2003, seeking an allocation of potable water for the camp and geothermal energy development. The application is currently being considered by DWLBC as part of determination of existing user applications for the FNPA. The water allocation will be utilised for the extraction of potable water and, if required, make-up water

for the power plant. However it is unlikely that a significant volume of make-up water will be required due to the process being undertaken in a “closed-loop” process, where it expected to be insignificant losses from the system.

2.1.5.2 Surface water

Surface water in the area of the project is not prescribed, but permits under the NRM Act would normally be required for ‘water affecting activities’, such as the diversion of watercourses or extraction of water.

No surface water diversions or extraction of water from watercourses is proposed in relation to the 1 MW plant.

2.1.6 Native Vegetation Act 1991

This Act regulates the clearance, and provides for the management of, native vegetation throughout the state. It also ensures that areas of high conservation value are protected and that minor vegetation clearance is subject to a thorough assessment process. Under the Act, the clearance of native vegetation requires the consent of the Native Vegetation Council, which is advised by the Native Vegetation Branch of the Department for Land, Water and Biodiversity Conservation. Heritage Agreements are also covered and protected by this Act.

Regulation 5(1) zd (i) of the Native Vegetation Regulations provides for exemption for clearance that is incidental to operations authorised under the Petroleum Act. An application is required to be made to the Native Vegetation Council to trigger the exemption. Where clearance is undertaken pursuant to an SEO Geodynamics is required to reach agreement with the Native Vegetation Council in relation to significant environmental benefits that can be achieved at the site or within the region or within the same region. Alternatively Geodynamics is able to make a payment into the Native Vegetation Fund.

For projects that require approval under the Petroleum Act, PIRSA currently has delegation for the administration of the *Native Vegetation Act 1991*. Any clearance of intact native vegetation will need to include arrangements for compensation (provision of a Significant Environmental Benefit (SEB)).

2.1.7 National Parks and Wildlife Act 1972

This State Act was designed to allow for the establishment and maintenance of a system of reserves, as well as the protection of threatened species of flora and fauna. The Act identifies and protects certain species located within conservation parks and reserves, as well as any species listed under Schedules 7, 8 and 9 of the Act. The Act also classifies reserve types and designates under what conditions exploration and mining is allowed. Development of resources is allowed in Regional Reserves.

This EIR includes details regarding potential threatened fauna species in the project area, and measures to protect them.

2.1.8 Other relevant State legislation

There are a number of other South Australian Acts and polices that are, or may be, relevant to the project.

Details of these Acts and policies are provided in Table 2.1 below.

Table 2.1 Other relevant legislation and policies related to the project

Act	Objective/purpose	Relevant Section(s)	How it applies to the project
<i>Aboriginal Heritage Act 1988</i>	To provide for the protection and preservation of Aboriginal sites, objects and human remains (including burials).	Authorisation under Section 23 must be obtained before disturbing a known Aboriginal site. Section 12 provides a process for determining if a site or object is an Aboriginal site or object. Section 20 controls the discovery and search for Aboriginal objects and remains.	If an Aboriginal site is found or needs to be disturbed during the project, Geodynamics will be required to consult with the traditional owners. Appropriate Work Area Clearances have been undertaken for the project.
<i>Heritage Places Act 1993</i>	To provide for the identification, recording and conservation of places and objectives of non-Aboriginal heritage significance.	Section 16 provides the criteria of what is considered to be heritage significance. The proposal to make entry into the South Australian heritage register is provided in Section 17.	Investigations have indicated there are no heritage sites located within the defined project area.
<i>Occupational Health Safety and Welfare Act 1986</i>	To secure the health, safety and welfare of persons at work; to protect the public against risks to health or safety arising out of, or in connection with, the activities of persons at work or the use or operation of various types of machinery.	Part 3 – General Provisions related to occupational health, safety and welfare.	Geodynamics is required to comply with all aspects of the Act relating to occupational health, safety and welfare.
<i>Pastoral Land Management and Conservation Act 1989</i>	To make provision for the management and conservation of pastoral land; and for other purposes.	Section 22 – lessee's obligation to comply with <i>Natural Resource Management Act 2004</i> and <i>Petroleum Act 2000</i> and any regulations under those Acts.	Under the provisions of the Act Pastoral Lessee's are obliged to comply with <i>Natural resource Management Act 2004</i> & <i>Petroleum Act 2000</i> and any regulations under those Acts.
<i>Country Fires Act 1989</i>	Provides for the prevention, control and suppression of fires; to provide for the protection of life and property in fire and other emergencies.	Various provisions including: Section 36(1) Section 39(1)	Prohibits (subject to subsection provisions) the lighting of fires in the open air during fire danger season The Country Fire Service (CFS) can direct Geodynamics to extinguish or manage a fire or may undertake extinguishment / management of a fire themselves.
<i>Public Environment and Health Act 1987</i>	An Act dealing with public and environmental health	Various	Geodynamics will need to seek approval for the wastewater treatment system.

Act	Objective/purpose	Relevant Section(s)	How it applies to the project
<i>Environment Protection (Noise) Policy 2007</i>	No specific objective is established for the policy	3(a) definition of non-domestic premises includes “a mine within the meaning of the <i>Mines and Works Inspection Act 1920</i> ”. Sections 4 – 7	Geodynamics (as the occupier) of non-domestic premises must not cause or permit excessive noise to be emitted from the Project site. Excessive noise is noise that exceeds the background noise level at a measurement site (by more than 5dBA); and exceeds the maximum noise level for that time of day and the area (rural) in which the project site is situated. Provides guidance on instrumentation requirements as well as time and place of noise measurements procedures and records.
<i>Radiation and Protection Control Act 1982</i>	To provide for the control of activities related to radioactive substances and radiation apparatus, to protect the environment, and the health and safety of people against the harmful effects of radiation.	Section 29 – Registration of premises in which unsealed radioactive substances are handled or kept.	This may apply in relation to radionuclides that may be present in the brine and residues from the reverse osmosis plant. Studies are being undertaken by Geodynamics to determine this.

2.2 Commonwealth legislation

2.2.1 EPBC Act 1999

Under the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), referral of a proposal to the Australian Environment Minister is required for actions that may have a significant impact on matters of national environmental significance.

The EPBC Act identifies seven matters of national environmental significance:

- World Heritage properties
- National heritage places
- Wetlands of international importance (Ramsar wetlands)
- Threatened species and ecological communities
- Migratory species
- Commonwealth marine areas
- Nuclear actions (including uranium mining).

The EPBC referral is necessary to determine whether a project requires assessment and approval under the Act. When a project is referred under the EPBC Act, the Australian Department of the Environment, Water, Heritage and the Arts (DEWHA) makes a determination regarding the status of the proposal as a ‘Controlled Action’, ‘Not a Controlled Action’ or ‘Not Controlled Action Particular Manner’.

In terms of the project the following matters are considered relevant (EPBC 2006):

- wetlands of international importance (Ramsar wetlands)
- threatened species and ecological communities
- listed migratory species.

2.2.1.1 Ramsar Wetlands

An action is likely to have a significant impact if there is a real chance or possibility that it will result in:

- areas of the wetland being destroyed or substantially modified
- a substantial and measurable change in the hydrological regime of the wetland, e.g. a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland
- the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependant upon the wetland being seriously affected
- a substantial and measurable change in the water quality of the wetlands
- an invasive species that is harmful to the ecological character of the wetland being established (or an invasive species being spread) in the wetland.

2.2.1.2 Listed migratory species

An action is likely to have a significant impact if there is a real chance or possibility that it will:

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

2.2.1.3 Listed threatened species and ecological communities

The species covered by this category are defined as, extinct in the wild, critically endangered, endangered or vulnerable. The EPBC protected matters report indicates several species that have been defined as vulnerable.

An action is likely to have a significant impact on vulnerable species if there is a real chance or possibility that it will:

- lead to a long-term decrease in the size of an important population of a species
- reduce the area of occupancy of an important population
- fragment an existing important population into two or more populations
- adversely affect habitat critical to the survival of a species
- disrupt the breeding cycle of an important population
- modify, destroy, remove, or isolate or decrease the availability of quality of habitat to the extent that the species is likely to decline
- result in an invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
- introduce disease that may cause the species to decline
- interfere substantially with the recovery of the species.

3. Stakeholder consultation

Geodynamics has developed and implemented an ongoing stakeholder engagement plan throughout the previous phases of the project. Details of the consultation undertaken to date (for the entire project) and proposed ongoing activities are provided below.

3.1 Consultation objectives

The objectives of the stakeholder consultation for the project are to:

- provide consistent accurate project related information to all stakeholders
- listen and respond to stakeholder concerns
- identify areas for inclusion in the EIR and SEO, to ensure a smooth and efficient approvals process
- discuss project risks and possible mitigation measures prior to the development of the project; and
- receive feedback from various stakeholders prior to submission of approval documentation.

To meet these objectives Geodynamics has:

- identified stakeholders and ensured all parties received the same information
- discussed the components of the project with stakeholders; and
- undertaken ongoing consultation as required during the project approval phases.

3.2 Consultation undertaken

Geodynamics has undertaken consultation with a range of stakeholders as indicated in Table 3.1. As the project progresses, additional stakeholders will be added, as required.

Table 3.2 below provides a summary of the meetings and/or correspondence exchanges conducted and a brief summary of the matters discussed.

Table 3.1 Stakeholder identification

Stakeholder group	Individual stakeholder
State Government Authorities	Department for Environment and Heritage (including Innamincka Reserve park management) Department of Health (Applied Environmental Health Branch) Department of the Premier and Cabinet Department of Transport, Energy and Infrastructure Department for Water Land and Biodiversity Conservation Native Vegetation Council Natural Resources Management Board Planning SA Primary Industry and Resources South Australia (PIRSA) Environmental Protection Authority (Operations and Radiation Sections)

Stakeholder group	Individual stakeholder
Native Title Claimants	Yandruwandha/Yawarrawarrka native title claimants
Landholders	South Australian Department for Environment and Heritage Innamincka Pastoral Company
Communities	Innamincka Progress Association and community
Industry	Santos Ltd

Table 3.2 Consultation record

Date	Stakeholder	Geodynamics Representatives	Matters discussed
22 April 2002	Native Title Claimants	Doone Wyborn	<ul style="list-style-type: none"> Commitment by Geodynamics to undertake heritage surveys
19 March 2003	Innamincka Pastoral Company	Doone Wyborn	<ul style="list-style-type: none"> Site inspection associated with exploration drilling and stimulation of Habanero 1
20-21 March 2003	PIRSA	Doone Wyborn	<ul style="list-style-type: none"> Site inspection associated with exploration drilling and stimulation of Habanero 1
27-28 March 2003	Native Title Claimants	Doone Wyborn	<ul style="list-style-type: none"> Site inspection associated with exploration drilling and stimulation of Habanero 1
3 April 2008	State Government agencies as indicated in Table 3.1	Gerry Grove-White Doone Wyborn Alistair Webb	<ul style="list-style-type: none"> Information required for 1 MW power station Process involved to achieve 1 MW power station Understanding of plans to scale up to 500 MW power plant Amount of land required to build the 50 MW units Option of permanent residential accommodation in the longer term Airstrip potential Economic benefits to South Australia
6 June 2008	PIRSA, DWLBC, DEH, Premier and Cabinet, Planning SA	Rod Smith Don Jones	<ul style="list-style-type: none"> Briefing on 1 MW power plant project details Government approvals process Status of technical investigation
30 July 2008	PIRSA, DWLBC, DEH, Premier and Cabinet, Planning SA, Innamincka Pastoral Company, OACDT, Santos	Alex Eadie (Parsons Brinckerhoff) on behalf of Geodynamics	<ul style="list-style-type: none"> Comments sought on the EIR and SEO
11 August 2008	DEH	Alex Eadie (Parsons Brinckerhoff) on behalf of Geodynamics	<ul style="list-style-type: none"> Discussion on the EIR and SEO
14 August 2008	PIRSA, Innamincka Pastoral Company, Innamincka community	Rod Smith Andrew Taylor	<ul style="list-style-type: none"> Consultation at Innamincka on the EIR and SEO

4. Description of land and environment

4.1 Surrounding land use and Local Government

4.1.1 Surrounding land use

The proposed project is within the Innamincka Regional Reserve (Figure 1.2). The reserve is representative of a diversity of land systems not represented anywhere else in the reserve system. Regional Reserves are established under the *National Parks and Wildlife Act 1972* (NPWA) and are operated as multiple use concepts, such that the wildlife, natural and historical features within the reserve are conserved while also allowing for use of the natural resources of the land. Exploration and production are permitted in the reserves under arrangements administered by PIRSA.

The Coongie Lakes, which have been identified as significant arid wetland, are located within the Coongie Lakes National Park, and are surrounded by a mining exclusion zone (proclaimed under the NPWA) and by the Innamincka Regional Reserve. The Cooper Creek and the Coongie Lakes are included in the Register of the National Estate and have been identified as wetlands of international importance under the Ramsar Convention. South Australia's obligations under the Convention are to manage the wetlands and maintain their ecological character.

The major land use in the project area is pastoral, more specifically cattle grazing.

The closest town is Innamincka which is located approximately 12.3 km northwest of the site by road and about 7 km in a straight line.

As previously outlined the project area is located within Yandruwandha/Yawarrawarrka native title claimant's area.

Tourism is another activity that occurs in the area, with tourists visiting Innamincka and the nearby Coongie Lakes Ramsar site.

4.1.2 Local Government

The project area and surrounds are in an 'Unincorporated Area' in relation to local government administration. Development in the area is governed by the 'Land Not Within a Council Area' (Far North) Development Plan (consolidated 3 July 2008). The plan recognises that the natural resources, including minerals and petroleum products, should be managed to optimise productive efficiency of the diverse use of land while minimising land degradation, supporting economic stability and protecting the archaeological, ecological, historical, cultural and scenic values of the region. The plan is administered by Planning SA.

4.2 Climate

The climate of the Innamincka region is characterised by hot dry summers and mild dry winters. January and July are the hottest and coldest months respectively for the area with mean maximum summer temperatures typically averaging 36-39°C and mean winter maximum temperatures ranging from 18-24°C.

The mean annual rainfall for the area varies from 100–200 mm. January, February and December are the wettest months and are also the only months to exceed 20 mm. This can be associated with the northern monsoon occasionally drifting far enough south to cause rainfall. Rainfall in the region is however unpredictable, it can rain at any time of the year or not at all. Generally though when it does rain it will be local and very heavy and annual rainfall for the year can fall in one event (Arid Areas Catchment Water Management Board, 2006).

The predominant wind direction throughout the year is from the south and south-east with winds generally being stronger at the 9 am recordings than the 3 pm recordings. Light winds (<20 kph) are more common in winter, with stronger winds occurring in spring and summer months.

4.3 Land systems

The project area occurs in an area bounded by three land systems, the gibber slopes of the Merninie Land System, dunes of the Strzelecki Land System and floodplain of the Cooper Land Systems. The regional setting is indicated in Figure 4.1 and details provided in Table 4.1 (Fatchen 2002). The local setting of the site prior to establishment of the drilling operations and establishment of the site camp (under provisions of the *Petroleum Act 2000*) are indicated in Figure 4.4 and Plates 4.1–4.4 in section 4.7 (Fatchen 2002). The current site layout is indicated in Plates 1.1 and 1.2.

The majority of the proposed project lies within the Merninie Land System and comprises gibber. The gibber plains are essentially flat to undulating. Soils within this land system comprise red and brown clays that are covered by gibber. The surface has a variable cover of gibber, from 100% to 20%. While usually considered to be a stable environment, when the surface is disturbed there is potential for erosion to occur.

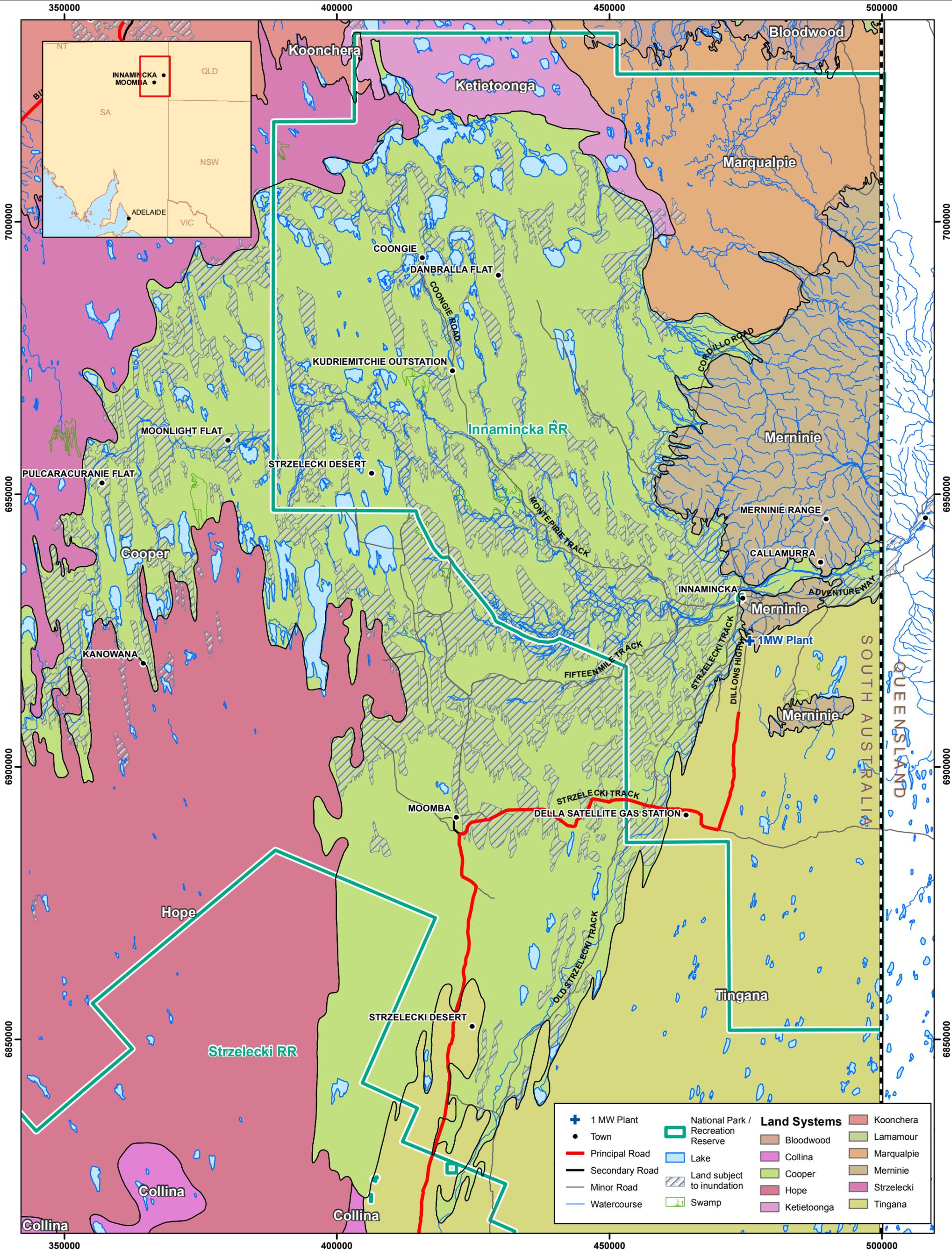
The Strzelecki dunefields are characterised by parallel dunes of red, yellow or white aeolian sands. The dunes are separated by flat interdunal swales which usually consist of clay pans. Sand dunes are able to be impacted by wind erosion following disturbance, particularly by earthworks. Red dunes are more susceptible to erosion than grey/brown dunes. Water erosion is less likely to occur in the dunes as the rain infiltrates the higher permeability soil.

The Cooper Creek and Strzelecki floodplains comprise braided channels, swamps and outwash plains. The soils in the land system comprise grey self mulching clays and some sands and conglomerate in river and creek beds.

4.4 Geology

The geology of north eastern South Australia is characterised by the Eromanga and Cooper Basins. The Eromanga Basin is overlain by the Tertiary and Quaternary age Lake Eyre Basin. Details of the geology are provided below and a typical cross section included in Figure 4.2 (Santos 2003).

The Lake Eyre Basin includes Tertiary and Quaternary age sediments with a thickness in the region ranging from 200–300 m. The near surface Quaternary soils include aeolian sands, alluvium, lacustrine and fluvial sands, silts and clays.



1 MW Plant	National Park / Recreation Reserve	Land Systems	Koonchera
Town	Lake	Bloodwood	Lamamour
Principal Road	Land subject to inundation	Collina	Marqualpie
Secondary Road	Swamp	Cooper	Merninie
Minor Road		Hope	Strzelecki
Watercourse		Ketietoonga	Tingana

1:600,000 at A3

Source: DEH, DWLBC, Geoscience Australia

Coord.: GDA94 MGA54

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Revision:	A	Date: 23/07/2008
Drawn By:	BHB	Checked by: AE
Client Ref:	GEODYNAMICS	

Innaminka 1 MW Geothermal Power Plant
Land Systems
Figure 4.1

GIS File: J:\A543-ENV\PROJ\2145533A_Approvals_Path\10_GIS\Projects\Drawings_Figures_Sketches\2145533A_GIS_F003_A.mxd

Table 4.1 Description of land systems

Land system (Marree Soil Conservation Board 1997)	Landform/soils
Merninie	Long gradual slopes of silcrete gibber (this area). Duplex friable sandy loam over light clay. Highly dispersible. Irreversible accelerated erosion will start at slopes above 2%. Dense gibber lag on surface.
Strzelecki (della)	Dunefield. Red siliceous sands, semi-mobile crest (in this area) and semi-stable slopes. Narrow interdunes with massive red sandy clays, with or without a sand veneer. Wider interdunes vary from similar through to grey self-mulching clays equivalent to those in the Cooper system.
Cooper	Floodplain; heavy pale grey self-mulching clays Floodout: red sandy clay with sand veneer, prone to flooding, in outwash partially dammed by Holocene sand rise. Numerous shallow gutters. Prone to ephemeral flooding

(modified from Fatchen 2002)

The sediments are underlain by:

- Yandruwantha Sand – medium to coarse grained sand
- Namba Formation – deltaic and lacustrine clay, silt and sand
- Eyre Formation – sandstone and shale.

The Jurassic to Cretaceous Eromanga Basin sediments were deposited in a shallow continental sea around 180–65 million years ago and range in thickness from 1,200 m to 2,700 m and comprise the following units (Armstrong et al 1995):

- Cretaceous – Winton Formation: fresh water fluvio-lacustrine sequence of fine sands, silts, clays and lignites
- Cretaceous – Oodnadatta Formation: marine sands, silts and clays
- Cretaceous – Bulldog Shale: mainly shale with occasional calcareous nodules
- Cretaceous – Cadna-owie Formation: sandstone, siltstone, carbonaceous claystone and locally pebbly layers
- Late Jurassic – Algebuckina Sandstone: fluvio-lacustrine sequence of mainly coarse sandstone
- Late Jurassic – Birkhead Formation: micaceous and carbonaceous shale
- Early-Middle Jurassic – Hutton Sandstone: coarse grained, conglomeratic, loosely cemented

The Permian-Triassic Cooper Basin occurs below the Eromanga Basin and has a thickness greater than 1,500 m and comprises fluvial, deltaic and swamp deposits. Two prominent north-east to south-west trending troughs are present, the Patchawarra and Nappamerri troughs. Within the Cooper Basin are the Nappamerri Group and the Gidgealpa Group. The Gidgealpa Group which has been deposited on either Warburton Basin sediments or granitic basement consist of the following units (Armstrong et al 1995):

- Merrimelia Formation: fluvio-glacial sandstones, conglomerates and rhythmites
- Tirrawarra Sandstone: conglomerate, sandstone, siltstone
- Patchawarra Formation: peat swamp and flood-plain deposits, siltstone, sandstone, coal
- Murteree Shale: homogeneous shaly siltstone containing thin lenses of sandstone
- Epsilon Formation: fluvio-deltaic to lacustrine shale, siltstone and sandstone

- Roseneath Shale: lacustrine shaly siltstone with minor sandstone lenses
- Daralingie Formation: fluviodeltaic sandstone, siltstone and coal sequence
- Toolachee Formation: sandstone, mudstone and peat swamp coal.

The Nappamerri Group consists of the Late Permian to Middle Triassic Arrabury Formation (Callamurra, Paning and Wimma Sandstone Members) and the Middle Triassic Tinchoo Formation.

4.5 Surface water

The Lake Eyre Basin contains the major surface water drainage systems of the Cooper and Diamantina systems. The flood plains of the Cooper Basin are associated with the Cooper Creek drainage system which originates in the wetter catchments of southwest Queensland and eventually discharges to Lake Eyre. Stream flow data suggests that the Cooper Creek has an annual average flow of 1.12 million ML (NLWRA, 2000).

The area also includes the Coongie Lakes and Strzelecki wetland systems and are included in the directory of nationally important wetlands and are also listed under the Ramsar Convention.

Permanent water does not occur in the gibber plains. Temporary pools can form after rain in depressions or gilgai.

The project area does not drain directly to the Cooper Creek, with drainage being to the east and southeast to clay pans, low lying inter-dune and dune areas (Plates 4.1 and 4.2).



PLATE 4.1
Drainage area east of the site



PLATE 4.2
Inter-dune drainage area southeast of the site

4.6 Hydrogeology

4.6.1 Regional hydrogeology

The project is located within an area of the Eromanga Basin which is part of the multi-aquifer Great Artesian Basin (Figure 4.3, Cotton et al 2006). The Eromanga Basin comprises two major confined aquifers:

- Upper confined aquifer – Eyre, Winton and Mackunda formations
- Lower confined aquifer – Algebuckina Sandstone and Cadna-owie Formation.

The upper confined aquifer is overlain by Tertiary sediments of the Lake Eyre Basin. The salinity of the upper aquifer can exceed 5,000 mg/L and would not be suitable for stock watering.

To the east the lower aquifer is thicker and includes the sediments of the Murta Formation, Namur Sandstone, Birkhead Formation and Hutton Sandstone. The lower aquifer is a source of artesian water with a salinity ranging from 600 – 2,000 mg/L.

Recharge to the GAB is generally considered to occur at the margins of the basin by direct infiltration of rainfall from the Great Dividing Range in Queensland. There is also minor recharge around the southern and western margins of the basin. Discharge from the GAB occurs via springs, bores and vertical leakage.

Groundwater resources of the GAB currently support the pastoral industry, mining and petroleum industries and many naturally flowing mound springs to the southwest. The Innamincka Progress Association maintains the ware supply for the town.

In March 2003 the Far North Prescribed Wells area was prescribed by the SA Government. A draft Water Allocation Plan was developed and is soon to be considered by the Minister.

The Water Allocation Plan will require all water users to have a licence to take water from the GAB.

4.6.2 Proposed water supply

The area within which the Geodynamics project is located in the Far North Prescribed Wells Area (FNPWA). The FNPWA incorporates the portion of the GAB which lies within South Australia and some immediately adjacent areas. The FNPWA has been set up to primarily achieve responsible use of the GAB resources in South Australia.

Approval (in the form of a licence and water allocation) is required for abstraction and use of groundwater for the project. Geodynamics made an application as an existing user (Reference 41029) in September 2003, seeking an allocation of potable water for the camp and geothermal energy development. The application is currently being considered by DWLBC as part of determination of existing user applications for the FNPWA. The water allocation will be utilised for the extraction of potable water and if required make-up water for the power plant. However it is unlikely that a significant volume of make-up water will be required due to the process being undertaken in a “close-loop process where no significant losses from the system are expected.

The existing Geodynamics operations extract potable water from Darby’s well, located about 500 m south of the proposed 1MW power plant site (Plate 4.3). The following information is available for Darby’s Bore.

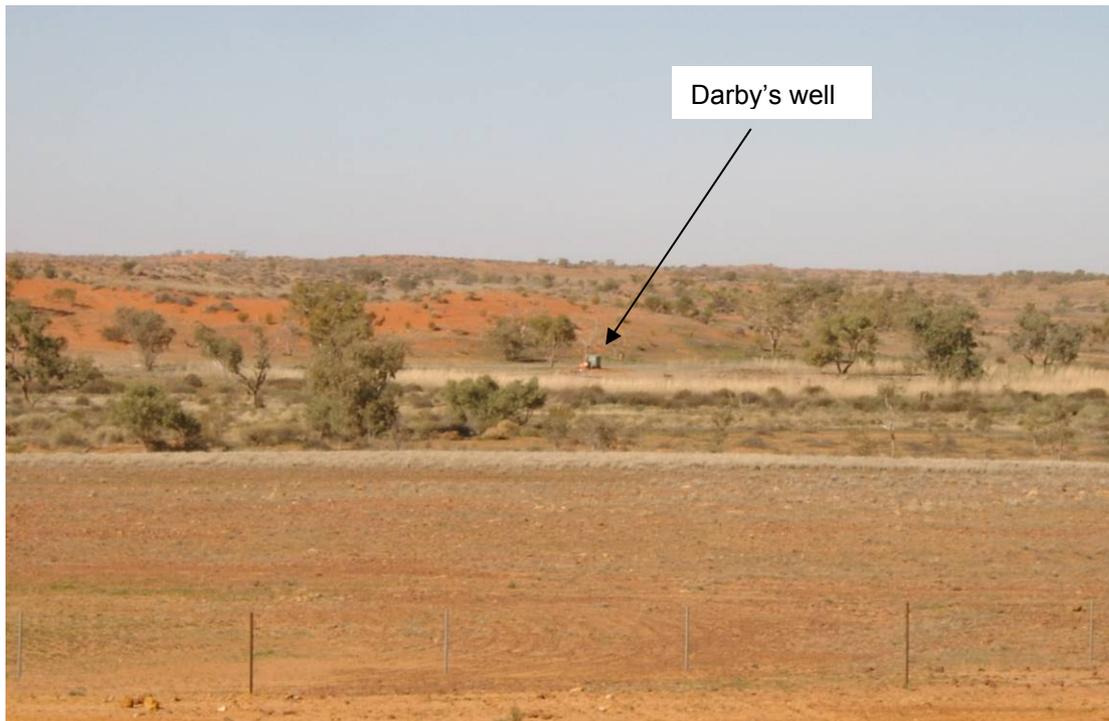


PLATE 4.3
Darby’s Well

Table 4.2 Hydrogeological data Darby’s Bore

Bore name	Depth (m)	Water level (m bgl)	EC (mS/cm)	TDS (mg/L)	Yield (L/s)
Darby’s Bore	40.0	22.0	570	314	2.00

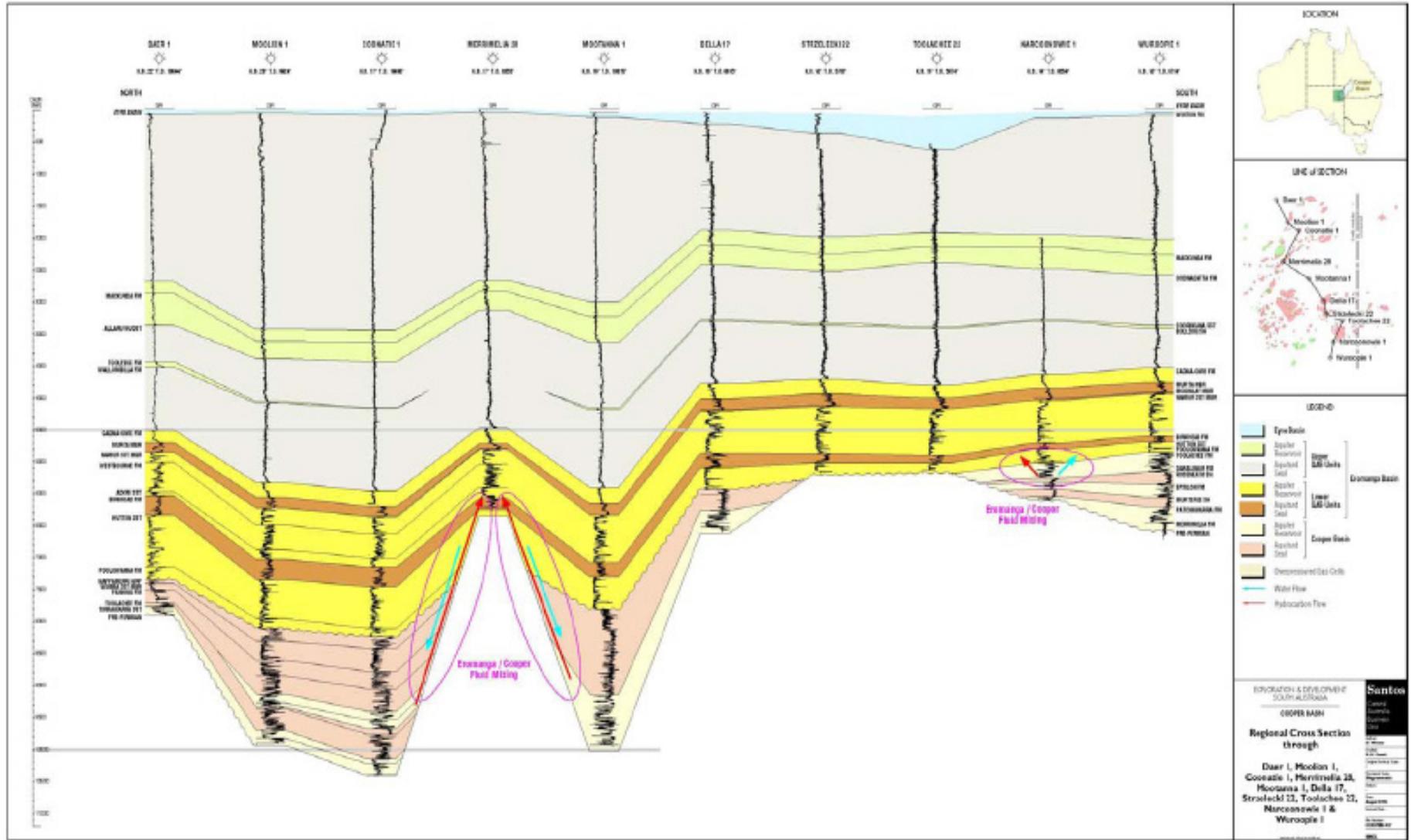


FIGURE 4.2
Geological cross section (from Santos 2003)

GREAT ARTESIAN BASIN (South Australia) HYDROSTRATIGRAPHY	
Quaternary sediments	Watertable (unconfined aquifer)
Tertiary of the Lake Eyre Basin	
Winton Formation	Upper confining bed
Mackunda Formation	Upper confined aquifer
Oodnadatta Formation Coorikiana Sandstone Bulldog Shale	Lower confining bed
Cadna-owie Formation Algebuckina Sandstone Murta Formation Namur Sandstone Westbourne Formation Adori Sandstone Birkhead Formation Hutton Sandstone	Main artesian aquifer
Drn TF	202770_075

FIGURE 4.3
Hydrostratigraphy of the Great Artesian Basin in South Australia
 (from Cotton, et al 2006)

4.7 Native vegetation

4.7.1 Regional context

The Geodynamics project site is located within the arid lands of South Australia, approximately 12.3 km south-east of Innamincka by road and about 7 km in a straight line, and falls within the Channel Country Bioregion (DEH and SA Arid Lands NRM Board 2008). The Channel Country Bioregion is characterised by the two huge drainage systems of the Georgina–Diamantina and the Cooper systems. Consisting of small stream channels and flood courses of the Coongie Lakes wetland system, extensive gibber plains, low hills and

mesa's and vast dunefields and sand plains supporting low shrubs, grasses and herbs. These habitat types also characterise the Geodynamics project area.

Major land uses within the Channel Country Bioregion include pastoralism, conservation, tourism, and mining and petroleum industries. The main land use within the Channel Country bioregion is cattle grazing, with the extensive flood plain areas supporting the highest densities of stock within the region. Pastoralism administered under the *Pastoral Land Management and Conservation Act 1989* covers over 75% of the region. In the Channel Country bioregion, land dedicated solely to conservation is restricted to the Coongie Lakes National Park and the Exclusion Zone at Cullyamurra Waterhole in the Innamincka Regional Reserve.

A multiple use framework applies in the Innamincka Regional Reserve which enables pastoralism and mining and petroleum activities to be undertaken. Petroleum industry activity in the bioregion is predominantly restricted to the oil and gas fields of the Cooper Basin. Mineral exploration licences are held over the Innamincka and Strzelecki Regional Reserves. Petroleum tenements cover over 10% of the region. In addition there are extensive geothermal energy tenements in the region, with Geodynamics' licences covering an area of 1,962 km².

The draft Biodiversity Plan for the bioregion (DEH and SA Arid Lands NRM Board 2008) lists the major threats to biodiversity in the bioregion as:

- excessive total grazing pressure (the combined effects of grazing from domestic stock and feral and native species)
- alteration to natural water flows (restrictions on natural flow and flooding regime of a watercourse due to diversions or artificial flow barriers and storages)
- competition for resources (between native and introduced species)
- predation (of introduced species upon native species)
- altered fire regimes (changes to fire that differ to the previous regime that the ecosystem was adapted to)
- mechanical disturbance (changes to vegetation cover and soil exposure due to human activities)
- pollution (reduction in the quality of ground and surface water); and
- climate change (changes in rainfall patterns and increase in temperature)

The proposed 1 MW power plant site is located within the Innamincka Regional Reserve. The Innamincka Regional Reserve has been used for pastoral grazing since the 1870s and has been leased and managed by the Kidman family company since the early 1900s. Interest in the potential for petroleum in the area began in the 1950s and today the petroleum resources of the reserve are extracted and refined by Santos Ltd.

The Birdsville and Strzelecki Tracks are the major tourism routes through the region. There have always been visitors to the area through Aboriginal use and trading routes, early European explorers, and more recently, a growing tourism industry (DELM 1993).

4.7.2 Vegetation in the project area

4.7.2.1 Previous site investigations

Previous studies have been undertaken at the project site as part of statutory requirements under the *Petroleum Act 2000* prior to Geodynamics undertaking drilling and testing (Fatchen 2002). A copy of the report is included in Appendix A.

The studies which were undertaken in May 2002 are relevant to the project as they were undertaken within the footprint area of the 1 MW power plant. The following sections summarise the results of the investigations.

In addition, previous reports about species which may occur within or near the Geothermal Plant site were reviewed, these reports include:

- DEH and SA Arid Lands NRM Board (2008), South Australian Arid Lands Biodiversity Strategy Draft.
- Nano, C., Harris, M., and Pavey, C. R. (2007). National recovery plan for threatened Acacias and *Ricinocarpos gloria-medii* in central Australia. Northern Territory Department of Natural Resources, Environment and the Arts, Alice Springs.

4.7.2.2 EBS Study

Environmental and Biological Services (EBS) was commissioned to undertake Flora investigations for the proposed electricity transmission line route along Dillons Highway to Innamincka. Whilst approval for the electricity transmission line is not part of this EIR, information from the area adjacent to the 1 MW plant site is relevant and has been used to update the EIR.

4.7.2.3 Vegetation description

The proposed project site is located at the boundary of three land systems; the gibber slopes of the Merninie Land System, the dunes of the Strzelecki Land System, and floodouts and floodplains associated with the Cooper Land System. All activities associated with the project will be undertaken within the Merninie Land System.

The dominant habitat types identified, within and adjacent to the project area, during the initial survey (Fatchen 2002) are indicated in Figure 4.4 and Table 4.4 and typical site photographs prior to development of the Habanero 1 drill site and accommodation camp are included in Plates 4.4–4.7. The list of species detected during the investigations is included in Table 4.3.

The dominant habitat types identified within and adjacent to the main Geodynamics project area during the initial survey (Fatchen 2002) were:

- stony tablelands defined by gibber with little gilgai development, supporting open perennial grassland of Mitchell grass-copperburr (*Astrebla pectinata* – *Sclerolaena ventricosa*) and perennial grassland with cover of 10-15%
- an intermittent swamp containing lignum shrubland (*Muehlenbeckia florulenta*), coolabah woodland (*Eucalyptus coolabah*) and some bloodwood (*E. centralis*) emergent
- dunefield with short grass and short-lived perennial dwarf shrubs primarily *Aristida contorta*, *Enneapogon avenaceus* and *Sclerolaena diacantha*
- sandy rises mixed with low woodland of the whitewood, beefwood, hopbush and *Bauhinia sp.*

Table 4.3 Species records from the area around Habanero 1 – Project site

Species	Common name
Alien species	
<i>*Malvastrum americanum</i>	
<i>*Salsola kali</i>	Buckbush
Trees and tall shrubs	
<i>Atalaya hemiglauca</i>	Whitewood
<i>Corymbia terminalis</i>	Bloodwood
<i>Eucalyptus coolabah</i>	Coolabah
<i>Hakea leucoptera</i>	Needlebush
Perennial and short-lived perennial grasses and dwarf shrubs	
<i>Astrebla pectinata</i>	Mitchell grass
<i>Atriplex sp.</i>	Saltbush
<i>Chenopodium auricomum</i>	Queensland Bluebush
<i>Crotalaria cunninghamii</i>	Regal Birdflower
<i>Crotalaria eremaea ssp. Strehlowii</i>	Rattlepod
<i>Cullen australasicum</i>	Tall Verbine
<i>Eragrostis eriopoda</i>	Neverfail
<i>Goodenia lunata</i>	
<i>Maireana ciliaris</i>	
<i>Muehlenbeckia florulenta</i>	Lignum
<i>Panicum decompositum</i>	Native Panic
<i>Salsola kali</i>	Buckbush
<i>Sclerolaena brachyptera</i>	
<i>Sclerolaena diacantha group</i>	Grey bindyi
<i>Sclerolaena lanicuspis</i>	Wooly bindyi
<i>Sclerolaena ventricose</i>	Salt bindyi
<i>Sida ammophila</i>	Sand sida
<i>Sida corrugate</i>	
<i>Sida pinnatifida</i>	
<i>Tribulus hystrix</i>	Sandhill Puncture Vine
<i>Zygophyllum howittii</i>	Clasping Twinleaf
Ephemeral grasses and herbs	
<i>Aristida contorta</i>	Kerosene grass
<i>Aristida spp</i>	Kerosene grass
<i>Dactyloctenium radulans</i>	Button grass
<i>Enneapogon avenaceus</i>	Bottlewashers
<i>Eragrostis brownie</i>	
<i>Eragrostis dielsii</i>	Mulka
<i>Eragrostis setifolia</i>	Neverfail
<i>Euphorbia drummondii</i>	
<i>Euphorbia tannensis</i>	Bottle tree spurge
<i>Lotus cruentus</i>	
<i>Portulaca oleracea</i>	Pigweed
<i>Rhynchosia minima</i>	

Species	Common name
<i>Sporobolus actinocladus</i>	
<i>Swainsona Formosa</i>	Sturt pea
<i>Tragus australianus</i>	
<i>Tribulus terrestris</i>	Caltrop
<i>Trigonella suavissima</i>	Cooper clover
<i>Triodia basedowii</i>	Lobed Spinifex
<i>Tripogon loliiformis</i>	Five minute grass
<i>Zygochloa paradoxa</i>	Sandhill Canegrass

(from Fatchen, 2002 and EBS, 2008)

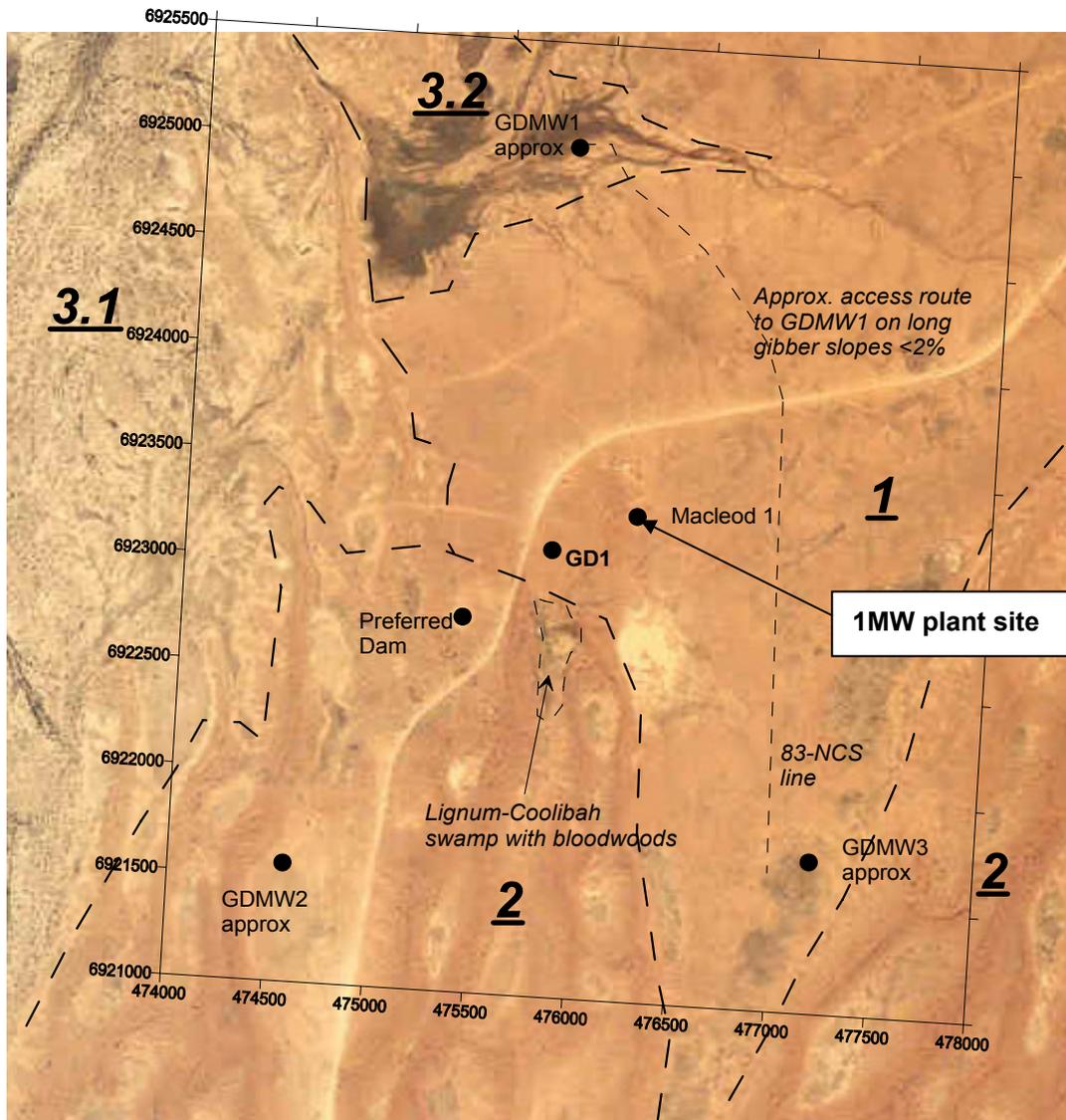


FIGURE 4.4
Local area prior to development of drilling sites and current operations
 (from Fatchen 2002)

Table 4.4 Description of land systems

Key	Land system	Landform/soils	Vegetation
1	MERNINIE	Long gradual slopes of silcrete gibber (this area). Duplex friable sandy loam over light clay. Highly dispersible. Irreversible accelerated erosion will start at slopes above 2%. Dense gibber lag on surface.	Mitchell grass-neverfail perennial grassland with short-lived chenopod shrubs, especially <i>Sclerolaena brachyptera</i> . Effectively treeless.
2	STRZELECKI (DELLA)	Dunefield. Red siliceous sands, semi-mobile crest (in this area) and semi-stable slopes. Narrow interdunes with massive red sandy clays, with or without a sand veneer. Wider interdunes vary from similar through to grey self-mulching clays equivalent to those in the Cooper system.	Sandhill canegrass hummock grassland on dunes. Mid-slopes and narrower swales with low open woodland of whitewood, sandhill wattle, hopbush, needlebush. Narrower swales with bean tree, bloodwood (this area) over short grasses: swampy areas with lignum, coolabah as shrubland or woodland. Stands of beefwood common. Broader swales with herbland or areas of <i>Eragrostis</i> and short-lived chenopod shrubs; trees largely limited to sandy or swampy areas.
3.1	COOPER	Floodplain; heavy pale grey self-mulching clays	Woodland: coolibah, whitewood, spotted emubush, bean tree over lignum, old man saltbush, herbs
3.2	COOPER	Floodout: red sandy clay with sand veneer, prone to flooding, in outwash partially dammed by Holocene sand rise. Numerous shallow gutters. Prone to ephemeral flooding	Short grass cover (<i>Enneapogon</i> , <i>Aristida</i> , perennial <i>Eragrostis</i> spp.) with flat sedge and areas of tree or tall shrub cover: beefwood, sandhill wattle, prickly wattle, spotted emubush.

(from Fatchen 2002)



PLATE 4.4
GD1 (Habanero 1) wellsite looking north to Dillon's Highway.
Mitchell grass-Sclerolaena cover on gibber, slopes 2% (from Fatchen 2002)



PLATE 4.5
GD1 (Habanero 1) wellsite looking southeast from road.
Mitchell grass-Sclerolaena cover on gibber, slopes 2% (from Fatchen 2002)



PLATE 4.6
GD1 (Habanero 1) Wellsite eastern edge:
roadway drain erosion on 4% slope (from Fatchen 2002)



PLATE 4.7
Lignum (*Muehlenbeckia florulenta*) and coolibah (*Eucalyptus coolabah*)
swamp in swale immediately south of GD1 (Habanero 1) site area.
Bloodwood (*E. centralis*) also present (lower trees) (from Fatchen 2002)

4.7.3 Listed threatened species

The Commonwealth EPBC 'Protected Matters Search Tool' indicated that *Acacia pickardii* (Birds Nest Wattle, Pickard Wattle) may have habitat available in the Geothermal Plant project area. The species has a national rating of Vulnerable (*EPBC Act 1999*) and a state rating of Rare (*National Parks and Wildlife Act 1972*).

Field inspection (Fatchen 2002) uncovered no species listed in the schedules of both the SA *National Parks and Wildlife Act 1972* and the *Environment Protection and Biodiversity Conservation Act 1999*. Current searches have not found prior records to date. However, attention is drawn to the presence of bloodwoods (*Eucalyptus centralis*) in the drainage terminus a short way south of Habanero 1. This species at this point is almost at its southernmost limit, and there is the potential for other species, not evident at the time of survey, to also be present at limits of distribution. Fatchen 2002 recommended that the drainage terminus should therefore be regarded as sensitive, and avoided in operations, even though the vegetation and habitat is not sufficiently distinctive to suggest potential for presence of rare or threatened species.

4.8 Fauna

4.8.1 Regional context

The Channel Country Bioregion (DEH and SAANRMB 2008) supports a number of fauna species, including endemic species (particularly reptiles). Within this region, the Coongie sub bioregions are known to support up to 18 Raptor Species, 73 water bird species (particularly the Australian Painted Snipe (*Rostratula australis*) and another 13 wetland dependent species. The Channel Country Bioregion contains the Coongie Lakes Ramsar Wetland (protected under the Ramsar Convention and the EPBC Act) which supports many of these species.

As outlined previously, the Geodynamics Project site falls within the Channel Country Bioregion. This Bioregion contains a diverse range of habitats to support various fauna throughout the region. Within this bioregion is the Sturt's Stony Desert Sub Bioregion, within which the Geodynamics Project site is located. This region consists of gibber plains and scattered long red sand dunes. The nationally Vulnerable Kowari (*Dasyercus byrnei*) has its South Australian stronghold in the gibber plains on the eastern flanks of Goyder Lagoon, and one of the inland burrowing frogs listed as rare in South Australia, the Knife-footed Frog (*Cyclorana cultripes*), lives in the gibber and gilgai areas and relies on the periodic wetting and drying of the cracking clays for survival.

The stony gibber plains are characterised by a high proportion of ephemeral species. These species have short lifecycles, enabling them to exploit the irregular and infrequent rains. Most of the perennial vegetation is in the highly productive areas of the gilgais and minor drainage depressions, and even modest rainfall events trigger extensive ephemeral growth. It is this localised and short-lived ephemeral vegetation that provides the unique habitats that are able to be exploited only by certain animals with specific adaptations. This means that more species are restricted or endemic to this landscape type than any other in the bioregion.

4.8.2 Fauna in the project area

Additional fauna investigations were undertaken by EBS in July 2008 (Appendix B). More favourable results could be expected if surveys were undertaken in late autumn or spring. All field surveys were undertaken using standard methodology developed by the Department for Environment and Heritage (Owens 2000), in line with South Australian government requirements; with the exception being the use of Elliott traps (Plate 4.8).



PLATE 4.8
Elliott traps locate near the proposed 1MW plant

Trapping was undertaken at four separate sites, situated in the following three habitat types:

- *Astrelba pectinata* (Mitchell Grass) open grassland / gibber plain (geothermal energy pilot plant)
- *Muehlenbeckia florulenta* (Lignum) / *Chenopodium auricomum* (Queensland Bluebush) shrubland / Flood plain / intermittent wet area (located south of the site near Darby's well)
- *Zygochloa paradoxa* (Sandhill Canegrass) hummock grassland / sand dunes (south and east of the site).

4.8.2.1 Mammals

Nine mammal species were detected within the study area, through trapping and searches (including for digging, scats and tracks). Specifically, these are:

- House Mouse (*Mus musculus*)
- Rabbit (*Oryctolagus cuniculus*)
- Fox (*Vulpes vulpes*)
- Dingo / dog (*Canis lupus dingo / familiaris*)
- Fat-tailed Dunnart (*Sminthopsis crassicaudata*)

- Stripe-faced Dunnart (*Sminthopsis macroura*)
- Gould's Wattled Bat (*Chalinolobus gouldii*)
- Little Broad-nosed Bat (*Scoterepens greyii*)
- White-striped Freetail-bat (*Tadarida australis*).

It is also possible that the Southern Free-tail Bat (*Mormopterus sp. 3*) is present within the survey area, however, the calls of this species could not be positively identified.

The most commonly recorded species was the House Mouse (*Mus musculus*) with 34 individuals captured. The least commonly detected species, with each only being captured once at the trapping sites, were the Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and Stripe-faced Dunnart (*Sminthopsis macroura*). This is likely due to a combination of factors, predominantly a lack of suitable habitat within the survey area (Gilgais, cracking clays) and the cold weather experienced during the survey period.

The bat species identified within close proximity to the project site, from the Anabat recordings, were expected to occur within the project area. All of these species are widespread within the region and occupy a variety of habitats. No bat species of conservation significance were recorded during the current surveys or have been previously recorded within close proximity to the project site.

No mammal species of conservation significance were observed or detected.

The nationally vulnerable Kowari (*Dasyuroides byrnei*) has been recorded in the Channel Country Bioregion (Neagle 2003), which encompasses the study area. It is not likely, however, that Kowaris occur in the survey area, since there is a lack of preferred habitat within and surrounding the geothermal energy pilot plant. The nationally vulnerable Dusky Hopping Mouse (*Notomys fuscus*), however, could possibly utilise the sand dune habitat located approximately 250 metres to the east and south east of the geothermal energy pilot plant site.

No other mammal species of state or national conservation significance are considered likely to occur within the project area.

4.8.2.2 Birds

Twenty-nine bird species and 238 individuals were observed in the study area. Each species and the numbers recorded are listed in Table 4.5.

Table 4.5 Bird species recorded

Species	Common name	Numbers observed
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill	2
<i>Aquila audax</i>	Wedge-tailed Eagle	2
<i>Artamus cinereus</i>	Black-faced Woodswallow	6
<i>Cacatua roseicapilla</i>	Galah	7
<i>Cacatua sanguinea</i>	Little Corella	25
<i>Cinlosoma cinnamomeum</i>	Cinnamon Quail-thrush	3
<i>Corvus coronoides</i>	Australian Raven	3
<i>Euseyornis cinctus</i>	Red-kneed Dotterel	4
<i>Euseyornis melanops</i>	Black-fronted Dotterel	2
<i>Ephthianura aurifrons</i>	Orange Chat	2

Species	Common name	Numbers observed
<i>Falco cenchroides</i>	Nankeen Kestrel	4
<i>Falco subniger</i>	Black Falcon	1
<i>Gallinula ventralis</i>	Black-tailed Native-hen	11
<i>Gymnorhina tibicen</i>	Australian Magpie	8
<i>Haliastur sphenurus</i>	Whistling Kite	1
<i>Hamirostra sphenurus</i>	Black-breasted Buzzard	4
<i>Hirundo ariel</i>	Fairy Martin	8
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck	5
<i>Malurus leucopterus leuconotus</i>	Variiegated Fairy-wren	36
<i>Manorina flavigula</i>	Yellow-throated Miner	9
<i>Milvus migrans</i>	Black Kite	32
<i>Northiella haematogaster</i>	Blue Bonnet	4
<i>Ocyphaps lophotes</i>	Crested Pigeon	30
<i>Petrocia goodenovii</i>	Red-capped Robin	2
<i>Pomatostomus ruficeps</i>	Chestnut-crowned Babbler	6
<i>Psophodes cristatus</i>	Chirruping Wedgebill	2
<i>Rhipidura leucophrys</i>	Willie Wagtail	2
<i>Taeniopygia guttata</i>	Zebra Finch	12
<i>Vanellus miles</i>	Masked Lapwing	5
TOTAL		238

The *Muehlenbeckia florulenta* (Lignum)/*Chenopodium auricomum* (Queensland Bluebush) shrubland associated with a flood plain/intermittent wet area site had the highest bird species diversity and abundance with 133 individuals and 18 species detected.

The Black-breasted Buzzard (*Hamirostra melanosternon*), a species of state conservation significance (listed under the *National Parks and Wildlife Act 1972*), was recorded in the Mitchell Grass (*Astrebla pectinata*) open grassland over gibber site. It is likely that this species would utilise the area for foraging and feeding purposes, however, due to the small scale of the project, it is unlikely that a significant impact on the species will occur.

Further, an uncommon species within South Australia (Carpenter and Reid 2000), the Chestnut-crowned Babbler (*Pomatostomus ruficeps*), was recorded at trapping site INN002 (refer to Appendix B). However it should be noted this conservation rating is not formally recognized under the *National Parks and Wildlife Act 1972*. Despite this, it is unlikely that this species would utilise the project site due the lack of shrubs and trees across the site.

Several bird species of national conservation significance were identified as possibly occurring within the project area. However none of the species have actually been previously recorded within close proximity to the site. Further, several migratory and/or marine species (listed under the EPBC Act 1999) are also known to occur in the area. These species generally rely on areas containing water and are likely to be concentrated around the Cooper Creek and Coongie Lake Systems. It is possible, however, that on occasions, individuals may be found within the *Muehlenbeckia florulenta* (Lignum) / *Chenopodium auricomum* (Queensland Bluebush) shrubland when surface water is present. It is unlikely that the project will have a significant impact on any of these species due to the distance between the proposed site and the areas containing suitable habitat.

Numerous bird species of state conservation significance have been recorded within close proximity to the project site (see Appendix B). However, a number of these species are waterbird species and are only likely to occur within the *Muehlenbeckia florulenta* (Lignum) / *Chenopodium auricomum* (Queensland Bluebush) shrubland areas. It is likely that some of the raptor species occur in the area and use the proposed site for foraging and feeding. Due to the small size of the project, however, it is unlikely to have a significant impact on any of the listed species.

4.8.2.3 Reptiles and amphibians

Four reptile species and one amphibian species were detected in the study area. The species and the numbers observed are listed in Table 4.6.

Table 4.6 Reptile and amphibian species recorded

Species	Common name	Numbers observed
Reptiles		
<i>Ctenophorus pictus</i>	Painted Dragon	2
<i>Ctenotus regius</i>	Eastern Desert Ctenotus	1
<i>Gehyra variegata</i>	Tree Dtella	2
<i>Heteronotia binoei</i>	Bynoe's Gecko	1
Amphibians		
<i>Neobatrachus centralis</i>	One Trilling Frog	1

Generally the reptile activity was very low due to the time of the year and the cold conditions experienced during the survey period.

The highest reptile / amphibian abundance (6 individuals detected) was found at the site with *Zygochloa paradoxa* (Sandhill Canegrass) hummock grassland associated with sand dunes.

No reptile or amphibian species of conservation significance were observed or detected.

Previous records (Neagle 2003) suggest that four state rated species may occur in the study area:

- Gilbert's Dragon (*Amphibolurus gilberti*)
- Blacksoil Ctenotus (*Ctenotus joanae*)
- Carpet Python (*Morelia spilota*)
- Blacksoil Skink (*Proablepharus kinghorni*)

However none of these species have been recorded within close proximity to the geothermal energy pilot plant site. Further, no suitable habitat occurs within the project site for Gilbert's Dragon (*Amphibolurus gilberti*) or the Carpet Python (*Morelia spilota*).

Although the habitat on site appears to be suitable for the Blacksoil Ctenotus (*Ctenotus joanae*) and the Blacksoil Skink (*Proablepharus kinghorni*), as both species are known to occur on stony plains, there is, however a distinct lack of cracking clays, required by both species as refuge areas. The two are therefore considered unlikely to occur within the proposed geothermal energy pilot plant site

4.8.3 Potential listed threatened species and requirement for EPBC referral

Database searches undertaken as part of investigations at the site included a search of the EPBC Act (1999) protected matters database.

The potential for these threatened species to have habitat in the area, and the presence of any species of state conservation significance, was assessed by EBS.

Three nationally vulnerable fauna species were identified as possibly occurring within the project area from the EPBC Protected Matters database. These species are discussed in more detail below.

A further five Migratory and/or Marine species were also listed as possibly occurring in the area. The five species are unlikely to be directly affected by the project as they would not be reliant on the habitat present within the project site.

Grey Grasswrens (*Amytornis barbatus barbatus*) is listed as nationally vulnerable and occurs on the floodplains of the Bulloo River, in south-western Queensland and north-western New South Wales (Barrett et al. 2003). The extent of the species' occurrence is estimated to be 100 km². Since the only known population occurs in a single location (the Bulloo River drainage basin), it is unlikely that the species would occur in the study area.

The Australian Painted Snipe (*Rostratula australis*), also listed as vulnerable, usually inhabits shallow inland wetlands, freshwater or brackish, that are either permanently or temporarily filled (Morcombe 2003; Garnett & Crowley 2000). The species, therefore, would not utilise habitat within the project site. However, they may be a rare visitor to the nearby low lying *Muehlenbeckia florulenta* (Lignum)/*Chenopodium auricomum* (Queensland Bluebush) shrubland area when water is present. The project will not be impacting upon this vegetation community, and as such, it is highly unlikely that the Painted Snipe will be affected.

Whilst the nationally rated **vulnerable** Dusky Hopping Mouse (*Notomys fuscus*) is unlikely to utilise habitat within the direct area of the geothermal energy pilot plant site, it could possibly utilise the nearby sand dune habitat (located approximately 250 m to the east and south east). However, as the project will not be impacting upon this dune habitat it is considered that there will not be any significant impact upon this species.

It is unlikely that the geothermal energy pilot plant site will have any significant impacts on nationally threatened fauna species, migratory species or marine listed species. As such, it is considered that a referral under the EPBC Act is not required in relation to threatened or migratory species.

4.8.4 Recommendations

EBS recommended the following management measures to reduce or avoid potential impacts of construction and operation of the proposed pilot plant site on animals, their habitat and vegetation in general:

- keep vegetation clearance and disturbance to an absolute minimum
- implement weed and pest animal programs as required
- ensure dust (created by construction and operational activities) levels are minimised

- minimise free water by ensuring leaking water pipes are repaired immediately, regardless of the size of the leak
- enforce the 40 km speed limit designated for the Reserve, along access tracks to reduce the impact of road collisions on native fauna
- ensure lights, machinery and equipment are turned off when not being used, particularly overnight, to reduce area avoidance behaviours of fauna species; and
- undertake staff training sessions to promote the awareness of fauna species and fauna habitat within the project area and their reliance on undisturbed habitat. Additionally, reinforce the need to minimise impacts on these species through works undertaken on site. Ensure that all drivers are aware of speed limits and that animals regularly cross the roads

4.9 Pest plants and animals

4.9.1 Plant species

The Fatchen 2002 report indicated that the following weed species were present *Malvastrum americanum* and Buckbush (*Salsola kali*). Management measures are included in section 7 of this EIR.

4.9.2 Animal species

Three exotic mammal species were detected within the geothermal energy pilot plant trapping site (INN001 in Appendix B) including the introduced House Mouse (*Mus musculus*), Rabbits (*Oryctolagus cuniculus*) and Fox (*Vulpes vulpes*). Management measures are included in section 7 of this EIR.

4.10 Geohazards

4.10.1 Radioactivity

The granite located below the site and from which geothermal power will be generated has low concentrations of radioactive elements (uranium, thorium and potassium) which are contained in heavy minerals such as zircon and monazite. Decay of these elements generates heat. Groundwater in the granite will also contain low levels of radioactive elements. Radon gas a daughter product of radium will be dissolved in the water and if discharged in an open system would be present in steam.

The Geodynamics geothermal project in the Cooper Basin is designed to recirculate the superheated water in a closed loop, not an open system. This design was primarily adopted to preserve water (there will be no steam release) and to prevent scale build up by keeping the system under pressure. Any minor amounts of radon that is generated will be returned to 4 km underground where it decays during circulation over a short period of time (radon has a half life of 3.7 days).

In the event of any accidental fluid escape, the instantaneous amount of dissolved radon in the water has been modelled in open systems to be below the maximum permissible level for drinking water.

Emergency response procedures were developed as part of the closed loop testing program and these will be reviewed for the 1 MW pilot plant and if required upgraded.

It is concluded that the risk to public health and safety and impact to the environment associated with the proposed geothermal power generation are low and manageable.

4.10.2 Flooding

The Cooper Creek area is subject to occasional flooding notwithstanding the arid climate. The project site is located outside the flood-prone areas associated with Cooper Creek and its tributaries (Figure 4.1). On this basis direct impact on the 1 MW plant is considered unlikely. However flooding associated with Cooper Creek could have an impact on the unsealed roads in the area and limit access to the site.

Fatchen (2002) made reference to potential flooding associated with an area defined as lignum swamp located approximately 300 to 500 m south of the site. The proposed building area and associated infrastructure is elevated at least 2–3 m above the level of this drainage feature (refer to Plate 4).



PLATE 4.9
Elliott traps locate near the proposed 1MW plant

This is part of a drainage area east of the site that drains to the south in between two longitudinal dunes. Given the topographical location of the proposed operations relative to the drainage area it is not considered likely that the operations would be flooded.

Drilling activities have been undertaken at the site for a period of four years and in that time there has been no impact due to heavy rainfall events.

4.11 Air quality

While there has been no specific monitoring of dust levels in the Project area, existing ambient air quality has been inferred from existing land uses and vegetation cover in the area.

Particulate matter (dust), as the result of wind, is likely to have the most significant impact on air quality. Oodnadatta, 575 km east of the project site, experiences on average five dust storms annually (Arid Areas Catchment Water Management Board 2006). This frequency is related to lack of ground cover and major dust storms have been recorded after periods of drought. High wind levels may exacerbate dust generation and lead to an increase in the concentration of airborne dust at the site.

4.12 Noise

No specific noise monitoring has been collected for the project area. However, no significant, permanent man-made noise sources are located near the project area. The current major noise sources in the area are related to the drilling operations and closed loop testing being undertaken by Geodynamics. Other transient noise would result from wind blowing over vegetation and vehicle movements along Dillons Highway. The nearest sensitive noise receptor to the proposed operation is Innamincka township which is located 12.3 km north-west of the project area by road and about 7 km in a straight line.

Geodynamic has indicated that the 1 MW power plant would result in noise levels of 85 dB (A) at 50 m from the facility.

The noise level at Innamincka, approximately 7 km radial distance from the source, is expected to be below 30 dB(A). On this basis there would not be any concern with operation of the plant.

4.13 Heritage

4.13.1 Indigenous heritage

A search of the Register of Aboriginal Sites and Objects, maintained by the Aboriginal Affairs and Reconciliation Division of the Department of Premier and Cabinet, was conducted for Habanero 1 and the pipeline route between Burlieburly Water hole and Habanero 1 in 2002 (ACHC 2002). They revealed that there are no legally protected Aboriginal Sites included on the Register. The closest of these is located 200 metres to the south of the Habanero 1 drilling site.

Work Area Clearances (WACs) were undertaken for activities in the vicinity of Habanero 1 and the water pipeline route between Burlieburly Waterhole on the Strzelecki Creek and Habanero 1 Well. WACs are documented in the following reports (Appendix C):

- Archaeologist and Cultural Heritage Consultant (2002) – Work Area Clearance of the proposed activities in the vicinity of Habanero 1 Well on GEL 98, south of Innamincka, South Australia.

- Archaeologist & Cultural Heritage Consultant (2003) – Further Work Area Clearance of the proposed water pipeline route between Burlieburle Waterhole on Strzelecki Creek and Habanero 1, south of Innamincka, South Australia.

Cultural and archaeological heritage sites have been identified away from the Habanero 1 site. These were found on rocky outcrops, in deflations at the edges of clay pans, sand dunes and sand ridges. The reports recommended that all activities and access are restricted to those areas given clearance and that all personnel should not disturb any Aboriginal cultural sites or cultural material.

As the proposed building and waste water treatment plant system is located within the already cleared area there will be no need for additional site clearance.

4.13.2 Non-Indigenous heritage

No places or items of non-indigenous heritage have been identified within the project area.

4.14 Socio-economic

4.14.1 Study area

The 1 MW pilot plant site is situated 12.3 km south-east of Innamincka by road and about 7 km in a straight line, in the north-east of South Australia. Innamincka has a population of 16 and the township includes one hotel and a store/roadhouse. The other nearest settlement is at the Moomba oil and gas production facility, approximately 80 km south-west of the site.

A summary of socio-economic data obtained from the Australian Bureau of Statistics 2006 Census is provided below and data included in Appendix D. The site is included within the Innamincka (State Suburb) and incorporates the northeast portion of South Australia (east of Maree).

4.14.2 Population

In the 2006 Census there were 131 persons that were usually resident in the Innamincka (Suburb), of which 74% were males and 26% were female. Of the total population in the region 4.6% were indigenous persons, compared to 2.3% in Australia.

The population within the Census area consists of 9.9% children between the ages of 0-14 years and 13% were persons 55 years and older. The median age was 40 years, compared to 37 years for Australia.

4.14.3 Employment

At the 2006 Census 96 people who were 15 years and older 89.6% were in full time employment, 4.2 % had part time employment and 6.3 % were employed away from the region.

The most common industries of employment were as follows; 20.8% in sheep, beef cattle and grain farming, 13.5% in the oil and gas industry, 8.3 % in accommodation, 7.3 % in other mining services and 5.2% livestock farming.

Of those employed, 31.3% were technicians and trade workers, 18.8% were managers, 18.8% were labourers, 13.5% were machinery operators and drivers, 6.3% were clerical and administrative workers. Sales workers, professionals, community and personal service workers, each were 3.1% of the workforce.

4.14.4 Income

The median reported weekly individual income was \$892 and the median household income was \$700.

4.14.5 Tourism

The majority of tourism is based on private vehicles, usually 4WD, but there is also a component of bus and safari-type commercial tours (Soil Conservation Council of South Australia, 2004).

The main tourist attractions in the area are:

- Cooper Creek and the Coongie Lakes – Ramsar wetlands
- The Birdsville and Strzelecki tracks
- Innamincka
- Moomba Oil and Gas production facility.

The State of the Outback Report (Outback Areas Community Development Trust, 2005) indicates an increasing average duration of visitations and a rising total number of overnight visitors to the Flinders Ranges and Outback Tourism region.

Tourists use the Dillons Highway which provides access for travels from south-west Queensland into South Australia. Travel by off-road vehicles to remote scenic areas has also been increasing which can create problems for environmental management and privacy for regional station owners (Planning SA 2003).

4.14.6 Social status of the outback areas

The following observations on the social status for the region were made in the State of the Outback Report (Outback Areas Community Development Trust, 2005):

- 3.5 years less average life expectancy
- similar literacy rates to Adelaide for year 7 aboriginal students
- crime rates were lower in the outback areas than metropolitan areas
- access to education was perceived to be good for primary school services and neutral for secondary and TAFE education
- accessibility to doctors (including the flying doctor service) was considered to be acceptable on balance
- access to air services was considered to be poor
- access to internet was considered to be good, whereas mobile phone access was poor.

4.15 Infrastructure and transport

4.15.1 Infrastructure

4.15.1.1 Electricity

The project area is not connected to the state grid. Electricity at the existing camp and warehouse is provided by diesel generator. Households in Innamincka are powered by diesel generators. The intent of the project is to produce power via the 1MW plant to power the camp, visitor centre and other on-site requirements and also to provide power to Innamincka, at no charge.

4.15.1.2 Water supply

Pastoralists operating in and around the project area utilise underground water resources for stock watering. The existing Geodynamics operations extract potable water from Darby's well located approximately 500 m south of the site. The Innamincka water supply is sourced from Cooper Creek.

4.15.1.3 Other infrastructure

Geodynamics has installed a fence around its existing operation (camp site and warehouse).

4.15.2 Transport

4.15.2.1 Road

The Dillons Highway is located adjacent to the site and provides a link between Innamincka, the Queensland border and Moomba. This highway is unsealed and maintained by DTEI and is used by pastoralists, tourist traffic, exploration companies and Geodynamics. The site is 80 km by road from Moomba and 12.3 km from Innamincka by road and about 7 km in a straight line.

Within the area there are also station tracks, tracks within reserves and exploration tracks used by the oil and gas industry. All of these tracks are not classified as public roads. Santos has an extensive network of tracks for the transport of oil and gas production activities.

4.15.2.2 Air

National Jet operates a daily service between Adelaide and Moomba, primarily to service the Moomba oil and gas production facility. The Innamincka Progress Association manages an air strip in Innamincka. Emergency airstrips are used by the Royal Flying Doctor Service and are located on various pastoral properties.



5. Description of operations

5.1 Introduction

The objectives of the pilot plant are to:

- Construct a small (1MW) pilot generating plant using the Habanero 1 and 3 wells.
- Use the plant to generate power for the:
 - ▶ Site camp
 - ▶ ‘Innamincka Visitor Centre’ to be built in close proximity to the Habanero 1 well. (The Innamincka Visitor Centre will include the Turbine hall for the 1MW plant and is therefore a dependent project.)
 - ▶ Warehouse proposed to be built between the Habanero 1 and 3 wells
 - ▶ Innamincka township
 - ▶ Potentially the Innamincka Cattle Station.²
- A power line from the 1MW Plant to the Innamincka township (and possibly to the Innamincka Cattle Station). This component of the project will be undertaken as a design, construct and management with all approvals being sought by the selected ‘electricity entity’ as defined in the *Electricity Act 1996*

5.2 Operations

5.2.1 Key Characteristics

Key characteristics of the 1 MW pilot plant are summarised in Table 5.1.

Table 5.1 Key characteristics of the project

Item	Description
Project Location	12.3 km south-east of Innamincka by road and about 7 km in a straight line, South Australia
Geothermal Licence	GEL 98
Trial Project Area	0.1 ha
Operating hours	Continuous operation, up to 24 hours per day, 7 days per week
Power source	On site geothermal energy
Potable water source	Existing production bore
Accommodation	All staff will reside at the on site accommodation
Employees	10 trades people during construction, 3-8 during operations

5.2.2 Habanero 1 and 3 Doublet

Power generation from the 1 MW pilot power plant will involve circulation of water between Habanero 1 and 3 wells, which are 500 m apart. The wells are connected by a pipeline and

² This is subject to negotiation with the Kidman Cattle Company.

water will be circulated from Habanero 3 to Habanero 1 via an above ground pipeline (refer to Figure 5.1 and Plate 5.1) and heat exchangers.

The heat exchangers are located east of the building (refer to Figure 5.1 of the EIR, indicated as external plant). Thermal coolers (involving three units approximately 4 m wide by 12 m long) are proposed to be established adjacent to the heat exchangers. All piping between the heat exchangers, thermal air coolers and power plant will be above ground.



PLATE 5.1
Pipeline between Habanero 1 and Habanero 3

5.2.3 Visitor Centre, Power Plant and Warehouse

The visitor centre, power plant and warehouse are all located within the disturbed footprint of the existing operations. The total site footprint for the 1 MW plant and associated components is 0.1 ha, of which the building containing the visitor centre, power plant and workshop occupies an area of 400 m². There will be no requirement to establish borrow pits for the proposed development.

It should be noted that there will be no access to the building area to the general public. The visitor centre will be used for Geodynamics' approved technical tours and organised visits to the pilot plant. An information board will be provided outside the fenced site, near Dillons Highway for the general public.

The general site layout is included in Figure 5.1 and architectural drawing of the building is included in Figure 5.2.

Roof run-off will be collected in rainwater tanks and the overflow will be discharged by sub-surface piping to the existing lined dams (refer to Figure 5.1) located to the east of the site to minimise the potential for soil erosion.

The foundations for the visitor centre and power plant building and warehouse will be concrete slabs on ground. The slabs are supported by 600 mm and 350 mm wide deep edge beams excavated into the existing surface. Soil disturbance will be the minimum that is required to enable construction of the footings.

The heat exchanger and thermal air coolers are founded on strip footings. Design of the footings is being undertaken, however, they are likely to be to a similar depth indicated above..

5.2.4 Wastewater treatment

Wastewater will be collected from the visitor centre complex and treated in a package wastewater treatment plant that will be manufactured off-site for assembling on the site. The visitor centre will have 2 toilets, one first aid room with small sink, a small kitchen, a cleaners room with one sink and a disabled toilet and shower. The existing camp has a septic tank system which will be maintained until a new camp is established in the future. The new camp is not part of this EIR.

Geodynamics is proposing to utilise the OzziKleen RP 10 aerobic treatment plant manufactured by Suncoast Waste Water Management (Appendix E). The plant which will treat both grey and black water has been approved by the Department of Health for use in South Australia.

The package wastewater treatment plant (WWTP) will be skid mounted. Sewer pipes will be established in trenches. The excavated material will be placed adjacent to the trench with each soil unit kept separate and will be used as backfill where practicable. Gibber will be placed as the final layer and compacted in place.

The proposed wastewater treatment plant and subsurface infiltration area is located within part of the existing cleared footprint, which was established as part of earlier works programs (refer to Plates 1.1 and 1.2). The proposed location of the plant and subsurface irrigation area are indicated in Figure 5.1 and layout plans included in Appendix E.

The estimated maximum hydraulic loading for the system is as follows:

- 30 visitors x 30 litres = 900 litres
- 2 attendants x 30 litres = 60 litres
- 1 x disable toilet with shower = 200 litres
- Total hydraulic load = 1160 litres/day
- Add Safety margin 25% = 1,450 litres/day

The estimated organic loading is as follows:

- 30 visitors x 10 grams = 300 g. BOD
- 2 attendants x 25 grams = 50 gr. BOD
- 1 disable toilet & shower = 25 gr. BOD
- Total BOD loading = 375 gr
- Add safety margin 25% = 468.75gr. BOD

The treatment plant has the following key features:

- Treatment capacity of 2,000 L/day and organic load of 700 grams BOD
- 4000 litres pump station fitted with duty/standby sewage pumps allowing for possible shock load

Sludge from the treatment plant will be collected periodically for appropriate disposal to an EPA licensed landfill. The treated wastewater will be discharged via a subsurface infiltration system (Sulldrain). Approval for installation of the wastewater treatment system from the Department of Health.

5.3 Site water management

The project site is located in an arid environment where evaporation far exceeds rainfall. Integral to the ongoing management of the project's water resources will be water conservation principles such as recycling and minimising water consumption.

5.3.1 Site run-off

The proposed operations will not affect site run-off, given the size of the project and the surface geography. The project site does not intersect any drainage lines (Figure 5.1) and as a result, no surface water diversion is required.

Stormwater runoff from the roof surfaces will be collected in rainwater tanks and any overflow discharged by sub-surface piping to the existing lined dams (refer to Figure 5.1) located east of the site to minimise the potential for soil erosion.

5.3.2 Dust control

Dust generation will be minimised by the appropriate application of water or other dry methods and control of vehicle speeds on the site.

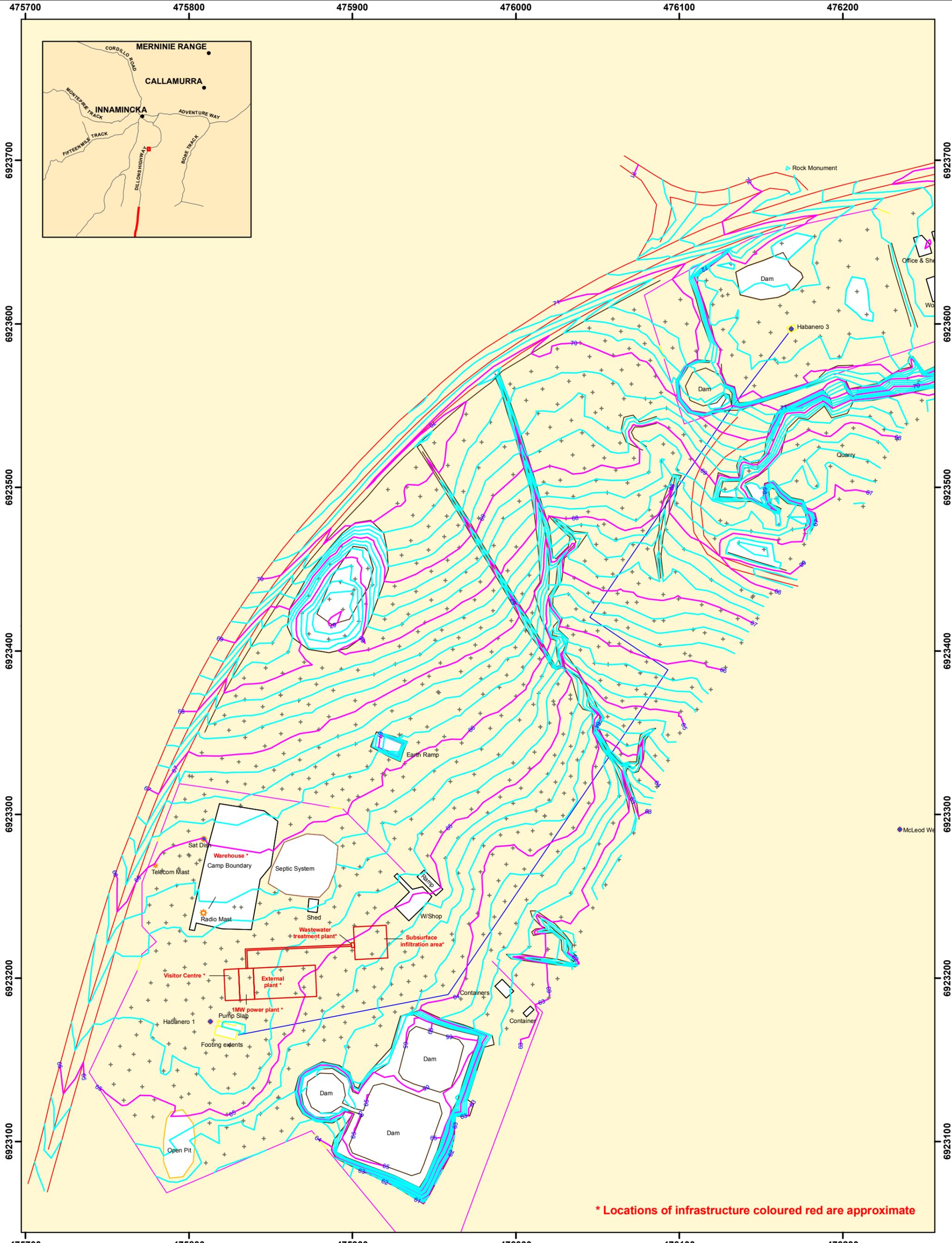
5.4 Site access

Access to the site will be via the unsealed Dillons Highway. There will not be a need for a new access road as the trial site is located adjacent to Dillons Highway. It is proposed to upgrade the existing site access if required within the current "footprint". There will be no general public access to the site.

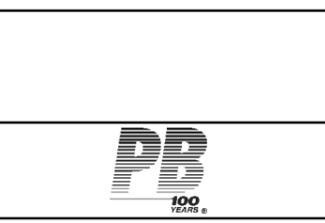
5.5 Infrastructure and ancillary requirements

5.5.1 Energy supply

The 1 MW power generation plant will be used to provide power for all on-site activities.



* Locations of infrastructure coloured red are approximate

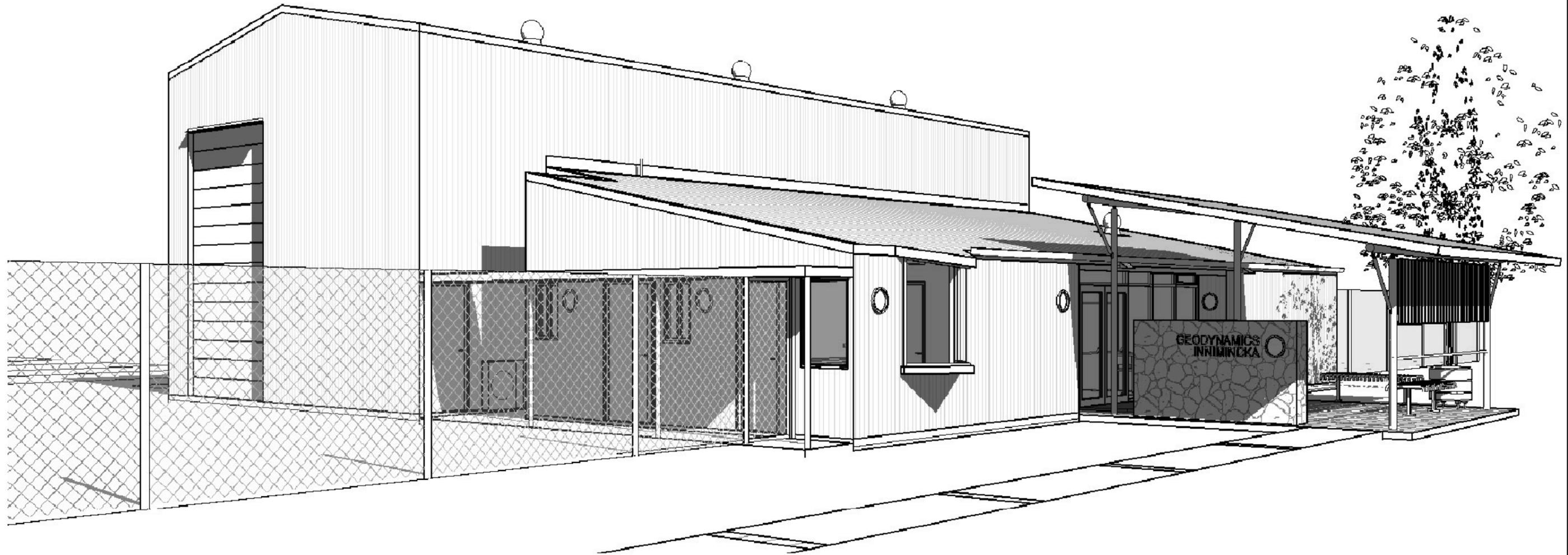


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Innaminka 1 MW Geothermal Power Plant Site Layout Plan Figure 5.1



Data Source: Geodynamics

Coord. Sys.: NOT TO SCALE

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Drawn By: BHB

Checked by: XX

Client Ref: GEODYNAMICS

Innaminka 1 MW Geothermal Power Plant
Building layout
Figure 5.2

5.5.2 Fuel storage

Fuel will be delivered on an as need basis and there will be minor on-site storage in appropriately banded areas.

5.5.3 Water supply

The site will require water for:

- potable use
- dust suppression
- minor make up for the “closed loop system”

The estimated potable water requirement during the trial is about 200 L/day and will be supplied from Darby’s well. In addition there may be a need for minor make up water.

5.5.4 Waste management

Waste material from the project will comprise the following:

- general solid waste from the camp and visitor centre
- packaging and other wastes from construction activities
- waste oils, greases and packaging from the workshop.

The wastes will be segregated and where feasible recycled. It is not proposed to dispose of waste material on-site. All waste will be transported to an EPA licensed landfill. Based on the size of the operations, all waste will be placed in lidded drums and removed from site weekly.

5.6 Workforce and accommodation

The project will employ a maximum of 10 trades persons during construction of the buildings over a period of seven weeks. Construction of the power plant would involve about 10 people for a period of 12 weeks. During operation of the pilot plant there would be between 3–8 people.

All personnel would reside in the existing camp, which has capacity for 50 people.

5.7 Site decommissioning and rehabilitation

Decommissioning and rehabilitation of the project site will only be undertaken in the event that geothermal power generation does not proceed beyond the pilot plant stage.

In the event that the project does not proceed to full power generation, the following activities would be undertaken:

- all wells associated with the closed loop system will be decommissioned
- all pipelines associated with the closed loop system will be decommissioned and removed from site
- all buildings, camp, warehouse, workshop and wastewater treatment plant will be dismantled and removed from site
- existing water storage ponds will be back filled
- hardstand areas will be scarified and rehabilitated.

Details on the proposed closure and rehabilitation activities (in the event that full power generation does not proceed) are outlined in Section 8.

6. Risk assessment process

6.1 Approach

6.1.1 Risk identification and assessment

6.1.1.1 Process

Risk is a measure of the likelihood and consequences of environmental harm occurring from an activity related to the project.

The Risk Level (RL) has been assessed on the basis of knowledge of the existing environment and proposed operations (refer Section 5), experience with similar operations in an arid environment and issues of concern identified by project stakeholders. As defined in the *Petroleum Act 2000*, the environment includes environment, social and economic issues.

Consideration has then been given to avoidance, mitigation and/or management measures that can be adopted to minimise the potential impacts.

6.1.1.2 Likelihood rating

The likelihood of each event occurring should be determined, based on information such as past experience, known meteorological data/site conditions etc, and the effectiveness of proposed control measures. The likelihood (LHD) of the event is classified using the following categories (Table 6.1):

Table 6.1 Qualitative measures of likelihood

Level	Rating	Description
1	Virtually Impossible (VI)	Has almost never occurred but conceivably could
2	Unlikely (U)	May occur in some operations
3	Possible (P)	May occur at operations
4	Likely (LI)	Likely to occur during operation of the pilot plant
5	Virtually Certain (VC)	Will occur, or is of continuous nature, or the likelihood is unknown

6.1.1.3 Consequence rating

The severity of each event occurring should be determined, based on information such as the potential scale of the event, the range of stakeholders who may be affected, the duration of the event and the difficulty in remediating the impact. The consequence of the event is classified using the following categories (Table 6.2).

Table 6.2 Qualitative measures of consequence

Level	Rating	Description
A	Disastrous (D)	Extreme permanent changes to the environment (rehabilitation is not practical), major public outrage or the consequences are unknown. Could result in death.
B	Severe (S)	Substantial and significant changes will attract public concern, only partial rehabilitation possible or uncertain if rehabilitation can be successful. Could cause serious injury.
C	Moderate (MOD)	Significant changes may be rehabilitated with difficulty. Could cause moderate injury.
D	Minor (MIN)	Some limited consequence but no significant long-term changes, may simply be rehabilitated, not of significant concern to wider community. Could cause minor injury.
E	Negligible (N)	Possible impacts but without noticeable consequence. No impact or injury.

6.1.1.4 Risk determination

The risk associated with each event is then determined using the matrix below (Table 6.3):

Table 6.3 Risk determination and categories

			Likelihood of Consequences				
			1	2	3	4	5
			Virtually Impossible	Unlikely	Possible	Likely	Virtually Certain
Severity of Consequence	E	Negligible Effects	VL	VL	L	L	L
	D	Minor Effects	VL	L	MED	MED	MED
	C	Moderate Effects	L	L	MED	MED	H
	B	Severe Effects	MED	MED	MED	H	H
	A	Disastrous	MED	MED	H	H	H

Legend

H : High risk	L: Low risk
MED : Medium risk	VL : Very Low risk

6.1.2 Identification of events and potential consequences

The following events and potential consequences were determined as being relevant to the proposed 1 MW plant (Table 6.4).

Table 6.4 Identification of events and potential consequences

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
Natural Environment Impacts							
Soil Impacts	Earthworks during construction of building and establishment of wastewater irrigation area	Soil erosion, soil compaction, disturbance of soil structure Increased weed occurrence	Activities to be carried out on existing disturbed “footprint” Equipment and personnel will only be allowed access into designated work areas Stormwater from roof captured in rainwater tanks and overflow discharged in a controlled manner Weed removal on site as needed	Possible	Moderate	Medium	Small area of operations
	Vegetation clearance for building and wastewater treatment plant and other infrastructure	Erosion	Minimise vegetation disturbance and plan construction to avoid vegetation areas	Possible	Negligible	Low	Small area of operations

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
	Storage of fuel and chemicals	Contamination of soil from spills and leakage	Storage in accordance with EPA Guideline 080/07 Bunding and Spill Management, Australian Standards and Best Practice Management Establishment of appropriate emergency spill practices and induction on use of spill containment equipment Immediate clean-up of spills Regular inspection of storage areas to ensure integrity, good house keeping and correct use Periodic review and practice of emergency response procedures Maintain a register of spills and leaks and implementation of corrective actions	Unlikely	Moderate	Low	Containment and spill management measures would limit potential impacts
	Storage and disposal of waste materials	Contamination of soil	Waste collected and stored on-site for short period in a single storage area then disposed off-site No burial or burning on-site Cover loads of waste when transporting to waste depot	Unlikely	Negligible	Very Low	
	Wastewater treatment plant	Contamination of soil from nutrients, e-coli due to inappropriate design	Design in accordance with Dept. of Health requirements Maintenance in accordance with manufacturer's manual	Unlikely	Moderate	Low	Location of plant and infiltration area consistent with soils and wastewater volumes

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
	Unsuccessful rehabilitation	Unacceptable erosion rates	Ensure topsoil is respread evenly Rip areas of compacted soil, except gibber areas Undertake progressive rehabilitation	Possible	Negligible	Low	
	Saline water used for dust suppression	Degraded soil quality and structure	Use potable water from Darby's bore or from roof runoff or other dry methods in preference to saline water	Possible	Negligible	Low	
Flora/Native Vegetation Impacts							
	Airborne dust	Smothering and reduced plant growth	Restriction of traffic movement and appropriate management of soil stockpiles	Possible	Negligible	Low	Small area of operations
	Dust suppression with saline water	Adverse effect on vegetation adjacent to site	Controlled water application	Possible	Negligible	Low	Small area of operations
	Soil disturbance	Increased weed occurrence and competition with native species	Weed removal on site as needed	Likely	Negligible	Low	Small area of operations
	Onsite traffic movement	Introduction of weed species	Undertake vehicle washdown before entering Cooper Basin area or after operating in high risk areas and areas of known weed infestation	Possible	Negligible	Low	Limited uncontrolled traffic movement
	Unsuccessful rehabilitation	Loss of critical vegetation Smothering of vegetation	Ensure topsoil is respread evenly Rip areas of compacted soil, except gibber areas	Possible	Negligible	Low	
	Access outside construction and operation area	Disturbance of intact vegetation	Ensure there is no access to areas not required for construction and operation	Possible	Moderate	Medium	

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
Fauna Impacts							
	Construction activities	Potential reduction in species due to entrapment in excavations or barriers established by project e.g. (fences)	<p>Management Plan for construction activities</p> <p>Minimise impact by not leaving trenches open for long periods</p> <p>Monitor open excavations daily for fauna entrapment and if possible provide fauna escape routes</p> <p>Induction to include appropriate disposal of cigarette butts and litter that could be ingested by fauna</p> <p>Reinstate construction area as soon as practicable</p>	Unlikely	Minor	Low	Construction activities will be limited in extent
	Noise	Potential reduction in species due to movement away from area	Noise levels to be consistent with Noise Policy	Unlikely	Negligible	Low	
	Traffic movement on site	Potential reduction in species due to collisions	Speed restrictions on access roads to minimise potential impacts	Unlikely	Minor	Low	No significant traffic movement
	Construction and operations	Risk of introduced species	<p>Appropriate waste management measures</p> <p>Fencing of the operations area</p>	Unlikely	Negligible	Very Low	
Groundwater Impacts	Development of on-site potable water supply bore	Reduction in groundwater levels and availability	<p>Extraction in accordance with DWLBC licence</p> <p>Monitoring of water level in Darby's bore</p>	Possible	Negligible	Low	

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
	Storage and use of chemicals	Impact on shallow aquifer due to spills and/or leakage	Storage in accordance with EPA Guideline 080/07 Bunding and Spill Management, Australian Standards and Best Practice Management Establishment of appropriate emergency spill practices Immediate clean-up of spills Regular inspection of storage areas to ensure integrity, good house keeping and correct use Periodic review and practice of emergency response procedures Maintain a register of spills and leaks and implementation of corrective actions	Unlikely	Moderate	Low	Containment and spill management measures would limit potential impacts
	Wastewater treatment plant	Impact on shallow aquifer from nutrients, e-coli due to inappropriate design	Design in accordance with Dept. of Health requirements Maintenance in accordance with manufacturer's manual	Unlikely	Moderate	Low	Location of plant and infiltration area consistent with soils and wastewater volumes
	Storage and disposal of waste materials	Contamination of groundwater	Waste collected and stored on-site for short period in a single storage area then disposed off-site No burial or burning on-site Minimise generation of waste Reduce, re-use and recycle	Unlikely	Negligible	Very Low	
Surface Water Impacts	Sediment release from construction and operation activities	Contamination of surface water	Restrict area of clearance to minimum amount required Install appropriate silt control measures as required Inspections after heavy rainfall	Unlikely	Negligible	Very Low	Limited area of operations No direct drainage to Cooper Creek or tributaries

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
	Storage of fuel and chemicals	Potential impact of toxic elements from spills and leakage	Storage in accordance with EPA Guideline 080/07 Bunding and Spill Management, Australian Standards and Best Practice Management Establishment of appropriate emergency spill practices Immediate clean-up of spills Regular inspection of storage areas to ensure integrity, good house keeping and correct use Periodic review and practice of emergency response procedures Maintain a register of spills and leaks and implementation of corrective actions	Unlikely	Moderate	Low	
	Storage and disposal of waste materials	Contamination of surface water	Waste collected and stored on-site for short period in a single storage area then disposed off-site Waste storage area to be located well away from potential drainage areas or floodplain No burial or burning on-site Minimise generation of waste Reduce, re-use and recycle	Unlikely	Negligible	Very Low	
	Wastewater treatment plant	Leakage from system resulting in contamination and elevated nutrients and weed growth	Design in accordance with Dept. of Health requirements Maintenance in accordance with manufacturer's manual	Unlikely	Moderate	Low	Location of plant and infiltration area consistent with soils and wastewater volumes

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
Air Quality Impacts	Airborne dust from on-site roads and soil stockpiles	Potential effect on local air quality	Minimise area of disturbance Traffic speed restrictions Controlled use of water and dust suppressants	Possible	Negligible	Low	Small area of operations
	Combustion emissions	Potential effect on local air quality	Emissions to be in accordance with Air Quality Policy Vehicles and machinery fitted with appropriate emission control equipment and maintained in accordance with manufacturers requirements	Virtually certain	Negligible	Low	
	Waste storage and disposal	Odour	Waste collected and store on-site for short period in a single storage area then disposed off-site No burial or burning on-site Cover loads of waste when transporting to waste depot	Unlikely	Negligible	Very Low	
	Storage of fuel and chemicals	Atmospheric pollution from vapours	Storage in accordance with EPA Guideline 080/07 Bunding and Spill Management, Australian Standards and Best Practice Management Establishment of appropriate emergency spill practices Immediate clean-up of spills Regular inspection of storage areas to ensure integrity, good house keeping and correct use Periodic review and practice of emergency response procedures Maintain a register of spills and leaks and implementation of corrective actions	Unlikely	Negligible	Very Low	Containment and management measures would limit potential impacts

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
	Wastewater treatment plant	Overloading and leakage resulting in odour	Design in accordance with Dept. of Health requirements Maintenance in accordance with manufacturer's manual	Unlikely	Moderate	Low	Location of plant and infiltration area consistent with soils and wastewater volumes
Social Impacts							
Amenity Impacts	Noise during construction and operation	Possible disturbance to neighbours	Compliance with EPA Noise Policy Monitor complaints Regular servicing of equipment and noise control measures	Possible	Negligible	Very Low	Site is about 7 km from nearest receivers in Innamincka
	Airborne dust from on-site roads and soil stockpiles	Potential effect on local air quality	Minimise area of disturbance Traffic speed restrictions Controlled use of water and dust suppressants	Possible	Negligible	Low	Small area of operations
	Waste management	Odour	Waste collected and store on-site for short period in a single storage area then disposed off-site Waste storage area to be located well away from potential drainage areas or floodplain No burning on-site Minimise generation of waste Reduce, re-use and recycle Cover loads of waste when transporting to waste depot	Virtually Impossible	Negligible	Very Low	

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
	Storage of fuels and chemicals	Odour	Storage in accordance with EPA Guideline 080/07 Bunding and Spill Management , Australian Standards and Best Practice Management Establishment of appropriate emergency spill practices Immediate clean-up of spills Regular inspection of storage areas to ensure integrity, good house keeping and correct use	Unlikely	Negligible	Very Low	
Visual Impacts	Operation of plant	Potential reduced visual amenity due to building Perception that the Reserve is becoming industrialised	Design and construction with materials that minimise visual effect	Virtually Certain	Minor	Medium	Little through traffic
	Decommissioning and rehabilitation	Decreased visual amenity if not fully undertaken	Ensure appropriate decommissioning and rehabilitation is undertaken	Unlikely	Minor	Low	
Cultural and Indigenous Heritage	Construction of plant	Disturbance of Aboriginal heritage sites (without prior approval)	Clearance from native title holders before construction activities commence Compliance with Aboriginal Heritage Act if objects uncovered Relocation of infrastructure if required	Unlikely	Minor	Low	Clearance of work sites would significantly reduce risks
Non-indigenous Heritage	Construction of plant	Disturbance of heritage sites	Compliance with Heritage Places Act	Virtually Impossible	Negligible	Very Low	No sites of non-indigenous heritage have been identified within the project area

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
Community Health and Safety	Increased vehicle traffic on roads	<p>Impacts due to spills associated with transport of chemicals and fuels</p> <p>Accidents and degradation of Dillons Highway due to increased traffic during construction and operation</p>	<p>Transport of chemicals and fuels in accordance with ADG Codes</p> <p>Regular education and training of drivers</p> <p>Speed restriction on unsealed roads</p> <p>Vehicles maintained and serviced regularly</p> <p>No transportation during wet conditions</p> <p>Restriction of transportation at night</p> <p>Establishment of appropriate spill management procedures</p> <p>Immediate clean-up of spills</p> <p>Establishment of register of spills and clean-up</p> <p>Establishment of traffic management procedures for vehicles entering and leaving the site</p>	Possible	Moderate	Medium	<p>Risks of traffic impacts will be minimised by signage and site management:</p> <ul style="list-style-type: none"> ■ Do not enter – authorised personnel only ■ Stop signs at access points to the site ■ Report to site office

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
	Fire or explosion	Injury to public	<p>Establish plant in accordance with best practice</p> <p>Operation and management of plant in accordance with operational procedures and emergency response plans</p>	Unlikely	Severe	Medium	<p>This event is considered unlikely due to design procedures and operation management control procedures and emergency response plans that are being developed by Geodynamics</p> <p>Signage indicating the requirement for appropriate personal protective equipment</p> <p>Muster points located well away from process areas</p>
	Dust generation	Disturbance to local users	Restrict traffic to that which is necessary	Possible	Negligible	Low	
	Disposal and transport of waste	Risk to human health	<p>Waste collected and store on-site for short period in a single storage area then disposed off-site</p> <p>No burial or burning on-site</p> <p>Minimise generation of waste</p> <p>Cover loads of waste when transporting to waste depot</p>	Unlikely	Negligible	Very Low	

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
	Noise associated with plant operation and vehicle movement	Risk to human health and disturbance to local community	Speed restriction on unsealed roads Vehicles and equipment maintained and serviced regularly Restriction of transportation at night Compliance with EPA Noise Policy Monitor complaints	Possible	Negligible	Very Low	Site is about 7 km from nearest receivers in Innamincka
	Radiation exposure	Risk to human health	Operates plant as closed loop Have in place emergency control and management procedures	Unlikely	Negligible effects	Very Low	Low levels of radioactive substances and potential for radon gas emission
Economic Environment							
Existing Land Use Impacts	Decrease in grazing land due to vegetation clearance	Potential decrease in pastoral income	Limited footprint of operations	Unlikely	Negligible	Very Low	Small extent of operations
	Collision with cattle due to increased traffic movement	Potential decrease in pastoral income	Site fenced Notification to pastoral owner in the event of collisions with cattle and appropriate compensation Notification to landowner of construction timing	Unlikely	Negligible	Very Low	Small extent of operations
	Inadequate decommissioning	Decrease compatibility with land use due to incomplete removal of plant and equipment	Undertake progressive rehabilitation Remove all infrastructure and rubbish Return land to pre-existing use Assess the potential for contamination	Possible	Negligible	Low	

Type of Event	Event	Potential Consequence	Management Measure	Likelihood	Consequence	Risk	Comment
	Storage of fuel and chemicals	Disruption to land use due to soil, groundwater and surface water contamination	Storage in accordance with EPA Guideline 080/07 Bunding and Spill Management , Australian Standards and Best Practice Management Establishment of appropriate emergency spill practices Immediate clean-up of spills Regular inspection of storage areas to ensure integrity, good house keeping and correct use Periodic review and practice of emergency response procedures	Unlikely	Moderate	Low	Containment and spill management measures would limit potential impacts
	Storage and disposal of waste materials	Disruption to land use due to soil, groundwater and surface water	Waste collected and store on-site for short period in a single storage area then disposed off-site No burial or burning on-site Minimise generation of waste Reduce, re-use and recycle Cover loads of waste when transporting to waste depot	Unlikely	Negligible	Very Low	
	Wastewater treatment plant	Disruption to land use due to soil, groundwater and surface water contamination	Design in accordance with Dept. of Health requirements Maintenance in accordance with manufacturer's manual	Unlikely	Moderate	Low	Location of plant and infiltration area consistent with soils and wastewater volumes

6.2 Risk level summary and discussion

6.2.1 Summary

A summary of the project related environmental issues and associated inherent and residual risk levels are provided in Table 6.5 below.

Table 6.5 Risk level summary

Issue	Risk level			
	H	MED	L	VL
Soil impacts		1	5	1
Flora and Native Vegetation		1	5	
Fauna			3	1
Groundwater			3	1
Surface water			2	2
Air quality			4	2
Amenity impacts			1	3
Visual Amenity		1		
Cultural and Indigenous Heritage			1	
Non-Indigenous heritage				1
Community Health and Safety		2	1	3
Existing Land Use Impacts			3	3

6.2.2 Discussion

Due to the limited size and potential impact of the 1MW pilot plant, and the proposed control and management measures the risk assessment resulted in a total of 50 events and potential consequences being identified across 12 categories for the 1 MW plant.

Of the 50 events, 5 risks were considered to have a medium risk level, 28 were low and 17 were considered to be very low.

Although the majority of the risks associated with the project were considered to be low or very low, with the exception of three medium, Environmental Management Plans (EMPs) have been developed and are discussed in Section 7.

7. Environmental management and mitigation

7.1 Erosion management plan

7.1.1 Introduction

This erosion management plan has been developed in order to manage the potential environmental impacts associated with disturbance of soils at the site of the proposed 1 MW power generation plant and associated infrastructure during construction and operation.

Potential hazards that involve or may affect the project comprise:

- increase in erosion due to removal of gibber and exposure of the underlying soils
- loss of soil due to inappropriate stockpiling and re-use of excavated soil
- disturbance of gibber and soil due to increased trafficking.

In order to reduce the risk of these hazards, a number of objectives, strategies and criteria have been developed as described below.

The overall aim of the erosion management plan is to:

- to enable foundation excavation activities to be undertaken
- to enable storage of excavated material for re-use
- to re-use excavated material where possible
- to minimise the disturbance of gibber to ensure that erosion of soils located below gibber does not occur as far as is practicable
- to restrict access to parts of the site that are necessary.

7.1.2 Objectives

The following soil erosion and sedimentation prevention objectives have been adopted for the site:

- protect the land surface to minimise soil erosion
- protect exposed soils from wind erosion, intercept, divert and safely dispose of surface water runoff
- control and collect sediment generated from surface flows
- prevent water with heavy sediment loads from impacting other off-site areas
- regularly inspect and maintain erosion and sediment control devices in proper working order
- progressively stabilise and rehabilitate disturbed areas of the site
- protect against erosion of soil stockpiles.

7.1.3 Strategy

The following strategies are proposed:

- protect against the loss of soil from stockpiles by stabilisation e.g. water sprays or polymers
- place excavated soils in stockpiles adjacent to the excavations based on soil characteristics to minimise mixing

- select stockpile locations avoiding work areas, areas of natural drainage and on site traffic areas
- ensure soil horizons are replaced in the same order that they were removed, with soil re-used as close as possible to its point of origin
- gibber not able to be re-used in excavation to be used to fill depressions on the existing footprint and proof rolled
- appropriate siting and implementation of temporary and permanent sediment control devices, including; sediment control perimeter bunds, silt traps and silt fences
- ensure erosion and sediment control structures are available for use and in place well in advance of expected rain events
- sediment control devices will be established around areas prone to erosion, including stockpiles and drainage lines
- controlling stormwater flows onto, through and from the site
- inspecting and maintaining (temporary and permanent) erosion and sediment control measures to ensure efficient function
- excavate gibber and subsoil only from those areas that are required for foundations using mobile equipment appropriate to the task
- proof roll gibber areas that are proposed as equipment and construction material lay down areas
- restrict access to only those areas of the site required for construction and operation of the plant
- ensure there is controlled access to site through dedicated points of entry and exit for construction and operation vehicles and equipment
- minimising the extent and duration of disturbance of any one area.

Water for dust suppression will be sourced from a range of sources, including Darby's bore and roof runoff collected in the on-site water dam in preference to using the more saline McLeod's well. In addition Geodynamics will look at the option of using the treated wastewater, subject to agreement from the Department of Health.

7.1.4 Criteria for measuring against objectives

The following criteria will be used to measure the success of the objectives:

- no visible impact of off-site erosion and sedimentation as a result of construction and operation of the plant
- sediment and erosion control measures implemented prior, during construction and operation to be inspected at regular intervals, e.g. during and immediately after a period of strong winds and during and after heavy rain events, otherwise once per month
- soils excavated and stored in appropriate stockpiles
- visual assessment to confirm soil horizons replaced in the same order as excavated
- locations of stockpiles documented.

7.2 Native vegetation management and mitigation

During the establishment of the operations the following activities will be undertaken to manage and mitigate native vegetation impacts:

- inspection and identification of areas for vegetation clearance prior to clearance occurring
- areas not required to be disturbed by construction activities shall be flagged for avoidance
- inspection of the site area and the access road for the presence of weeds (see weed and pest management plan)
- induction/education of contractors – key messages to contractors to include:
 - ▶ details on the restricted access to the site
 - ▶ requirements of interstate or high risk vehicles to be cleaned prior to entering the site to prevent the spread of weed species
 - ▶ prohibition of additional vegetation clearance/access outside of the proposed areas
 - ▶ requirements regarding dust suppression activities (no overspraying)
 - ▶ requirements regarding reporting of unauthorised clearing or overspraying of saline water for dust suppression.
- establishment of a formal record of pre-construction site vegetation
- as far as is practicable, construction areas that are no longer required for other components of the works will be progressively rehabilitated.

7.2.1 Post pilot plant

In the event that the full scale operation does not proceed, the areas disturbed as part of the operations will be rehabilitated. However, following completion of the trial, the following activities will be undertaken to manage and assess native vegetation impacts, and to assist in rehabilitation (if required):

- re-assessment of vegetation adjacent dust suppression areas to ensure that any impacts are within the specified clearance area
- inspections to be undertaken of disturbed areas and traffic areas for the presence and removal of any introduced weed species (see weed management plan)
- completion of all vegetation records (to be used as baseline if the main project proceeds)
- collection of seeds for revegetation (with appropriate permit from DEH) followed by revegetation and ongoing monitoring (see Section 8).

7.2.2 Significant Environmental Benefit (SEB)

Establishment of the exploration drilling program was undertaken under the provisions of the *Petroleum Act 2000*. Exploration activities are not required to develop an SEB. The proposed 1 MW pilot plant and associated infrastructure will be undertaken in the previously disturbed footprint (Plates 1.1 and 1.2). On this basis it is not considered that there will be a need to disturb any native vegetation.

Discussion with the Native Vegetation Council suggests that it is unlikely that an SEB will need to be established for development of the 1 MW pilot plant as long as the works are undertaken on the current disturbed “footprint”.

7.3 Weed and pest management plan

7.3.1 Introduction

Environmental weeds can impact the local environment by: competing with native plants for resources, preventing recruitment/establishment of native plants, altering geomorphological processes, altering the water table level, altering nutrient content of soil, altering the natural fire regime and altering the abundance of native fauna.

The objective for the project that relates to weed and pest management is to prevent new infestations of weeds and populations of pest species on site so that native flora and fauna are protected.

The following principles will be adopted for weed and pest management during operations:

- retaining areas of native vegetation on site that are not required for the pilot plant operations
- making sure that the areas to be retained/protected are clearly identified, defined and avoided
- restricting access to site and on site vehicle movements
- minimising the time of exposure of cleared land i.e. undertaking clearing immediately prior to development
- adherence to strict waste management procedures.

7.3.2 Weed management

The following weed management activities will be undertaken:

- all interstate or higher risk vehicles or equipment shall be checked and cleaned prior to entering the Cooper Basin area
- all vehicles will be required to remain on formed roads and tracks within the project area
- weed transfer between areas with minimal disturbance and high disturbance will be avoided by working in less disturbed areas first, where possible
- regular inspections of area surrounding the operations to identify any new weeds (including susceptible areas such as roads and soil stockpiles)
- removal or control of any identified weeds or outbreaks
- completion of records regarding weed species during and at the completion of operations (to be used as baseline if the main power generation proceeds).

7.3.3 Pest management

There is a potential that exotic fauna species that would not normally inhabit the area could be attracted to the site due to changes in habitat as well as activities associated with operations on site e.g. storage of waste on site.

The following pest management activities will be undertaken:

- establish and follow strict waste management procedures (waste to be stored in lidded drums Water for dust suppression will be sourced from a range of sources, including Darby's bore and roof runoff collected in the on-site water dam in preference to using the more saline McLeod's well. In addition Geodynamics will look at the option of using

the treated wastewater, subject to agreement from the Department of Health. and removed weekly from the site) to minimise food sources

- completion of records regarding pest species during and at the completion of trial operations (to be used as baseline if the main project proceeds).

7.4 Dust management plan

7.4.1 Objectives and principles

Dust generated from the proposed activities may include:

- wind erosion of exposed surfaces including soil stockpiles
- general vehicle movements around site over unsealed roads.

The dust and general air quality objective for the trial project is to ensure that particulate emissions do not adversely affect environment values or the health and amenity of people.

Water for dust suppression will be sourced from a range of sources, including Darby's bore and roof runoff collected in the on-site water dam in preference to using the more saline McLeod's well. In addition Geodynamics will look at the option of using the treated wastewater, subject to agreement from the Department of Health and updating of the management plan.

The following principles will be adopted for dust management during the pilot plant operations:

- retaining areas of native vegetation on site that are not required to be cleared
- undertaking dust suppression (roads, stockpiles) as required
- restricting access to site and on site vehicle movements
- minimising the time of exposure of cleared land i.e. undertaking clearing immediately prior to development.

7.4.2 Management plan

Proposed management and mitigation measures to be implemented during construction and operation to assist in minimising the impacts associated with dust generation include:

- establishing and enforcing speed limits on roads used by trial mine traffic
- using water or dust suppressants on trafficked areas, exposed surfaces and other disturbed areas
- minimising the extent of exposed areas susceptible to wind erosion.

7.5 Groundwater management plan

7.5.1 Introduction

Groundwater in the regional area is a vital resource to pastoralists, Innamincka township and the petroleum industry. Groundwater management and monitoring are important aspects of the management of the project.

It is proposed to extract water from an existing supply bore located near the site for potable use, dust suppression activities and potentially make-up water (assuming that the water licence and allocation is granted by DWLBC). An application from Geodynamics as a current user is being considered by DWLBC.

7.5.2 Objectives

The groundwater objective for the project is to ensure that extraction and use of groundwater does not adversely affect environmental values, existing users or the health and amenity of people.

7.5.3 Management plan

Proposed management and mitigation measures to be implemented by Geodynamics during construction and operation to assist in minimising the impacts associated with groundwater include:

- extraction and use of groundwater in accordance with allocation and conditions of approval
- monitoring of extraction volume during pilot plant operations in accordance with conditions of approval
- quality and depth monitoring to be undertaken of the bores prior to and at the completion of pilot program in order to assess any impacts.

7.6 Fauna management plan

7.6.1 Objectives and principles

The fauna objective for the project is to maintain the regional abundance, diversity, and productivity of fauna.

The following principles will be adopted for fauna management during the pilot plant program:

- retaining areas of native vegetation on site that are not required to be cleared
- restricting access to site and on site vehicle movements
- minimising the time of exposure of cleared land i.e. undertaking clearing immediately prior to development.

7.6.2 Management plan

Proposed management and mitigation measures to be implemented during construction and operation to assist in minimising the impacts to fauna include:

- clearance of vegetation to be in accordance with the specified areas
- adherence to strict site rules to minimise off-road driving and access to non designated work areas
- maintenance of site fencing to avoid, minimise and manage impacts associated with grazing animals

- contractor induction sessions to be undertaken to promote the awareness of fauna species within the project area and their reliance on undisturbed habitat and the requirement for appropriate disposal of cigarette butts and other litter that can be ingested by fauna
- adherence to waste management procedures (all wastes to be stored in lidded drum and removed at least weekly) to reduce potential food sources for introduced pests and vermin.

7.7 Indigenous heritage management plan

7.7.1 Objectives and principles

The indigenous heritage objective for the project is to avoid disturbance to sites of indigenous heritage significance.

The following principles will be adopted during the pilot plant program:

- locate infrastructure and operations well away from known sites
- comply with the statutory requirements of the Aboriginal Heritage Act 1988.

7.7.2 Management plan

Proposed management and mitigation measures to be implemented during construction and operation to assist in minimising the impacts to fauna include:

- obtain clearance from native title holders before construction activities commence
- stop work and notify the Aboriginal Affairs Division of the Department of Premier and Cabinet if aboriginal heritage objects uncovered
- relocation of infrastructure if required.

7.8 Chemical and fuel management plan

7.8.1 Objectives and principles

The objective for the project is to minimise the potential for contamination of soil, groundwater and surface water from inappropriate storage and use of chemicals and fuels.

The following principle will be adopted during the pilot plant program:

- Storage in accordance with EPA Guideline 080/07 Bunding and Spill Management, Australian Standards and Best Practice Management.

7.8.2 Management plan

Proposed management and mitigation measures to be implemented during construction and operation to assist in minimising the impacts include:

- establishment of appropriate emergency spill practices
- immediate clean-up of spills

- regular inspection of storage areas to ensure integrity, good house keeping and correct use
- periodic review and practice of emergency response procedures
- maintain a register of spills and leaks and implementation of corrective actions.

7.9 Waste management plan

7.9.1 Objectives and principles

The waste management objective for the project is to minimise the impact on the environment of waste storage, handling and disposal.

The following principles will be adopted for waste management during the pilot plant program:

- minimise the production of waste
- reuse, recycle.

7.9.2 Management plan

Proposed management and mitigation measures to be implemented during construction and operation to assist in minimising the impacts include:

- segregate waste for recycling
- waste stored on site for short period in single storage area
- waste storage area to be located well away from drainage areas or floodplain
- no burial or burning on-site
- adherence to waste management procedures (all wastes to be stored in lidded drums and removed at least weekly) to reduce potential food sources for introduced pests and vermin
- cover waste loads when transporting to EPA licensed landfill.

8. Rehabilitation and closure plan

8.1 Introduction

Geodynamics proposes to decommission and rehabilitate the site in the event that the project is not expanded to commercial production.

The decommissioning (closure) and rehabilitation objectives for the project are outlined as follows:

- to remove all site equipment and infrastructure
- to recreate a safe, stable, vegetated landform that is consistent with surrounding conditions and allows the re-establishment of pre-works land use (stock grazing and conservation).

Principles of the rehabilitation and closure are summarised as follows:

- minimisation of areas to be disturbed, thereby minimising the areas to be rehabilitated
- progressively rehabilitate disturbed areas of the site no longer required for construction and operational activities
- final land form and condition of disturbed areas to be stable and revegetated, and compatible with land use (cattle grazing) to the satisfaction of the pastoral lessee and landowner
- final land condition not to pose an unacceptable risk to local soil, groundwater or surface water resources.

8.2 Proposed rehabilitation and closure activities

8.2.1 Decommissioning

- All equipment decommissioned and removed from site.
- All ancillary equipment dismantled and removed from site.
- Stockpiled soil material re-used in rehabilitation.
- Wells decommissioned.

8.2.2 Rehabilitation

- The access road will be rehabilitated post use.
- Disturbed areas will be scarified and watered (with non-saline water).
- Stockpiled topsoil and vegetation (from site clearance activities) will be used to replace vegetation on surface areas that have been scarified and/or disturbed.
- Vegetation will be watered (with non-saline water) to assist in encouraging vegetation to bind with surface sands and to settle dust, reducing dust related impacts following operations.
- Area to remain fenced until vegetation sufficiently established.



9. Management systems

Geodynamics will prepare a Management Plan, a Supplier and Subcontractor Management Plan and an Occupational Health and Safety Management Plan. These plans describe the processes and strategies implemented to ensure the safe and successful execution of the works and management of the pilot power plant.

Geodynamics and its senior management team confirms its commitment to management systems outlined in the plans and to continued improvement that will ensure technical specifications are met and safety is never compromised.

9.1 Management plan objectives

As part of the management plan, capability guidelines and procedures have been developed for implementation during the pilot plant operation covering the following areas:

- Project Management
- Personnel Administration
- Reporting
- Document and Record Management
- Purchasing and Sub-contractor Management
- Quality Management
- Risk Management

Environmental risks will be managed by Geodynamics via the EMPs, control and management measures and assessment criteria detailed within the Environmental Risk Assessment.

9.2 Supplier and subcontractor management plan objectives

As part of the supplier and subcontractor management plan, guidelines and procedures have been developed for the management of suppliers and subcontractors during the pilot plant operations covering the following areas:

- pre-start requirements
- start-up requirements
- execution requirements
- verify completion.

9.2.1 Health, safety, environment and quality

Induction into the requirements relating to health, safety, environment and quality for the pilot plant operation will be communicated and achieved by:

- sending the requirements via correspondence
- purchase order terms and conditions
- extract from contract documents
- copies of HSEQ Documentation

- other statement of requirements
- verbally through a documented meeting.

Through these various induction methods, details of the environmental risks and management requirements (as detailed within the Environmental Risk Assessment and EMPs) will be thoroughly conveyed.

9.3 Occupational health and safety management plan objectives

Geodynamics' Occupational Health, Safety and Welfare methodology is based on the South Australian Occupational Health, Safety and Welfare Act and Regulations (latest publications and amendments).

Every employee is expected to be familiar with and fully comply with the legal and company responsibilities as set out in the state legislation and the Occupational Health, Safety and Welfare Manual.

The OH&S Management Plan will be used as a basis for induction into OH&S requirements for employees, suppliers and subcontractors, in addition to the other induction methods described above.

9.4 Operational and emergency procedures

Geodynamics will develop procedures for the safe operation of the 1 MW pilot plant and emergency procedures to ensure there are no risks to the health and safety of workers and the general public.

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Appendix A

Vegetation survey – Fatchen 2002

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VEGETATION, LANDFORM AND HABITAT PROPOSED DEEP DRILLING AND ASSOCIATED DEVELOPMENT NEAR MCLEOD 1 WELL, INNAMINCKA AREA

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Prepared for

Geodynamics Limited

by

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1. INTRODUCTION

1.1 Scope

The following report provides a description of the surface biology, soils and landform in an area proposed for drilling for geothermal testing near Innamincka, SA. Potential impacts and risks are indicated as regards surface questions, but the report does not constitute an Environmental Impact Report (EIR) under the Petroleum Act. The report does not deal with subsurface issues.

1.2 Proposed drilling and requirements

Geodynamics Ltd proposes deep drilling within the Cooper Basin at GD1 (27° 48.973' S 140° 45.248' E), approximately 400m SW of the suspended McLeod 1 well. Three additional monitoring bores are proposed, currently at GDMW1 (27° 47.956' S 140° 45.283' E), GDMW2 (27° 49.902' S 140° 44.508' E) and GDMW3 (27° 49.739' S 140° 46.101' E). The primary well, GD1, will require the equivalent of a 1.5 ha petroleum drilling lease, and pad development to permit a large rig. In other respects, we understand that requirements of the lease and pad (sumps, rubbish disposal, muds and liquids handling) will be equivalent to that for petroleum exploration and will be detailed in Geodynamics Environmental Impact Report for the project.

The monitoring wells will require only minor pad development, as we understand that these will be drilled as water wells, using water well rigs rather than full-scale petroleum drilling equipment. Accordingly, in the following we have assumed that both access to and any pad construction associated with monitoring wells will be low-key, and that the main pad development will be associated with the GD1 well.

We understand that the suspended Santos McLeod 1 well will also be used for monitoring purposes: this well is on a cut and fill pad, but no impacts beyond the pad are expected.

1.3 Proposed dam and requirements

A dam of maximum cubic volume 20,000 m³ (100m x 100m x 2m) is required within a few hundred metres of the primary well. Other parameters are a reasonable clay seal will minimal earthmoving needed for construction. These conditions locally are only met in clay swales within the dunefield adjoining the proposed GD1 well.

The proposed location, marked by Geodynamics during field inspection, is centred on 27° 49.179' S 140° 45.013' E. There are alternative locations within this swale, still within reasonable distance of the proposed GD1. Physically satisfactory locations in swales immediately east have been excluded to limit impacts.

Subsidiary near-surface water bores (unconfined aquifer) will be required to provide water to this dam: no locations have been provided nor determined for these. It is expected that drilling will be by small truck-mounted equipment, with no particular access or pad requirements.

1.4 Inspection

The general locations for the main GD1 well, the three monitoring bores and their access and the holding dam were inspected on 3 May 2002. Proposed locations for each well and the dam were pegged by Geodynamics after considering local alternatives in the light of the field examination. GD1, on gibber, immediately adjoins the new Strzelecki Track, while GDMW2 and the dam, in sandy clay swales of the red (Della) dunefields are very close to or easily accessible from it.

The other monitoring wells GDMW1 and GDMW3 require extended access across gibber, and the routes indicated here are effectively the best in terms of erosion risk of a series of alternatives examined during the inspection.

2. SUMMARY OF LOCAL BIOPHYSICAL ENVIRONMENT

2.1 Regional context

2.1.1 Land use

The proposed wellsites, dam and access all lie within the Innamincka Regional Reserve, in an area used for extensive livestock (cattle) grazing. The wellsites, dam and all local access lie outside the boundaries defining the areas of the Coongie Lakes Wetlands of International Importance under the 1971 Ramsar Convention. Parts of regional access lie within this area, in particular Innamincka township (Figure 1).

2.1.2 Landform and soils

The proposed activities will all be taking place at the boundary three land systems; the gibber slopes of the Merninie LS, the dunes of the Strzelecki LS, and floodouts and floodplains associated with the Cooper LS (Marree Soil Conservation Board 1997). Boundaries are shown and landform and vegetation summarised in Figure 2.

GD1, GDMW3 and its access, and most of the access to GDMW1 are on gibber. The proposed dam and GDMW2 are on swales within dunefield, GDMW1 is on floodout. The gibber landscapes pose the highest erosional risks.

Soils of the gibber slopes are a duplex shallow loam over light clay of moderate dispersibility. There is a dense gibber pavement, with stone also in the soil profile. Slopes of greater than 1° (>2%) are likely to erode irreversibly if the gibber pavement is disturbed. Pavements vary from complete (100%) to sparse, 20% or less at GDMW3. Throughout this area, there is minor gilgai patterning.

Most drainage about the proposed sites does not reach the Cooper/Strzelecki Creek system. GD1, GDMW2, GDMW3 and the associated dam are all in catchments with their terminus in dunefield. GDMW1 however is on a floodout directly connected to the Strzelecki Creek floodplain, and hence with an ultimate connection to the Cooper Creek system to the south or Coongie Lakes to the west. The last presents the only opportunity possibility for operations to impinge on the area defined as the Coongie Lakes Wetlands of International Importance through drainage.

2.1.3 Vegetation and habitat

The primary vegetation cover on gibber is open perennial grassland of Mitchell grass with *Sclerolaena* spp. (copperburrs) and other grasses. Cover is generally under 20%, denser in gilgai areas, but reducing almost to zero in drought. Gibber tops and slopes are effectively treeless: sand veneers on the edge of dunefield, and drainage lines, may carry shrubs to low trees especially of needlebush, sandhill wattle, and *Senna* spp. (punny bushes)

The red deep sands of dunefields in this locality show a vegetation gradient from dune crest to interdune areas, depending on the amount of clay exposed in interdunes. Generally, crests are semi-mobile, with a hummock grassland of sandhill canegrass, occasionally with porcupine grass also present. Backslopes and lower slip-faces of dunes support, variously, low open woodlands with whitewood, beefwood, needlewood and Queensland bean tree prominent, tall shrubland or open shrubland of sandhill wattle, or a short grass/herbaceous ground cover of *Aristida holathera*, *Enneapogon* spp, buckbush and copperburrs. As more clay appears in the interdunes, tree and tall shrub cover tends to thin, with massive sandy clay exposures in claypans largely unvegetated, and the main cover on shallow sand veneers over clay limited to shortgrasses with scattered tall shrubs or small trees. The concentration of tall shrub and tree species on the lower dune slopes is a consequence of soil water storage and availability provided by the dune.

Where interdunes are subject to frequent run-on, clay areas tend to have a mid-shrub cover, particularly of lignum, with low open woodland of coolibah on swamp fringes. Bloodwoods may be present on claypan and swamp fringes also.

The floodplain of Strzelecki Ck (Unit 3.1 of Figure 2) is coolibah woodland over lignum or old man saltbush shrubland. This however does not extend onto the outwash area shown as unit 3.2: this is a perennial grassland/sedgeland of neverfail, *Enneapogon* spp, and the flat sedge *Cyperus*

squarrosus, with other sedges present. Gutters and sandy rises have a variety of small shrubs including *Lechenaultia divaricata*, various mallows, and emergent sandhill wattle and emu bushes.

In terms of faunal habitat, there are no peculiarities of landform or landcover which might suggest the potential for any unusual faunal assemblage. General proximity to Coopers Creek means that the area may be visited, especially when wet, by migratory and other birds actually associated with the Coopers Creek habitats. The juxtaposition of dunefield, gibber and floodplain is likely to result in a somewhat higher faunal species diversity than would be the case for an extended area of any one of the land systems.

2.2 Wellsite and dam localities

2.2.1 Terrain, soils and vegetation at GD1

The main well, GD1, is on almost level gibber almost at the junction of gibber (Merninie LS) and dunefield (Strzelecki LS). Figure 3 sketches landform and slope in the area, illustrated further in Figures 4 and 5. Soils are a red sandy clay loam over red dispersible clays, with a variable gibber lag and little gilgai development. There is also a thin veneer of aeolian sand on the steeper but short slopes on the edge of the site. The existing McLeod 1 well and a Transport SA borrow pit (indicated in Figure 3) are on equivalent terrain, the former however cut and filled into a 3-4% slope and now eroding. A spur drain from the Strzelecki Track crosses the area; this also is eroding on the 3-4% slopes (Figure 6)

Vegetation is Mitchell grass-copperburr (*Astrelba pectinata* - *Sclerolaena ventricosa*) perennial grassland, grazed very low at the time of inspection and with a cover 10-15%. Associated species, mainly herbs, grasses and short-lived perennial dwarf shrubs, were typical of Mitchell grass areas (Table 1). Apart from one needlebush, the site lacks any tall shrub or tree cover (Figures 4, 5).

The incised creekline on the eastern boundary of the general site drains into an intermittent swamp, with a shrubland of lignum (*Muehlenbeckia florulenta*) with coolibah (*Eucalyptus coolabah*) and some bloodwood (*E. centralis*) emergent (Figure 7). The bloodwood is very close to its southernmost distribution in South Australia and there may be other such species present.

Table 1. Species records from wellsites and proposed dam areas

Species	Common name	<u>GD1</u>	GDMW1	GDMW2	GDMW3	Damsite*
Alien species:						
* <i>Acetosa vesicaria</i>	Rosy dock					(+)
* <i>Heliotropium europaeum</i>	Potato weed					(+)
* <i>Malvastrum americanum</i>		+	+	+	+	+
* <i>Salsola kali</i>	Buckbush	+	+	+	+	+
Trees and tall shrubs:						
<i>Acacia ligulata</i>	Sandhill wattle		+			+
<i>Acacia oswaldii</i>				+		
<i>Acacia victoriae</i>	Prickly wattle		+			
<i>Atalaya hemiglauca</i>	Whitewood					+
<i>Dodonaea viscosa</i>	Hopbush		+			+
<i>Eucalyptus centralis</i>	Bloodwood					+
<i>Grevillea striata</i>	Beefwood					+
<i>Hakea leucoptera</i>	Needlebush	+				+
<i>Lysiphyllum gilvum</i>	Bauhinia, bean tree					+
<i>Senna artemisioides ssp oligophylla</i>	Limestone cassia		+			
<i>Senna artemisioides nothosp sturtii</i>	Grey cassia		+			
Sedges and wet-area species:						

<i>Cotula australis</i>	Water buttons						(+)
<i>Cyperus bifax</i>	Downs nut-grass		+				
<i>Cyperus squarrosa</i>	Bearded flat-sedge		+				(+)
<i>Glossostigma ?cleistanthum</i>							(+)
<i>Marsilea spp.</i>	Nardoo						(+)
Perennial and short-lived perennial grasses and dwarf shrubs							
<i>Astrelba pectinata</i>	Mitchell grass	+	+	+	+	+	+
<i>Chenopodium desertorum</i>							+
<i>Dissocarpus biflorus</i>						+	
<i>Eragrostis eriopoda</i>	Neverfail	+	+	+			+
<i>Eragrostis setifolia</i>	Neverfail		+	+			(+)
<i>Eragrostis xerophila</i>	Neverfail			+			+
<i>Goodenia lunata</i>		+		+			
<i>Goodenia pinnatifida</i>			+				+
<i>Lechenaultia divaricata</i>	Tangled lechenaultia		+				
<i>Maireana ciliaris</i>		+	+	+		+	
<i>Osteocarpum acropterum</i>						+	
<i>Osteocarpum dipteroacarpum</i>						+	
<i>Sclerolaena bicornis</i>	Goats head burr		+				
<i>Sclerolaena brachyptera</i>		+	+	+		+	
<i>Sclerolaena decurrens</i>	Green copperburr						+
<i>Sclerolaena diacantha group</i>	Grey bindyi	+		+		+	+
<i>Sclerolaena divaricata</i>	Povertybush		+	+		+	(+)
<i>Sclerolaena lanicuspis</i>	Wooly bindyi	+	+			+	
<i>Sclerolaena ventricosa</i>	Salt bindyi	*	+	+		+	+
<i>Sida ammophila</i>	Sand sida	+		+			+
<i>Sida corrugata</i>		+	+			+	
<i>Sida pinnatifida</i>		+					
Ephemeral grasses and herbs:							
<i>Amaranthus grandiflorus</i>							+
<i>Aristida contorta</i>	Kerosene grass	+		+		+	+
<i>Aristida holathera</i>	Kerosene grass						+
<i>Aristida spp</i>	Kerosene grass	+				+	
<i>Atriplex limbata</i>			+			+	+
<i>Atriplex lindleyi</i>						+	
<i>Boerhavia dominii</i>	Tar vine		+	+			+
<i>Calotis multicaulis</i>							(+)
<i>Centipeda minima</i>	Sneezeweed						(+)
<i>Swainsona formosa</i>	Sturt pea	+					
<i>Dactyloctenium radulans</i>	Button grass	+	+	+		+	+
<i>Enneapogon avenaceus</i>	Bottlewashers	+	+	+		+	+
<i>Enneapogon cylindricus</i>	Bottlewashers		+				+
<i>Eragrostis brownii</i>		+					
<i>Eragrostis dielsii</i>	Mulka	+	+	+			+
<i>Euphorbia drummondii</i>		+		+			

<i>Euphorbia tannensis</i>	Bottle tree spurge	+	+	+	+	+
<i>Lavatera plebia</i>	Hollyhock		+			
<i>Lepidium phlebopetalum</i>					+	
<i>Lotus cruentus</i>		+		+		
<i>Minuria leptophylla</i>	Minnie daisy					(+)
<i>Nicotiana velutina</i>	Velvet tobacco					+
<i>Portulaca oleracea</i>	Pigweed	+	+	+	+	(+)
<i>Rhodanthe spp.</i>						(+)
<i>Rhynchosia minima</i>		+				
<i>Sporobolus actinocladius</i>		+	+	+	+	+
<i>Tephrosia sphaerospora</i>	Mulga trefoil					(+)
<i>Tetragonia eremaea</i>	Desert spinach				+	
<i>Tragus australianus</i>		+		+		+
<i>Tribulus terrestris</i>	Caltrop	+				+
<i>Trigonella suavissima</i>	Cooper clover	+				
<i>Tripogon loliiformis</i>	Five minute grass	+	+		+	(+)
<i>Vittadinia eremea</i>	Fuzzweed			+		
<i>Zygophyllum prismatothecum</i>				+		

(+) Present in claypan and claypan fringe

2.2.2 Terrain, soils and vegetation at dam site

The dam associated with water supply for GD1 is in dunefield, on an interdune with brown massive sandy clay exposures in claypans and elsewhere a veneer from a few centimetres to 1-2m of clayey sand. The current proposed centre of the dam is in a claypan (Figures 8, 9). The pan is subject to relatively frequent inundation, including some road runoff, and several wet-area species are present, including nardoo (*Marsilea* spp., Table 1).

Ground cover on the clayey sand veneer is shortgrass and short-lived perennial dwarf shrubs, primarily *Aristida contorta*, *Enneapogon avenaceus* and *Sclerolaena diacantha*, with cover about 15%. On sandy rises immediately south of the claypan (Figure 8) is mixed low woodland of whitewood, beefwood, hopbush and bauhinia, to 4-5m with about 5% cover. Elsewhere around the dam, trees and tall shrubs are mainly whitewood with some hopbush, scattered with a cover 1-2%. Adjoining dune slopes carry whitewood, with *Aristida holathera* prominent in the ground cover.

The dam can be fitted without impact on the main areas of tree cover. If the claypan is not useable, the dam can be shifted north in the swale: while this will entail more earthmoving to remove the sand veneer, it would not result in loss of more than a few whitewood individuals.

2.2.3 Terrain, soils and vegetation at GDMW1

The monitoring well at CDMW1 is on a floodout, of pale brown clay loam over clay with surface cracking. The area proposed for drilling is slightly higher than much of its surrounds, the latter showing gilgai formation with a degree of soil heaving. Nevertheless the well site is subject to inundation: the vegetation indicates that inundation will be of moderate frequency but short residency on the marginally higher ground, with longer residence times in gilgais. The vegetation on the wellsite (Figure 8) is largely ephemeral grassland (*Enneapogon avenaceus*, *Tripogon loliiformis*) or short-lived perennial dwarf shrubs (*Sclerolaena ventricosa*), but with perennial neverfail grasses also present, and small sedges, especially *Cyperus squarrosa* and *Cyperus bifax*. Cover was about 20% at time of inspection, relatively high for the state of growth in pastures.

Shallow sandy gutters cross the floodout, and are more densely vegetated, giving part of the distinctive signature to unit 3.2 in Figure 2. Gutters and sandy floodout have a shrub to tall shrub

cover, with common larger shrubs hophbush, prickly wattle, sandhill wattle, limestone and grey cassias, and low shrubs especially *Lechenaultia divaricata*.

Access to GDMW1 is over long gibber slopes (Figure 11), with soils, vegetation and risks effectively as for GD1 or GDMW3. It is possible to reach GDMW1 over 2% or less slopes with care in final route selection; with highest risks being on the footslopes nearest the floodout.

2.2.4 Terrain, soils and vegetation at GDMW2

GDMW2 is in a sandy clay swale approaching the slipface of a red dune. The higher part of the swale (Figure 12) is a light sandy clay with a more-or-less continuous cover of grasses, particularly *Enneapogon avenaceus* and the perennial neverfail *Eragrostis xerophila*. Lower parts of the swale have numerous scalds, with areas of mitchell grass growing with *Sclerolaena divaricata* in run-on basins. Species at the site are listed in Table 1.

The immediately adjoining dune has a tall shrubland of whitewood and hophbush along its base, with cover around 10% (Figure 12).

2.2.5 Terrain, soils and vegetation at GDMW3

GDMW3 (Figure 13) is on the footslope of a long, sloping tableland. The site itself has a slope of about 1%. Soils are friable loams over clay normally associated with the gibber areas, but the actual gibber pavement is highly variable, with poorly developed large gilgai areas with under 10% of gibber cover. The main vegetation cover is ephemeral grass (*Tripogon loliiformis*) or short-lived perennial bindyi, primarily *Sclerolaena divaricata* and *Sclerolaena ventricosa*. Other species are listed in Table 1. There are no trees or tall shrubs.

The best access to the site would appear to be via the rehabilitated seismic track 83-NCS, which for almost all of its run follows a very long slope at between 1% and 2%, over most of which vegetation is equivalent to that at GD1 (Plate 14).

3. BIOLOGICAL SIGNIFICANCE

3.1 Biophysical significance and sensitivity

Generally, there are no specific characteristics indicating particular conservation significance at any of the drilling sites, the damsite or along the access. There are constraints, discussed subsequently, which require care in construction and drilling, and in subsequent maintenance or rehabilitation. There are two general issues:

- The GD1 well in particular is at the junction of two quite distinct land units and land systems, and that this itself may result in a higher local biodiversity than would normally be the case.
- The GDMW1 well is in a floodout and will need both care in timing and provision to avoid downstream impacts

Nevertheless, biophysical impact significance and mitigation in this area is basically a matter of "good housekeeping" and conformity with licence requirements, not to do with any single aspect of the biophysical environment in particular.

3.2 Absence of rare species

Field inspection uncovered no species listed in the schedules of either the SA National Parks and Wildlife Act 1972 or the Environment Protection and Biodiversity Conservation Act 1999. Current searches have not found prior records to date. However, attention is drawn to the presence of bloodwoods (*Eucalyptus centralis*) in the drainage terminus a short way south of GD1. This species at this point is almost at its southernmost limit, and there is the potential for other species, not evident at the time of survey, to also be present at limits of distribution. The drainage terminus should therefore be regarded as sensitive, and avoided in operations, even though the vegetation and habitat is not sufficiently distinctive to suggest potential for presence of rare or threatened species.

Fauna over most of the area, including the GD1 wellsite, can be expected to be typical of the Merninie and Strzelecki Land Systems, as outlined in Marree Soil Conservation Board (1997), as there is no unusual habitat characteristics in the immediate area.

4. RISKS ARISING FROM PROPOSED ACTIVITIES

4.1 General risks and responses

Table 2 summarises possible biophysical risks, their avoidance or amelioration, and suggested environmental objectives to be pursued during operations.

Disturbance of soil surfaces, particularly the removal of gibber pavement, during construction has the potential to initiate accelerated erosion. In the case of gibber slopes >2%, this may be irreversible.

Access track and wellsite construction will result in at least temporary local destruction of vegetation and faunal habitat on the access and at all wellsites. The dam represents a potentially permanent impact, if it stays in use after the conclusion of drilling and testing.

There will be a high visual impact of operations, given the proximity to the new Strzelecki Track.

Spills, particularly refuelling spills, can contaminate soil and in the medium-term prevent the re-establishment of vegetation on the spill area.

There will be an issue with the relatively deep dam and cattle, which will hang on the water and attempt to use the dam. GD1 and the dam are in an area of apparently moderate to high levels of grazing.

4.2 Specific constraints, risks and responses

4.2.1 GD1 Wellsite, associated water storage dam, and access

The GD1 wellsite will require a level and firm pad for the rig and camp, with a combined total area of about 1.5 ha. There exists (Figure 3) an almost level 330m x 150m area bounded to the west by the new Strzelecki Track ("Dillon's Highway"), the north by a Transport SA borrow pit, and the south and west by 4%-7% short slopes into drainage. This level area will provide a level and firm pad for much of the intended use by simply rolling the gibber pavement. The consolidated clayed surface needed for supporting intensive and heavy use can use either borrow from the drilling sump, or borrow from the immediately adjacent borrow pit. No new source of borrow need be developed.

Pad development must stay on the level area: the ease of initiating accelerated and irreversible erosion on the short 4-7% slopes south and east is well illustrated by that resulting from Strzelecki Track spur drains (Figure 6). As well, the lignum swamp immediately south of the gibber (Figure 7), and the small creekline feeding it, have as their catchment several square kilometres of the gibber slopes and tableland. They thus present a flooding hazard, as well as the potential impact risks from the project on biodiversity and water quality.

Access to site presents little difficulty, at most 50-100m of access from the new Strzelecki Track.

Similarly, the associated storage dam will be within 150m of the new Strzelecki Track, sharing a common swale accessible without dune crossing. Only a lightly graded track will be necessary to define access for construction vehicles and subsequent use. The major constraints on the damsite are minimising the loss of mature trees, particularly the block of whitewood, beefwood and bean tree (bauhinia) south and west of the proposed site and visible in the background of Figures 8 and 9.

4.2.2 GDMW1 Wellsite and access

The monitoring well at GDMW1 is constrained by both the landform it is in and the access to it. The wellsite is in a level floodout without defined channels other than very shallow (30cm) sandy gutters

(Figure 10). The floodout drains most of the gibber lands west of the new Strzelecki Track, with some further catchment to the east. The site is prone to frequent inundation, evidenced not only by the landform but also by the frequency of small sedges in the generally grassy cover. It is likely that inundation would be shallow, but rapid in onset and of short duration. The rapid onset will be particularly pronounced given the rapidity of run-off in heavy rainfall events from gibber surfaces upstream.

Part of the risk of inundation may be reduced by drilling in winter, but additional precautions such as bunding around sumps and storage areas may be necessary to avoid downstream impacts.

The shortest access to this well site, on floodout linked to the Strzelecki Creek floodplain, is from the new Strzelecki Track, descending long gibber slopes. From a take-off point at the junction of the Strzelecki Track and line 83-NCS, a long gently sloping ridge can be followed to near GDMW1 while staying on gibber slopes usually under 2% and at the steepest, under 3% at the foot of slopes (Figure 11).

Alternative routes down from the Strzelecki Track were inspected: all entailed gibber slopes at 3% up to 10%, with unacceptable erosion risks. The importance of avoiding these is highlighted by erosion occurring on the local gas pipeline, despite extended rehabilitation works (Figure 15).

If a rolled gibber track is used, erosion risks should be minimal on the general route indicated, which follows a broad summit area down onto the floodout. The floodout itself can be crossed without difficulty, as the surface is entirely level: a right of way should be defined for drilling crews, but access clearing and grading is unnecessary. It is also undesirable, as it will result in changed surface flow patterns on the floodout.

The less preferred alternative is a longer new track creation in the Strzelecki Creek floodplain, reached via an eroding track westward from near McLeod 1 (the track is visible in aerial photography in Figure 2). This alternative would require major grading and some vegetation removal on the floodplain, and potential re-direction of floodwaters: these risks of impact are considerably higher than the slight-slope gibber route, and remediation only slightly less in difficulty.

4.2.3 GDMW2 Wellsite and access

The GDMW2 monitoring well is on relatively level ground in a swale which intersects the new Strzelecki track, with clayey sands and sandy clay substrates. Only minor pad works should be needed for monitor well drilling operations, and the substrate permits use of a graded access without the need for introducing borrow materials, provided active rehabilitation is applied on completion of activities. Drilling should not require removal of perennial trees and shrubs: the proposed drilling area has a cover of *Enneapogon* and neverfail shortgrasses only. There is a low-lying portion of the swale nearby, subject to frequent short-duration inundation. This shallow basin should be avoided in establishing access.

4.2.4 GDMW3 Wellsite and access

The GDMW3 wellsite is on level gibber, for which rolling is the only treatment needed for waterwell drilling. The actual drilling area would be best placed on less-vegetated areas, with a denser gibber cover, than on the better-vegetated areas visible in Figure 13: the latter may heave when wet and may present bogging problems. The most appropriate access to the wellsite would appear to be the rehabilitated 83-NCS seismic line (Figure 14). Rolling this line should provide an adequate track for immediate requirements. Some portions of the line may require imported borrow material to prevent collapse of the surface under traffic, but judicious use of a water truck should limit this problem.

On such a basis, the main constraint is weather: this wellsite and line should not be used if wet, and must be allowed to largely dry out before running vehicles, to avoid major rutting and the necessary rehabilitation works which would then be needed. Chances of initiating accelerated erosion are slight because of the very gentle slope over almost all the area.

4.2.5 Stock

The area about GD1 is at least moderately used by stock. The dam may need fencing to prevent miring or drowning: stock will certainly hang near it and additional stock water might be necessary. The issue should be resolved in consultation with the pastoral leaseholders.

4.2.6 Visual impacts, third-party use

There is no way of avoiding major visual impact given the siting of GD1, which also controls the siting of the dam and monitoring wells. GD1, the dam, and GDMW2 will all be immediately obvious from the Strzelecki Track, with no means at all available for hiding them. We suggest that the situation be turned around into an interpretative exercise, with appropriate signage provided.

Third-party use of access, particularly to the remote GDMW1 and GDMW3 monitoring wells, has potential for adding to soil and vegetation impacts, public risk issues aside. Signage should be provided at intersections with the public road.

4.2.7 Borrow

Obtaining borrow presents no constraints, given the proximity of an existing and operational borrow pit adjoining GD1.

4.2.8 Pad construction and during operations

Drilling and camp pads generally will be rolled gibber, other than at GDMW2 where the clayey sand and sandy clay permits grading with simple subsequent rehabilitation. Outlines should be irregular or curved to minimise later visual contrasts. Part at least of the GD1 pad will require a clayed surface free of stone. Clay from the drill sump can be used for such a surface, or from the adjoining borrow pit. The following should be undertaken to minimise impact and assist subsequent remediation.

- Minimise pad sizes for the GDMW monitoring wells. Roll rather than scrape: where scraping is necessary, stockpile the scraped material for re-spreading at the end of drilling.
- Provide low bunding around GDMW1 wellsite to divert flash-flooding during operations.
- Do not cut gibber areas, but use fill where major load-bearing operations are needed and where levels need to be rectified.
- For the GD1 sump, subsidiary pits and load bearing surfaces which must be stone free, scrape and stockpile the gibber mantle and its associated surface soil and plant debris for later rehabilitation.
- When constructing bunds, loading ramps etc on gibber surfaces, use fill rather than cutting the gibber pavement.

In the event of spills on gibber surfaces, the spills can be left to self-clean rather than risk disturbance of gibbers.

Table 2: Risks, impacts and management in relation to terrain, landcover, landscape and landuse

Possible impact	Main sources of risk	Avoidance, management, mitigation	Environmental objective
Physical damage to soils, vegetation and habitat	Access and pad construction; natural limits on rehabilitation	Use of existing access; rolled new access and pad development on gibber surfaces	Minimise disturbance to vegetation and habitat
Accelerated soil erosion. Potential start-up of long term irreversible erosion on gibber slopes >2%	Access and pad construction	Construction of GD1 pad on almost level ground, Run-on diverted. Rolling of most of pad area rather than scraping, cut or fill. Gibber and surface loam held for later re-spreading where scraped gibber surfaces are created (eg for sump). Access rolled with minimal scraping, alternatively temporarily formed using nearby borrow material. Access to GDMW1 via rolled gibber following very gentle slopes as indicated. Access to GDMW2 along former seismic line, rolled.	Minimise soil impacts Minimise disturbance to gibber surfaces
Disturbance to rare, endangered, vulnerable species	Access and pad construction, near-surface water bores, dam construction	No such species known to be present; if present, then most likely to be on floodplain and in swamp areas, which can be avoided. Tree areas can be avoided in constructing dam.	Avoid disturbance to rare, endangered, vulnerable species
Establishment of further alien species in the locality	Importation on vehicles	Requirement for contractor/other vehicles to be clean prior to entering district	Prevent introduction of pest plants
Development impacting high biological or wilderness value areas	Access, pad and dam construction	Area does not possess special biological/wilderness value	Avoid impacts on high biological value or wilderness value areas
Visual impacts through obtrusive access and pad development and/or visible long-term persistence of pad and access.	Access, pad and dam construction	GD1 especially and its dam, and also GDMW2, will be highly visible to visitors. There is no means of avoiding this if GD1 is to be drilled where indicated.	Minimise visual impacts
Interference with stock	No risk anticipated	GD1, the dam and GDMW1 all appear to be in an area of moderate stock use, and some interference with stock is likely. Fencing of the dam may be necessary to avoid bogging of cattle.	Minimise adverse impact on livestock

5. REHABILITATION

Rehabilitation should be commenced as soon as possible after completion of drilling and tests, if it is intended to abandon the wells and facilities

For the damsite, we are unaware of whether it would be usable for pastoral purposes. If not, and if not required for subsequent operations at the GD1 well, the walls should be collapsed and the dam area levelled; with the outlines blurred and some direct seeding applied. The intent should be to return in to a general similarity to the rest of the swale it is in, especially as this construct would otherwise remain highly visible from the new Strzelecki Track.

At GD1, after all pits have been filled and ancillary earth structures levelled, previously stockpiled gibber should be re-spread. Provided the constraints indicated above have been avoided, this should result in relatively rapid regrowth and rehabilitation.

The same applies, though on a smaller scale, for the gibber area GDMW2 and interdune GDMW3 monitoring wellsites.

At the GDMW1 wellsite in floodout, care should be taken to ensure that all bunds and flood-protection works be levelled back to grade, to avoid permanent alteration of overland flow of runoff in the area.

Rolled gibber access to GDMW1 and GDMW2 should simply be left, and not scarified in any way, as this is likely to increase, rather than reduce, the chance of accelerated erosion.

6. REFERENCES

Marree Soil Conservation Board (1997) "Marree Soil Conservation Board District Plan" ISBN073084203 7

7. FIGURES

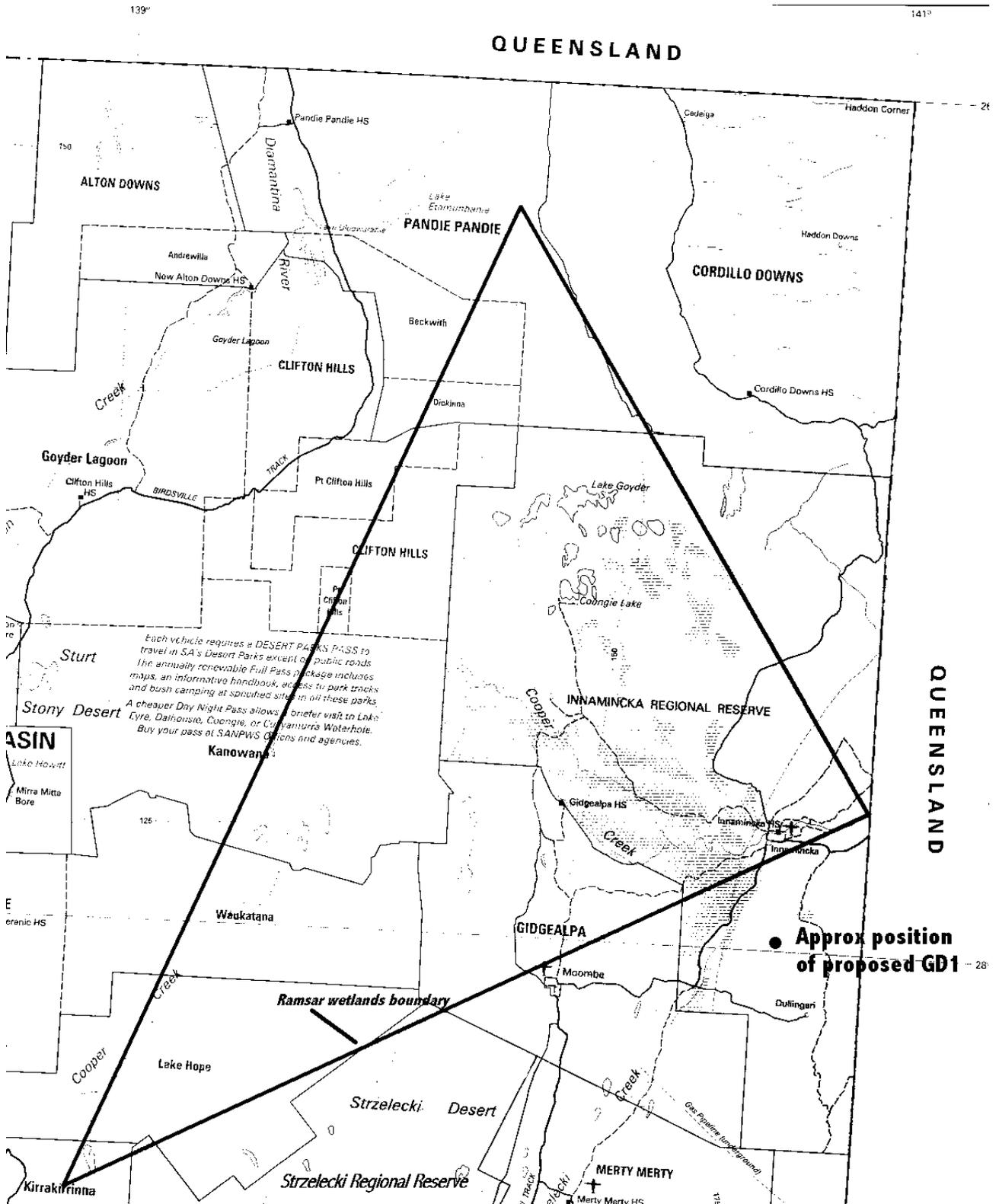
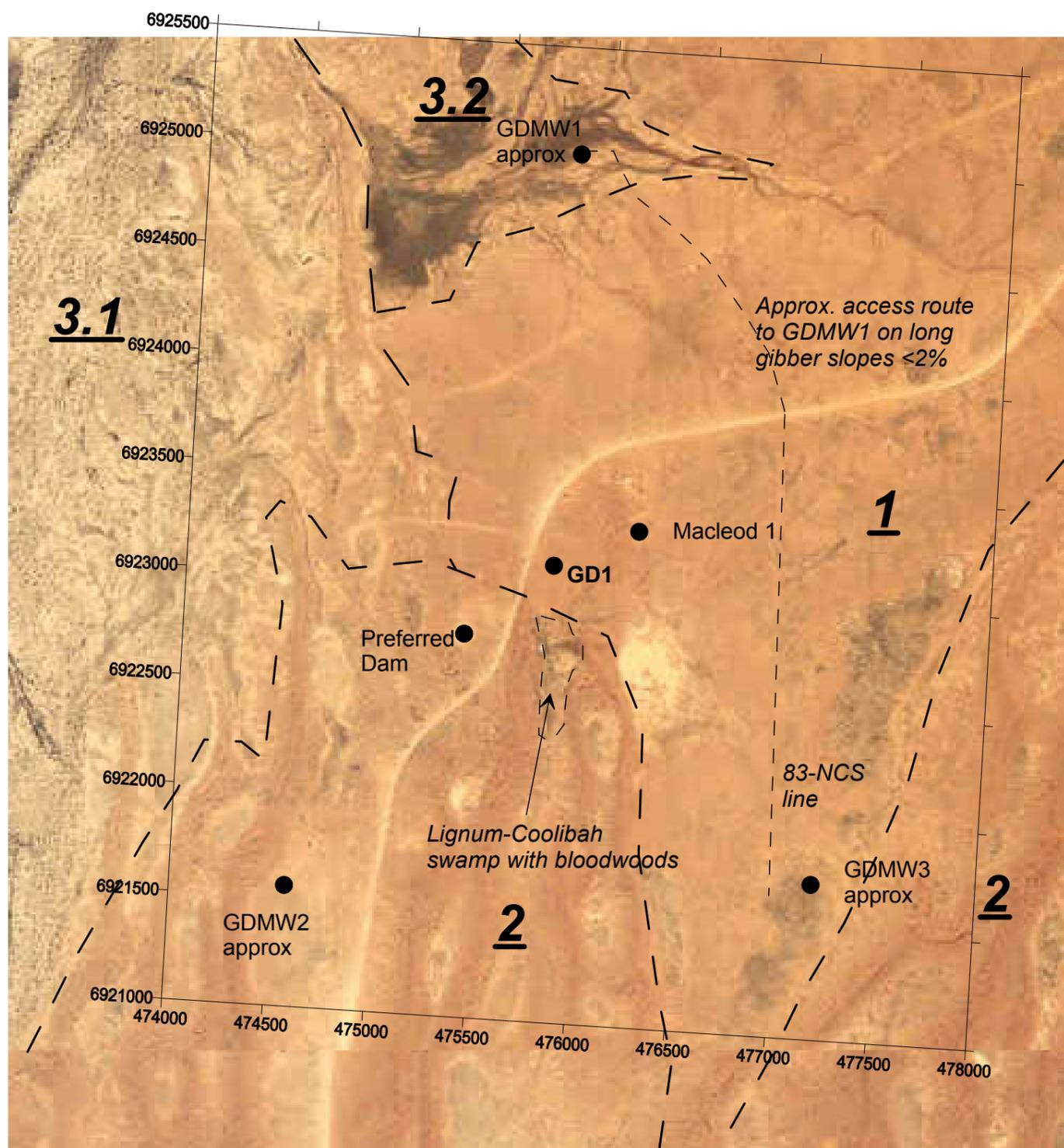


Figure 1. General location of Geodynamics GD1 wellsite in relation to Innamincka Regional Reserve, Ramsar Wetlands and local infrastructure. (Map base: DENR Pastoral areas 1:250000, 1993)

Figure 2: Local area, GD1 well, existing Macleod 1 well, measuring wells at GDMW1, GDMW2, GDMW3, and proposed damsite



Key number	Land System (Marree Soil Conservation Board 1997)	Landform/soils	Vegetation
1	MERNINIE	Long gradual slopes of silcrete gibber (this area). Duplex friable sandy loam over light clay. Highly dispersible. Irreversible accelerated erosion will start at slopes above 2%. Dense gibber lag on surface.	Mitchell grass-neverfail perennial grassland with short-lived chenopod shrubs, especially <i>Sclerolaena brachyptera</i> . Effectively treeless.
2	STRZELECKI (DELLA)	Dunefield. Red siliceous sands, semi-mobile crest (in this area) and semi-stable slopes. Narrow interdunes with massive red sandy clays, with or without a sand veneer. Wider interdunes vary from similar through to grey self-mulching clays equivalent to those in the Cooper system.	Sandhill canegrass hummock grassland on dunes. Mid-slopes and narrower swales with low open woodland of whitewood, sandhill wattle, hopbush, needlebush. Narrower swales with bean tree, bloodwood (this area) over short grasses: swampy areas with lignum, coolabah as shrubland or woodland. Stands of beefwood common. Broader swales with herbland or areas of <i>Eragrostis</i> and short-lived chenopod shrubs; trees largely limited to sandy or swampy areas..
3.1	COOPER	Floodplain; heavy pale grey self-mulching clays	Woodland: coolibah, whitewood, spotted emubush, bean tree over lignum, old man saltbush, herbs
3.2	COOPER	Floodout: red sandy clay with sand veneer, prone to flooding, in outwash partially dammed by Holocene sand rise. Numerous shallow gutters. Prone to ephemeral flooding	Short grass cover (<i>Enneapogon</i> , <i>Aristida</i> , perennial <i>Eragrostis</i> spp.) with flat sedge and areas of tree or tall shrub cover: beefwood, sandhill wattle, prickly wattle, spotted emubush.

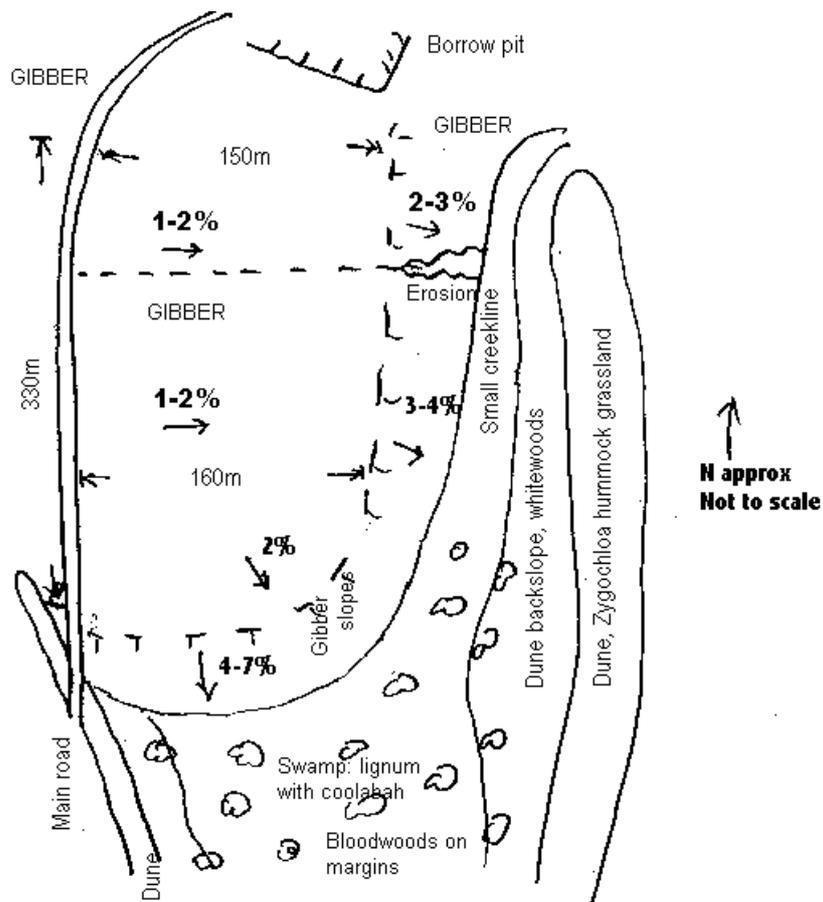


Figure 3. Field sketch of wellsite, at boundary of gibber (Merninie) and dunefield (Strzelecki). Available space on level gibber is approximately 150m by 330m.



Figure 4. GD1 wellsite looking north to new Strzelecki Track. Line across is a lateral drain. Mitchell grass-*Sclerolaena* cover on gibber. Slopes 2%



Figure 5. GD1 wellsite looking southeast from road. Mitchell grass-*Sclerolaena* cover on gibber. Slopes 2%.



Figure 6. GD1 Wellsite eastern edge: roadway spur drain erosion on 4% slope.



Figure 7. Lignum (*Muehlenbeckia florulenta*) and coolibah (*Eucalyptus coolabah*) swamp in swale immediately south of GD1 site area. Bloodwood (*E. centralis*) also present (lower trees).



Figure 8. Proposed dam area. Exposed massive clays in claypan in foreground, sand veneer on clays in background with shortgrasses (*Enneapogon* and *Eragrostis* spp), beefwood, whitewood.



Figure 9. Claypan in proposed dam area. Woodland on sandy rise immediately south of the proposed dam area is a mixture of bloodwood, beefwood, whitewood and bean tree with a grassy understorey.



Figure 10. GDMW1 measuring well location in floodout. Sandy clays subject to occasional inundation; *Eragrostis* spp and small sedges with *Sclerolaena* spp. Shrubs present in gutters (background).



Figure 11. Access to GDMW1 measuring well location from gibber slopes. Slopes largely under 3%.



Figure 12. GDMW2 measuring well location. Sandy clay swale with *Aristida*, *Eragrostis*, *Enneapogon* spp. shortgrasses and copperburrs.



Figure 13. GDMW3 measuring well location. Gilgai and drainage area on gibber tableland; *Sclerolaena* spp. and mitchell grass cover; irregular gibber cover.



Figure 14. Proposed access to GDMW3 measuring well: rehabilitated seismic line 83-NCS. Slopes 1-2%. Mitchell grass -*Sclerolaena* spp. cover with dense gibber.



Figure 15. Example of rapid and recent erosion on gibber slopes above 2%. Gullying prograding in gas pipeline trench, near proposed access to GDMW1.

Appendix B

Fauna survey – EBS 2008



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INNAMINCKA GEOTHERMAL ENERGY PILOT PLANT FAUNA SURVEY

July 7th – 11th 2007



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Cover Photo: *Astrebla pectinata* (Mitchell Grass) open grassland over gibber plain, typical landform of the geothermal energy pilot plant survey area.

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Executive Summary

This document reports on a fauna survey undertaken at a proposed geothermal energy pilot plant site, inside Innamincka Regional Reserve, by Environmental and Biodiversity Services (EBS). The survey site is located at a junction of gibber plain (Mernie land system) and the Strzelecki dunefields (Strzelecki land system). The survey was conducted from 7th – 11th July 2008. A number of survey techniques were used, including Elliott trapping, active searching, spotlighting and AnaBat detectors. Bird surveys were also undertaken and any opportunistic sightings of animals and their locations were noted. Pitfall trapping was not undertaken due to the time of year the survey was undertaken. One trapping site was installed within very close proximity to the proposed geothermal energy pilot plant site and a further three trapping sites were installed within one kilometre of the proposed geothermal energy pilot plant site. Whilst two of the extra trapping sites were located in different habitat to that of the geothermal energy pilot plant site it is possible that nearby habitat and therefore fauna species could be impacted. One of the trapping sites, INN002 was left open for four nights whilst the other three trapping sites were left open for three nights.

Four mammal species were detected within the geothermal energy pilot plant trapping site (INN001) including the introduced House Mouse (*Mus musculus*), Rabbits (*Oryctolagus cuniculus*), Fox (*Vulpes vulpes*) and Dingo / dog (*Canis lupus dingo / familiaris*). A further two species Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and Stripe-faced Dunnart (*Sminthopsis macroura*) were captured in similar habitat at site INN004. Anabat recordings from site INN002 identified the presence of three bat species including Gould's Wattled Bat (*Chalinolobus gouldii*), Little Broad-nosed Bat (*Scoterepens greyii*) and White-striped Freetail-bat (*Tadarida australis*). It is possible that the Southern Free-tail Bat (*Mormopterus sp. 3*) is present within the survey area, however, the calls of this species could not be positively identified. No mammal species of conservation significance were observed or detected during the survey.

One reptile species, Bynoe's Gecko (*Heteronotia binoei*) was detected at site INN001. A further three reptile and one amphibian species were detected during the survey period at trapping sites INN002, INN003 and INN004. Generally the reptile activity was low due to the time of the year and the cold conditions experienced over the survey period. Painted Dragon (*Ctenophorus pictus*), Tree Dtella (*Gehyra variegata*), Eastern Desert Ctenotus (*Ctenotus regius*) and Bynoe's Gecko (*Heteronotia binoei*) were all located whilst active searching. One Trilling Frog (*Neobatrachus centralis*) was detected whilst spotlighting. No conservation significant reptile or amphibian species were observed or detected.

Six bird species and fourteen individuals were observed at site INN001 during the survey period. The most abundant species were Variegated Fairy-wren (*Malalurus leucopterus*

leuconotus) (4 individuals), Australian Magpie (*Gymnorhina tibicen*) (3 individuals) and Yellow-throated minor (*Manorina flavigula*) (3 individuals). A further twenty-three bird species and 224 individuals were detected at trapping sites INN002, INN003 and INN004. The most abundant species were the Variegated Fairy-wren (*Malurus leucopterus leuconotus*), Little corella (*Cacatua sanguinea*), Black Kite (*Milvus migrans*) and Crested Pigeon (*Ocyphaps lophotes*). The least abundant species were the Black Falcon (*Falco subniger*), Whistling Kite (*Haliastur sphenurus*), Orange Chat (*Ephthianura aurifrons*) and Red-capped Robin (*Petrocia goodenovii*). One bird species of state conservation significance (listed under the *National Parks and Wildlife Act 1972*) was recorded at site INN004. Four Black-breasted Buzzards (*Hamirostra sphenurus*) were recorded flying high over the site. Six Chestnut-crowned Babblers (*Pomatostomus ruficeps*) were detected at trapping site INN002 with the species considered be **uncommon** across the state.

Several recommendations have been made to mitigate the potential impacts, including maintaining vegetation clearance and disturbance to a minimum, implementing exotic species management programs if needed, minimisation of dust levels and artificial watering points, reducing speed limits along access tracks, turning off lights and machinery when not required and undertaking staff training sessions to promote the awareness of fauna and their habitat.

1.0 Introduction

Environmental and Biodiversity Services (EBS) undertook a fauna survey at a proposed geothermal energy pilot plant site, in Innamincka Regional Reserve. The field survey was undertaken from 7th – 11th July, 2008. The fauna survey followed the South Australian Department for Environment and Heritage (SA DEH) vertebrate survey guidelines (as per Owens 2000) with some modifications.

The objectives of the geothermal energy pilot plant site fauna survey, and report were to:

- Review documents and databases that describe species that have been recorded in or in proximity to the study area;
- Undertake a field survey to determine the fauna present and potentially present in the proposed pilot plant study area;
- Produce a document detailing the findings of the survey and assess the potential impacts of the proposed pilot plant and its associated activities on native fauna species, particularly those of conservation significance; and,
- Provide recommendations to ensure that possible impacts of the construction and operation of the pilot plant on fauna and vegetation are minimised.

1.1 Regional context

The proposed geothermal energy pilot plant is located in Innamincka Regional Reserve (RR). Innamincka RR is 13 818 km² in size and located in the far north-east of South Australia, approximately 1 100 km from Adelaide. Innamincka RR is bounded to the east by the South Australia / Queensland border. The Township of Innamincka is located within the Reserve's boundaries, but is not included as part of the Reserve. The Reserve falls within the Marree Soil Conservation District (Far North Region Department of Environment and Land Management 1993; North Region Heritage and Biodiversity 1998). Coongie Lakes National Park is situated inside Innamincka RR. Coongie Lakes National Park is listed as a Ramsar Wetland of International Significance (SAM 2008).

The dominant land uses in Innamincka RR are pastoralism, tourism, petroleum and natural gas production. Wildlife and landscape conservation, and the conservation of historic structures, is also a key purpose of the Reserve. Innamincka has been declared a State Heritage Area (Morton et al. 1995); the Reserve has been grazed since the 1870s and is leased and managed by Kidman and Co. Pastoral Company. The area is significant to Aboriginal people of the Yandruwandha, Yarrawarka and Dieri groups (North Region Heritage and Biodiversity 1998).

Innamincka RR is located in the Channel Country Bioregion, which encompasses approximately 284 700 km² in South Australia, Queensland, the Northern Territory and New

South Wales. The Channel Country Bioregion is named as such because of the extensive network of braided flood and alluvial plains of the Georgina, Eyre, Cooper, Bulloo and Diamantina Rivers and Creeks. These braided plains are surrounded by gibber plains, sand dunes and ranges. The Bioregion is located in the Eromanga Basin, which contains major oil and natural gas deposits. The main land uses in this Bioregion, include pastoralism (cattle grazing), conservation, and crown land. The main cause of degradation is over-grazing by stock; however, a number of pest species such as Rabbits (*Oryctolagus cuniculus*), Camels (*Camelus dromedarius*), Pigs (*Sus scrofa*), Goats (*Capra hircus*), Foxes (*Vulpes vulpes*), and feral Cats (*Felis catus*) are also present (Australian Natural Resources Atlas 2007).

1.2 Climate

As animal abundance can be affected by climatic conditions, an assessment of general climatic conditions for Innamincka has been undertaken. Data were obtained from the nearest Bureau of Meteorology weather station at Moomba Airport. Data obtained from the Moomba Airport weather station indicate that the average maximum temperature for the region is 37.4°C in January (summer) and the lowest 6.3°C in July (winter). The highest mean rainfall (40.0 mm) also occurs in January and the lowest rainfall (8.6 mm) falls in August. Monthly rainfall was relatively low during the 12 months prior to the survey, with the exception of June, when 24.2 mm was recorded. In the 12 months prior to the survey, the region had experienced a total of 46.4 mm, which is below the average rainfall of 205.9 mm usually experienced during those months (Figure 1). Weather conditions during the July 2008 survey were cool to mild. The average daytime temperature was 17°C, the overnight minimum average was 6°C (Table 1). No rainfall was recorded during the survey period.

Table 1. Weather data for the period 7th – 11th July 2008, obtained from the Moomba Airport weather station

Date	Min Temp °C	Max Temp °C	Relative Humidity %	Ave Wind Speed km/h	Total Rainfall (mm)
7/07/2008	11.1	16.4	34	WSW 31	0
8/07/2008	4.5	15.1	39	SSW 24	0
9/07/2008	2.5	16.6	39	SW 12	0
10/07/2008	4.0	19.5	28	W 27	0
11/07/2008	7.7	16.5	39	SE 21	0

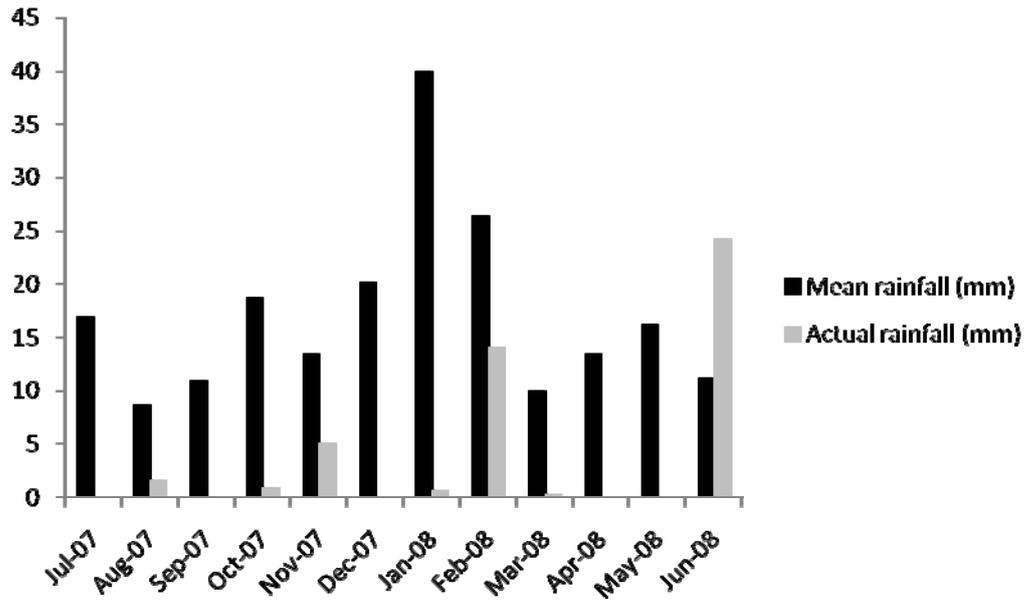


Fig. 1. Monthly rainfall at Innamincka Regional Reserve for the past 12 months, recorded by the nearest weather station (Moomba Airport); mean rainfall is based on data recorded from 1972-1999

2.0 Methods

2.1 Background research

Background research relating to the survey area, including an assessment of the potential presence of conservation significant fauna species, was undertaken via a literature review and database searches. A database search for fauna species previously recorded in and around the survey area was conducted by the Department for Environment and Heritage SA (DEH) using the Biological Database of South Australia (BDBSA). Additionally, a 'Protected Matters' search, for species listed under the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act 1999)*, was performed to determine if species of national significance, or their habitat, potentially occur in the survey area.

Several documents and reports pertaining to the general region were also reviewed, including:

- Innamincka Regional Reserve Management Plan (1993), Department of Environment and Land Management, Adelaide;
- A Review of Innamincka Regional Reserve 1988 – 1998 (1998), Department for Environment, Heritage, and Aboriginal Affairs, Adelaide;
- A Biological Survey of the Stony Deserts, South Australia, 1994-1997 (1998), Heritage and Biodiversity Section, Department for Environment, Heritage and Aboriginal Affairs, Adelaide;
- Action Plan for Australian Birds (2000), Canberra; and,
- Vegetation, Landform and Habitat, Proposed Deep Drilling and Associated Development near McLeod 1 Well, Innamincka Area (2002), Fatchen Environmental Pty Ltd, Adelaide.
- An Inventory of the Biological Resources of the Rangelands of South Australia (2003), Department for the Environment and Heritage, Adelaide.

2.1 Survey

The survey was undertaken over a five day period from July 7th – 11th 2008. A number of survey techniques were used to ensure a comprehensive coverage of species that occur in the survey area (detailed below). One fauna trapping site was installed within the geothermal energy pilot plant site and a further three trapping sites were installed within close proximity (<300 metres). In total, eight sets of 15 Elliott traps were installed. Traps were checked for fauna species and bait replaced (if necessary) each day in the morning and the late afternoon. One of the trapping sites, INN002 was left open for four nights whilst the other three trapping sites were left open for three nights.

The trapping and fauna detection methods used during the survey were based on standard biological survey methodology developed by the South Australian Department for Environment and Heritage (refer to Owens 2000), except that no pitfall traps were installed. This was due to the time of year and the low probability of catching reptile species. Elliott traps, active searching, spotlighting and AnaBat detectors were used to detect animals. Bird surveys were undertaken by an ornithologist at each of the fauna trapping sites. Opportunistic sightings of fauna species and their locations were also noted.

The survey was conducted under the following licences and permits:

- Scientific Research Permit No. Y25532 -1 (Department for Environment and Heritage)
- Wildlife Ethics Committee Permit No. 5/2006 (Wildlife Ethics Committee)
- Scientific Licence No. 158 (Animal Welfare, National Parks and Wildlife SA)

2.2 Survey techniques

Elliott traps

Elliotts are small aluminium traps approximately 330 mm long, 100 mm high and 90 mm wide. Each Elliott trap line consisted of 15 traps spaced at approximately 10 m apart. A small bolus of peanut butter, rolled oats and linseed oil was placed in all Elliott traps as bait. Elliott traps were left open day and night.

AnaBat Detectors

An AnaBat detector was used to record bat calls. This detector was located at site INN002, with four nights of recording being undertaken overall. The detector recorded bat calls from early evening until early the following morning. Although AnaBat recordings can be used to determine what species are present in an area they cannot be used to quantify bat numbers. All Anabat recordings are identified by Terry Reardon (SA Museum).

Bird survey

Bird species diversity and abundance was assessed at the fauna trapping sites. Bird surveys at the trapping sites consisted of a combination of slow walking and occasional stopping. All species seen or heard during these surveys were recorded. Opportunistic observations of bird species were also noted.

Active searching

Active searching (during the day) was used as an additional method to locate animals by looking for them underneath shrubs, in holes and under leaf litter, and searching for tracks. In particular, areas were searched for Hopping Mouse (*Notomys* spp.) tracks and Kowari (*Dasyuroides byrnei*) burrows.

Spotlighting

Spotlighting, both on foot (with handheld spotlights) and from the car, was undertaken for three nights at and within close proximity to the fauna trapping sites. All species detected were recorded. Spotlighting was undertaken in the first two hours after sunset.

Opportunistic observations

Opportunistic observations are chance sightings of fauna species, which are not premeditated through trap captures or active searching. Opportunistic observations of all fauna observed in the survey area were noted and their location recorded with a GPS unit.

Specimen identification

Each animal caught in a trap or observed when actively searching was, where possible, identified at the point of capture. If the animal could be identified to species level it was marked and released immediately. As a requirement of the survey's Scientific Permit, voucher specimens were taken for some fauna species captured. For those animals which were euthanized, a liver sample was taken and the carcass placed in formalin (for mammals) or setting trays (reptiles). At the culmination of the field survey, voucher specimens were taken to the South Australian Museum to confirm identification and to provide the museum with valuable biological data.

3.0 Results

3.1 Trapping site descriptions

The four trapping sites were situated in three habitat types: *Astrelba pectinata* (Mitchell Grass) open grassland / gibber plain (geothermal energy pilot plant), *Muehlenbeckia florulenta* (Lignum) / *Chenopodium auricomum* (Queensland Bluebush) shrubland / Flood plain / intermittent wet area and *Zygochloa paradoxa* (Sandhill Canegrass) hummock grassland / sand dunes (Table 2). Figure 3 indicates the location of each trapping site for the geothermal energy pilot plant fauna survey. Photos of each trapping site are provided in Appendix 1.

INN001 and INN004

Both trapping sites INN001 and INN004 were located in *Astrelba pectinata* (Mitchell Grass) open grassland over gibber. Common flora species include Mitchell Grass, *Salsola kali* (Buckbush), *Sclerolaena* sp. (Bindyi), *Atriplex* sp. (Saltbush), *Eragrostis setifolia* (Neverfail), *Eragrostis dielsii* (Lovegrass), *Sporobolus actinocladus* (Katoora), *Panicum decompositum* (Native Panic) and *Zygophyllum howittii* (Clasping Twinleaf). Sites INN001 and INN002 lack gilgais and shrub or tree cover.

INN002

Trapping site INN002 is located approximately 250 metres south of the geothermal energy pilot plant trapping site (INN001) in a *Muehlenbeckia florulenta* (Lignum) / *Chenopodium auricomum* (Queensland Bluebush) shrubland associated with a flood plain / intermittent wet area. Common flora species include Lignum, Queensland Bluebush, *Eucalyptus coolabah* (Coolabah) and *Cullen australasicum* (Tall Verbine). *Corymbia terminalis* (Bloodwood) was also present as an emergent species. Several large pools of water were present at the time of the survey.

INN003

Trapping site INN003 is located approximately 380 metres south east of the the geothermal energy pilot plant trapping site (INN001) in a *Zygochloa paradoxa* (Sandhill Canegrass) hummock grassland associated with sand dunes. Sandhill Canegrass is common on the dune crests, common flora species associated with the dune swales are *Atalaya hemiglauca* (Whitewood), *Crotalaria cunninghamii* (Regal Birdflower), *Crotalaria eremaea* ssp. *strehlowii* (Rattlepod), *Salsola kali* (Buckbush), *Tribulus hystrix* (Sandhill Puncture Vine) and *Triodia basedowii* (Lobed Spinifex).

Table 2. Site locations and associated habitat at each fauna trapping site

Site Name	Zone	Easting	Northing	Vegetation Association	Landform
INN001	54J	475770	6922937	<i>Astrelba pectinata</i> (Mitchell Grass) open grassland	Gibber plain
INN002	54J	475815	6922652	<i>Muehlenbeckia florulenta</i> (Lignum) / <i>Chenopodium auricomum</i> (Queensland Bluebush) shrubland	Flood plain / intermittent wet area
INN003	54J	476072	6922617	<i>Zygochloa paradoxa</i> (Sandhill Canegrass) hummock grassland	Sand dunes
INN004	54J	475884	6923724	<i>Astrelba pectinata</i> (Mitchell Grass) open grassland	Gibber plain

3.2 Trapping effort

Each Elliott trap line was left open for three nights with the exception of INN002 which was left open for four nights. Spotlighting was undertaken at the fauna trapping sites when weather conditions permitted. The survey area was actively searched during the day. The AnaBat detector was set for four nights and each fauna trapping was surveyed for birds for in the morning and in the afternoon (7.5 hours in total) (Table 3).

Table 3. Trapping and survey effort for the geothermal energy pilot plant fauna survey, July 2008

Site	Elliott traps		Spotlighting hours	Day search hours	Bat detector nights	Bird survey hours
	Nights	Trap nights				
INN001	3	45	1	2	0	1.5
INN002	4	120	1	2	4	3
INN003	3	135	4	4	0	1.5
INN004	3	90	1	2	0	1.5
Total	13	390	7	10	4	7.5

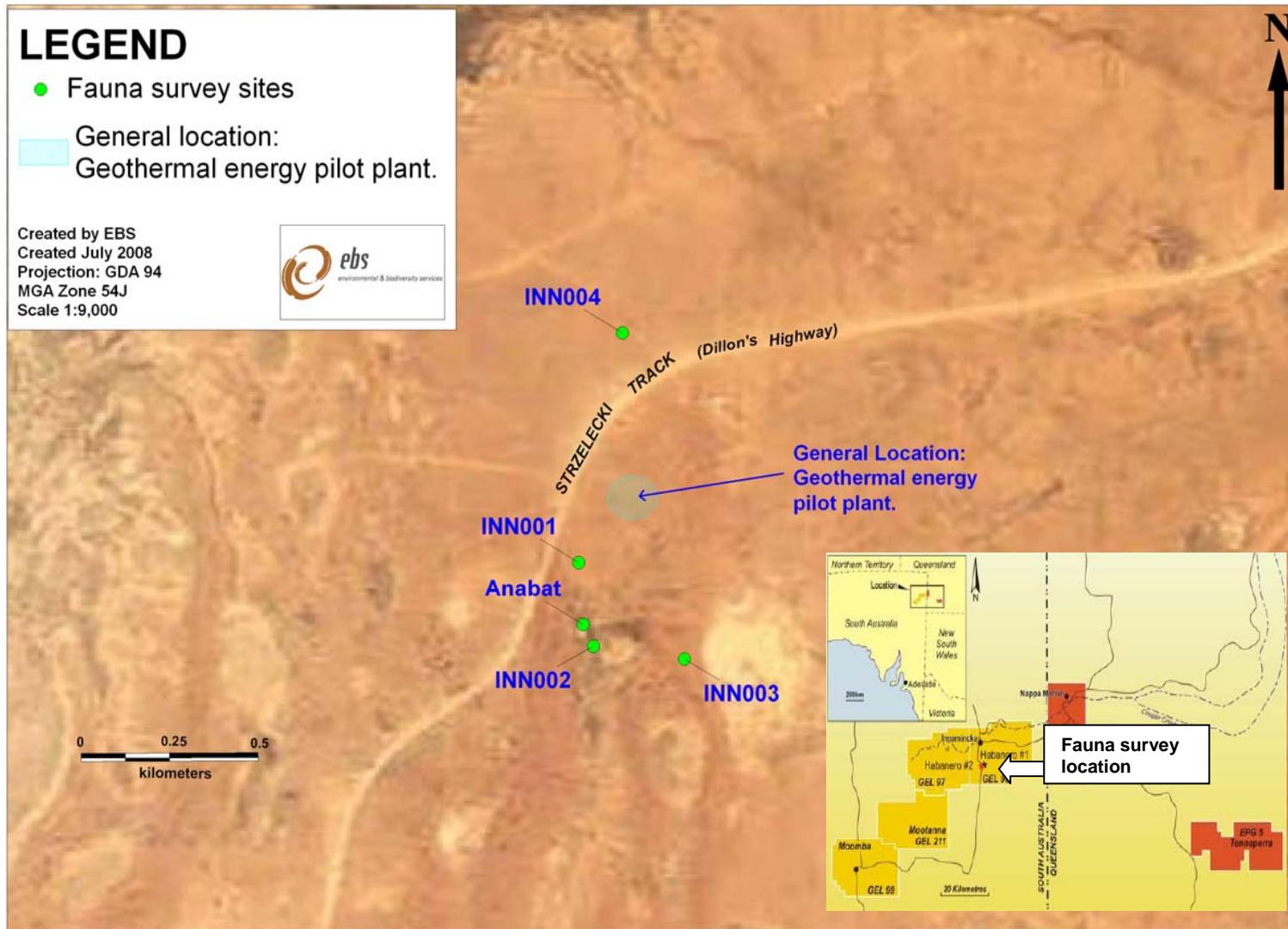


Fig 2. Locations of geothermal energy pilot plant fauna trapping sites, July 2008.

3.3 Mammals

Four mammal species were detected within the geothermal energy pilot plant trapping site (INN001) including the introduced House Mouse (*Mus musculus*), Rabbit (*Oryctolagus cuniculus*), Fox (*Vulpes vulpes*) and Dingo / dog (*Canis lupus dingo / familiaris*). A further two species Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and Stripe-faced Dunnart (*Sminthopsis macroura*) were captured in similar habitat at site INN004.

Anabat recordings from site INN002 identified the presence of three bat species including Gould's Wattled Bat (*Chalinolobus gouldii*), Little Broad-nosed Bat (*Scoterepens greyii*) and White-striped Freetail-bat (*Tadarida australis*). It is possible that the Southern Free-tail Bat (*Mormopterus sp. 3*) is present within the survey area, however, the calls of this species could not be positively identified. Example calls of each bat species are provided in Appendix 3.

The most commonly recorded species across all four trapping sites was the House Mouse (*Mus musculus*) with 34 individuals captured. The least commonly detected species, with each only being captured once at the trapping sites, were the Fat-tailed Dunnart (*Sminthopsis crassicaudata*) and Stripe-faced Dunnart (*Sminthopsis macroura*). No mammal species of conservation significance were observed or detected.

Table 4. Mammals detected during the fauna survey, July 2008

Species Name	Common Name	INN001	INN002	INN003	INN004	Total
* <i>Oryctolagus cuniculus</i>	Rabbit	Sc / Di	7 Sc / Di	Sc / Di	Sc	7
* <i>Mus musculus</i>	House Mouse	2	9	23		34
* <i>Vulpes vulpes</i>	Fox	Tr	1 Tr	Tr		1
<i>Canis lupus dingo / familiaris</i>	Dingo / Dog	Tr	Tr	Tr		
<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		A			
<i>Mormopterus sp3</i> or <i>Chalinolobus gouldii?</i>	Southern Free-tail Bat		A?			
<i>Scoterepens greyii</i>	Little Broad-nosed Bat		A			
<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart				1	1
<i>Sminthopsis macroura</i>	Stripe-faced Dunnart				1	1
<i>Tadarida australis</i>	White-striped Freetail-bat		A			
Total site observations		2	16	23	2	44
Total species for site		4	7	4	3	9

Key

*Exotic species; Sc = scat, species counted only, not abundance; Di = digging, species counted only, not abundance; Tr = tracks, species counted only, not abundance A = AnaBat confident identification; A? = AnaBat probable identification

3.4 Reptiles and amphibians

One reptile species, Bynoe's Gecko (*Heteronotia binoei*) was detected at site INN001 whilst a further three reptile and one amphibian species were detected during the survey period at trapping sites INN002, INN003 and INN004. Generally the reptile activity was very low due to the time of the year and the cold conditions experienced during the survey period. Painted Dragon (*Ctenophorus pictus*), Tree Dtella (*Gehyra variegata*), Eastern Desert Ctenotus (*Ctenotus regius*) and Bynoe's Gecko (*Heteronotia binoei*) were all located whilst active searching. One Trilling Frog (*Neobatrachus centralis*) was detected whilst spotlighting.

INN003 had the highest reptile / amphibian abundance with 6 individuals detected. No reptile or amphibian species of conservation significance were observed or detected.

Table 5. Reptiles and amphibians detected during fauna survey, July 2008

Species Name	Common Name	INN001	INN002	INN003	INN004	Total
<i>Ctenophorus pictus</i>	Painted Dragon			2		2
<i>Ctenotus regius</i>	Eastern Desert Ctenotus			1		1
<i>Gehyra variegata</i>	Tree Dtella			2		2
<i>Heteronotia binoei</i>	Bynoe's Gecko	1				1
<i>Neobatrachus centralis</i>	Trilling Frog			1		1
Total observations for site		1	0	6	0	7
Total species for site		1	0	4	0	5

3.5 Birds

Six bird species and fourteen individuals were observed at site INN001 during the survey period. The most abundant species were Variegated Fairy-wren (*Malalurus leucopterus leuconotus*) (4 individuals), Australian Magpie (*Gymnorhina tibicen*) (3 individuals) and Yellow-throated minor (*Manorina flavigula*) (3 individuals). A further twenty-three bird species and 224 individuals were detected at trapping sites INN002, INN003 and INN004. The most abundant species were the Variegated Fairy-wren (*Malalurus leucopterus leuconotus*), Little corella (*Cacatua sanguinea*), Black Kite (*Milvus migrans*) and Crested Pigeon (*Ocyphaps lophotes*). The least abundant species were the Black Falcon (*Falco subniger*), Whistling Kite (*Haliastur sphenurus*), Orange Chat (*Ephthianura aurifrons*) and Red-capped Robin (*Petrocia goodenovii*).

One bird species of state conservation significance (listed under the *National Parks and Wildlife Act 1972*) was recorded at site INN004. Four Black-breasted Buzzards (*Hamirostra sphenurus*) were recorded flying high over the site. Six Chestnut-crowned Babbler's (*Pomatostomus ruficeps*) were recorded at trapping site INN002. This species is considered to be **uncommon** within South Australia (Carpenter and Reid 2000), however, this conservation rating is not formally recognized under the *National Parks and Wildlife Act 1972*.

Trapping site INN002 had the highest bird species diversity and abundance with 133 individuals and 18 species detected.

Table 6. Birds detected during the fauna survey, July 2008

Species Name	Common Name	Cons. Rating		INN 001	INN 002	INN 003	INN 004	TOTAL
		AUS	SA					
<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill					2		2
<i>Aquila audax</i>	Wedge-tailed Eagle				2			2
<i>Artamus cinereus</i>	Black-faced Woodswallow					6		6
<i>Cacatua roseicapilla</i>	Galah				7			7
<i>Cacatua sanguinea</i>	Little Corella				25			25
<i>Cinclosoma cinnamomeum</i>	Cinnamon Quail-thrush					1	2	3
<i>Corvus coronoides</i>	Australian Raven				2	1		3
<i>Euseyornis cinctus</i>	Red-kneed Dotterel					4		4
<i>Euseyornis melanops</i>	Black-fronted Dotterel				2			2
<i>Ephthianura aurifrons</i>	Orange Chat					2		2
<i>Falco cenchroides</i>	Nankeen Kestrel				3	1		4
<i>Falco subniger</i>	Black Falcon					1		1
<i>Gallinula ventralis</i>	Black-tailed Native-hen				3	8		11
<i>Gymnorhina tibicen</i>	Australian Magpie			3	5			8
<i>Haliastur sphenurus</i>	Whistling Kite					1		1
<i>Hamirostra sphenurus</i>	Black-breasted Buzzard		R				4	4
<i>Hirundo ariel</i>	Fairy Martin					8		8
<i>Malacorhynchus membranaceus</i>	Pink-eared Duck				5			5
<i>Malurus leucopterus leuconotus</i>	Variiegated Fairy-wren			4	17	15		36
<i>Manorina flavigula</i>	Yellow-throated Miner			3	6			9
<i>Milvus migrans</i>	Black Kite			1	1		30	32
<i>Northiella haematogaster</i>	Blue Bonnet				4			4
<i>Ocyphaps lophotes</i>	Crested Pigeon			1	29			30

Species Name	Common Name	Cons. Rating		INN 001	INN 002	INN 003	INN 004	TOTAL
		AUS	SA					
<i>Petrocia goodenovii</i>	Red-capped Robin					2		2
<i>Pomatostomus ruficeps</i>	Chestnut-crowned Babbler		U		6			6
<i>Psophodes cristatus</i>	Chirruping Wedgebill				2			2
<i>Rhipidura leucophrys</i>	Willie Wagtail					2		2
<i>Taeniopygia guttata</i>	Zebra Finch				12			12
<i>Vanellus miles</i>	Masked Lapwing			2	2	1		5
Total observations				14	133	55	36	238
Total species				6	18	15	3	29

3.5 Protected Matters and BDBSA search results

Eight species of national significance (Vulnerable and/or a Migratory or Marine species), which may use habitat at the study area, were identified using the *EPBC* Protected Matters Search Tool (Table 7). One of these species, the Dusky Hopping Mouse (*Notomys fuscus*), has previously been observed in proximity to the study area (Table 8). Two individuals have been trapped in different locations, one approximately 9.5 kilometres north and one 8.5 kilometres south east of the geothermal energy pilot plant (BDBSA, 2008). Those species listed as marine and/or migratory species are unlikely to be affected as they would not be reliant on habitat directly within the survey area. Twenty-four species of conservation significance (one with both a state and national rating) have been recorded in the vicinity of the study area, based on records obtained from the BDBSA (Table 8). A further 28 species of conservation significance (six with a national rating) have been recorded in the Channel Country Bioregion (Table 9).

Table 7. Species that may use the survey area based on the Protected Matters Search results (DEH 2008)

Class	Species Name	Common Name	Type of presence	Conservation Status	
				Aus	SA
AVES	<i>Amytornis barbatus barbatus</i>	Grey Grasswren	Species or species habitat may occur within the area	VU	R
AVES	<i>Apus pacificus</i>	Fork-tailed Swift	Species or species habitat may occur within the area	Mi, **Lis	
AVES	<i>Ardea alba</i>	Great Egret, White Egret	Species or species habitat may occur within the area	Mi, Lis	
AVES	<i>Ardea ibis</i>	Cattle Egret	Species or species habitat may occur within the area	Mi, **Lis	R
AVES	<i>Merops ornatus</i>	Rainbow Bee-eater	Species or species habitat may occur within the area	Mi, **Lis	
AVES	<i>Rostratula australis</i>	Australian Painted Snipe	Species or species habitat may occur within the area	VU	
AVES	<i>Rostratula benghalensis s. lat.</i>	Painted Snipe	Species or species habitat may occur within the area	**Lis	
MAMMALIA	<i>Notomys fuscus</i>	Dusky Hopping Mouse	Species or species habitat may occur within the area	VU	

Key

Regions: AUS = Australia, SA = South Australia

Conservation ratings: R = rare, VU = vulnerable, Mi = migratory species, Lis = listed marine or wetland species, **Lis = may fly over marine areas

Table 8. Conservation significant species that have been recorded in proximity to the survey area (BDBSA, 2008)

Class Name	Species Name	Common Name	Conservation Rating	
			AUS	SA
AVES	<i>Actitis hypoleucos</i>	Common Sandpiper		R
AVES	<i>Anhinga melanogaster</i>	Darter		R
AVES	<i>Aprosmictus erythropterus</i>	Red-winged Parrot		R
AVES	<i>Ardea intermedia</i>	Intermediate Egret		R
AVES	<i>Ardeotis australis</i>	Australian Bustard		V
AVES	<i>Biziura lobata</i>	Musk Duck		R
AVES	<i>Cacatua leadbeateri</i>	Major Mitchell's Cockatoo		R
AVES	<i>Egretta garzetta</i>	Little Egret		R
AVES	<i>Elanus scriptus</i>	Letter-winged Kite		R
AVES	<i>Falco hypoleucos</i>	Grey Falcon		R
AVES	<i>Falco peregrinus</i>	Peregrine Falcon		R
AVES	<i>Grantiella picta</i>	Painted Honeyeater		R
AVES	<i>Grus rubicunda</i>	Brolga		V
AVES	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard		R
AVES	<i>Lophoictinia isura</i>	Square-tailed Kite		E
AVES	<i>Myiagra inquieta</i>	Restless Flycatcher		R
AVES	<i>Ninox connivens</i>	Barking Owl		R
AVES	<i>Oxyura australis</i>	Blue-billed Duck		R
AVES	<i>Phaps histrionica</i>	Flock Bronzewing		R
AVES	<i>Plegadis falcinellus</i>	Glossy Ibis		R
AVES	<i>Podiceps cristatus</i>	Great Crested Grebe		R
AVES	<i>Stictonetta naevosa</i>	Freckled Duck		V
MAMMALIA	<i>Notomys fuscus</i>	Dusky Hopping-mouse	VU	V
REPTILIA	<i>Emydura macquarii</i>	Macquarie Tortoise		V

Key

Regions: AUS = Australia, SA = South Australia

Conservation ratings: E = endangered, V = vulnerable, R = rare

Table 9. Threatened fauna species recorded in the Channel Country Bioregion (Neagle 2003)

Class Name	Species Name	Common Name	Conservation Rating	
			AUS	SA
AVES	<i>Amytornis modestus textilis</i>	Thick-billed Grasswren (eastern)	VU	R
AVES	<i>Anas rhynchos</i>	Australasian Shoveler		R
AVES	<i>Anseranas semipalmata</i>	Magpie Goose		E
AVES	<i>Aphelocephala pectoralis</i>	Chestnut-breasted Whiteface		R
AVES	<i>Botaurus poiciloptilus</i>	Australasian Bittern		V
AVES	<i>Burhinus grallarius</i>	Bush Stone-curlew		V
AVES	<i>Calyptorhynchus banksii samueli</i>	Red-tailed Black-cockatoo		E
AVES	<i>Conopophia whitei</i>	Grey Honeyeater		R
AVES	<i>Epthianura crocea</i>	Yellow Chat		R
AVES	<i>Geophaps plumifera</i>	Spinifex Pigeon		R
AVES	<i>Haliaeetus leucogaster</i>	White-bellied Sea-eagle		V
AVES	<i>Melithreptus gularis</i>	Black-chinned Honeyeater		V
AVES	<i>Neophema chrysostoma</i>	Blue-winged Parrot		V
AVES	<i>Neophema splendida</i>	Scarlet-chested Parrot		R
AVES	<i>Pedionomus torquatus</i>	Plains-wanderer	VU	E
AVES	<i>Pezoporus occidentalis</i>	Night Parrot	EN	E
AVES	<i>Porzana pusilla</i>	Baillon's Crake		R
AVES	<i>Tyto capensis</i>	Grass Owl		R
MAMMALIA	<i>Dasyuroides byrnei</i>	Kowari	VU	V
MAMMALIA	<i>Dasyercus cristicaudata hilleri</i>	Amperta	EN	R
MAMMALIA	<i>Notomys cervinus</i>	Fawn Hopping Mouse		E
MAMMALIA	<i>Pseudomys australis</i>	Plains Rat	VU	V
MAMMALIA	<i>Saccolaimus flaviventris</i>	Yellow-bellied Sheathtail Bat		R
REPTILIA	<i>Amphibolurus gilberti</i>	Gilbert's Dragon		R
REPTILIA	<i>Ctenotus joanae</i>	Blacksoil Ctenotus		R
REPTILIA	<i>Morelia spilota</i>	Carpet Python		V
REPTILIA	<i>Proablepharus kinghorni</i>	Blacksoil Skink		R
REPTILIA	<i>Ctenotus astarte</i>	Ashby Downs Ctenotus		Sig

Key

Regions: AUS = Australia, SA = South Australia

Conservation ratings: E = endangered, V = vulnerable, R = rare, Sig = no conservation rating, but species considered to be of conservation significance in the bioregion

4.0 Discussion

4.1 Survey limitations

Faunal diversity and abundance varies seasonally and in response to changing environmental conditions, such as large rainfall events. Due to the current fauna survey being undertaken in July, the cold overnight conditions and cool daytime temperatures, have adversely affected the number of species observed, particularly reptile species. The previous survey effort within the Innamincka Regional Reserve and surrounding areas is considered to be poor with it considered to be one of the most poorly surveyed areas (for fauna) in South Australia (Hutchinson, M. pers. comm.).

To obtain meaningful results, fauna surveys should be undertaken in spring or autumn, particularly if large rainfall events proceed the survey time by several months. The warmer night and daytime temperatures promote activity in a number of species, particularly reptiles, and therefore a broader range of species are identified. This would allow for a more comprehensive survey and more conclusive outcome.

4.2 Mammals

Overall, mammal diversity and abundance was low during the geothermal energy pilot plant fauna survey. All the species detected were those that could be expected to occur in habitats present in the survey area. House Mice (*Mus musculus*) were the most abundant mammal captured. In comparison the abundance of small native mammals (such as Dunnarts and Forest's Mice) was low. This is likely due to a combination of factors such as, a lack of suitable habitat within the survey area (Gilgais, cracking clays), the cold weather experienced during the survey period and the absence of pitfall trapping. Species such as Dunnarts, Planigales and Forest's Mice are more likely to be captured in pitfall traps, during warmer weather, rather than Elliot traps.

The bat species identified within close proximity to the project site, from the Anabat recordings, were expected to occur within the project area. All of these species are widespread within the region and occupy a variety of habitats. No bat species of conservation significance were recorded during the current surveys or have been previously recorded within close proximity to the project site.

No mammals of conservation significance were recorded during the fauna survey, however the nationally rated **vulnerable** Dusky Hopping Mouse (*Notomys fuscus*) could possibly utilise the sand dune habitat located approximately 250 metres to the east and south east of the geothermal energy pilot plant site. No other mammal species of state or national conservation significance are considered likely to occur within the project area.

The Dusky Hopping Mouse is rated as **vulnerable** under the *EPBC Act 1999*; it is a small (up to 50 g) nocturnal native rodent whose populations can fluctuate vastly (Robinson et al. 2000; Ehmann 2005) depending on seasonal factors. The species generally occurs in yellow sand dune systems with Sandhill Canegrass (*Zygochloa paradoxa*), Sandhill Wattle (*Acacia ligulata*), Nitrebush (*Nitraria billardierei*), Sticky Hopbush (*Dodonaea viscosa*) and ephemeral plants (Ehmann 2005). However, it has also recently been recorded in very sparse chenopod shrubland over gibber plains, in a white tea-tree (*Melaleuca glomerata*) sandy creekline, and in an elegant wattle (*Acacia victoriae*) over sparse mealy saltbush (*Rhagodia parabolica*) association with compacted sandy soil (Waudby and How, in press). A well-studied population is located at Montecollina Bore in the Cobbler Sandhills, not far from Innamincka Regional Reserve (Moseby et al. 1999; Moseby et al. 2006). The dominant plant species at this site is Nitrebush with ephemeral vegetation usually only present after significant rainfall events. Montecollina Bore was subject to grazing until 1937; prior to this date the area was dominated by Sandhill Canegrass and a number of other perennial species such as *Maireana* and *Atriplex* spp. (Moseby et al. 1999). This type of habitat is not necessarily ideal for the species, and it is more likely that for stable populations to persist, dune systems with intact perennial vegetation need to be present (Moseby et al. 1999).

The most recent surveys indicate that Dusky Hopping Mouse populations are present at several locations in the Strezlecki Desert and the nearby Cobbler Sandhills in South Australia and in south-west Queensland (Moseby et al. 1999). The species has also recently been discovered at Beverley Uranium Mine (Waudby and How in press) and on Quinyambie Station (Pedler pers. comm. 2008). Determining threats to the Dusky Hopping Mouse is difficult because these have not been well quantified. Subfossil records show that the species had a considerably more extensive distribution than currently; however it now persists in areas that have been degraded by cattle and rabbit grazing. It is considered that the most likely threats to the species are grazing of habitat by introduced herbivores and predation from Feral Cats and Foxes (Moseby et al. 2006). Potentially, maintaining rabbit numbers to low densities may be the most appropriate form of threat management for the species (Robinson et al. 2000) along with predator control.

The nationally **vulnerable** Kowari (*Dasyuroides byrnei*) have been recorded in the Channel Country Bioregion (Neagle 2003), which encompasses the study area. Kowaris persist in gibber habitats with minimal vegetation; they construct burrows or use those of other animals in grassy sand "islands" in gibber plains (Neagle 2003) or under saltbushes (Aslin and Lim 1995). It appears that the species is now confined to the Channel Country Bioregion (Neagle 2003). Threats to the species probably include destabilization of sand mounds by grazing and trampling of stock or alteration of vegetation communities (R. Brandle pers. comm., cited in

Neagle 2003). It is not likely that Kowaris occur in the survey area, since there is a lack of preferred habitat within and surrounding the geothermal energy pilot plant.

4.3 Reptiles and amphibians

Reptile and amphibian diversity and abundance was low during the geothermal energy pilot plant fauna survey. This is likely due to the timing of the survey (winter) and the cold weather experienced during the survey period. October through to December is generally the optimal time for reptile activity in temperate Australia (Owens et al. 1995). The reptile species recorded during the present survey are those that could be expected to occur in the habitats present within the survey area. No conservation significant species were detected.

Four state rated species may occur in the study area based on records from Neagle (2003); however, none have been recorded within close proximity to the geothermal energy pilot plant site previously (Table 8). No suitable habitat occurs within the project site for Gilbert's Dragon (*Amphibolurus gilberti*) or the Carpet Python (*Morelia spilota*) whilst the Ashby Downs Ctenotus (*Ctenotus astarte*) has not been previously recorded within South Australia. This species occurs just over the Queensland Border. The habitat on site appears to be suitable for the Blacksoil Ctenotus (*Ctenotus joanae*) and the Blacksoil Skink (*Proablepharus kinghorni*) (in relation to both species occurring on stony plains), however, there is a distinct lack of cracking clays across the project area. Both of these species would require the cracking clays as refuge areas and are therefore considered unlikely to occur within the proposed geothermal energy pilot plant site.

4.4 Birds

Bird species diversity and abundance was considered to be low at trapping site INN001 (geothermal energy pilot plant site). This is likely due to the lack of suitable bird habitat (trees and shrubs) and the disturbance associated with the existing camp and associated activities at Habenero 1.

Bird species diversity and abundance was considered to be high at site INN002 as it offers valuable habitat. The presence of shallow water and the *Muehlenbeckia florulenta* (Lignum) / *Chenopodium auricomum* (Queensland Bluebush) shrubland increases the diversity of bird species which may utilise the area.

Two species of significance, the Black-breasted Buzzard (*Hamirostra sphenurus*) (state **rare**) and the Chestnut-crowned Babbler (*Pomatostomus ruficeps*) (state **uncommon**) were recorded at site INN004 and INN002 respectively. It is unlikely that the Chestnut-crowned Babbler would utilise the project site due the lack of shrubs and trees across the site. The Black-breasted Buzzard was recorded flying over similar habitat to that found within the energy plant site. It is likely that this species would utilise the area for foraging and feeding

purposes, however, due to the small scale of the project, it is unlikely that a significant impact on the species will occur.

Several bird species of national conservation significance were identified as possibly occurring within the project area. None of the species have been previously recorded within close proximity to the site (Table 8). Several migratory and /or marine species (listed under the *EPBC Act* 1999) are known to occur in the area. These species generally rely on areas containing water and are likely to be concentrated around the Cooper Creek and Coongie Lake Systems. It is possible, however, that on occasions, individuals may be found within the *Muehlenbeckia florulenta* (Lignum) / *Chenopodium auricomum* (Queensland Bluebush) shrubland when surface water is present. It is unlikely that the project will have a significant impact on any of these species due to the distance between the proposed site and the areas containing the suitable habitat.

Grey Grasswrens (*Amytornis barbatus barbatus*) occur on floodplains of the Bulloo River, in south-western Queensland and north-western New South Wales (Barrett et al. 2003). The extent of the species' occurrence is estimated to be 100 km². Grey Grasswrens are known to occur in stands of dense Lignum (*Muehlenbeckia cunninghamii*), with Cane Grass (*Eragrostis australasica*), and/or Old Man Saltbush (*Atriplex nummularia*) (Department of the Environment, Water, Heritage and the Arts 2008a). Since the only known population occurs in a single location (the Bulloo River drainage basin), it seems highly unlikely that the species would occur in the study area.

The Plains-wanderer (*Pedionomus torquatus*) once occurred in lowland native grasslands of south-eastern South Australia, though it is now largely considered extinct in these areas. The species has been reported irregularly in arid north-east SA (Barrett et al. 2003) during optimal seasonal conditions (Baker-Gabb 2002). It is unlikely that the species occurs in or near the study area since only one definite record of a Plains-wanderer has been noted for the Channel Country Bioregion (Neagle 2003).

Historically, Night Parrots (*Pezoporus occidentalis*) have been recorded throughout arid and semi-arid Australia (Garnett and Crowley 2000). The species now probably occurs in low numbers throughout its former range (Garnett and Crowley 2000), although it has not been recorded from the study area in recent years. It is likely that Night Parrots persist in chenopod shrublands during dry years and move into *Triodia* spp. grasslands when enough rain falls to encourage seed set. The species has not been recorded from Innamincka in recent years (Barrett et al. 2003) and it is unlikely that the proposed transmission line would affect the species.

Numerous bird species of state conservation significance have been recorded within close proximity to the project site (Table 8). However, a number of these species are waterbird species and are only likely to occur within the *Muehlenbeckia florulenta* (Lignum) / *Chenopodium auricomum* (Queensland Bluebush) shrubland areas. For the remaining species, it is likely that some of the raptor species occur in the area and use the proposed site for foraging and feeding. Due to the small size of the project, it is unlikely to have a significant impact on any of the listed species.

4.5 Potential impacts of the proposed geothermal energy pilot plant

Semi-arid ecosystems rely on scarce resources and critical refuge for fauna can be limited. These ecosystems are fragile and the impacts of any construction can have a lasting effect, especially on threatened species. This section refers to the possible general impacts of any construction activities that might disturb animals, their habitat, or vegetation in the study area.

The main environmental impacts of the project upon the local landscape and/or individual species will include:

- Vegetation clearance
- Vehicle collisions
- Introduced pest species (flora and fauna)
- Excessive dust
- Noise, vibration and light pollution

Vegetation Clearance and Degradation

Habitat loss and/or fragmentation will have the most severe affect on fauna populations, especially conservation significant species. Wherever possible, existing tracks and developed areas should be utilised in preference to the additional clearance of native vegetation. Any construction activities should be confined to the smallest practical area to limit vegetation clearance. Stockpiles should remain on access tracks or disturbed areas to minimise additional disturbance of vegetation and soils. Areas that are disturbed should be appropriately rehabilitated as soon as possible after any construction to promote regeneration of native vegetation.

Potential Impacts

- Reduced habitat availability
- Reduced species abundance and diversity
- Separation of faunal populations through vegetation fragmentation

Vehicle Collisions

It is expected the potential for animal collisions is most likely to occur along access tracks. Road-collisions may affect large species (such as Red Kangaroos) but also smaller species (such as lizards, birds and small mammals) that are not easily seen. Additionally, animals and their habitat may be destroyed by inappropriate driving/activities. For example, if vehicles do not remain on designated tracks and areas, lizard holes, exposed nests, and their occupants may be killed.

Potential Impact

- Death or injury to animals as a result of direct collision and habitat destruction
- A reduction in species abundance, particularly those that are already under threat

Spread of Introduced Pest Species (Flora and Fauna)

Increased traffic and disturbance in the project area will potentially introduce or spread pest species in and out of the site. Colonisation of the site by weeds would negatively affect the current native vegetation community through competition and consequently, animal habitats. The creation and/or maintenance of access tracks may facilitate movements of exotic predators such as Foxes and Feral Cats.

Potential Impacts

- Change in native flora species assemblages
- Alteration of native food and shelter resources available for fauna
- Possible increase in pest species (i.e. Foxes, Feral Cats, Rabbits)

Excessive Dust

Construction, road installations and/or upgrades, and cleared spaces create an opportunity for increased dust generation. Excessive dust has the potential to reduce plant growth and cause damage to existing vegetation.

Dust may affect the surrounding vegetation during the exploration, construction and operation of any infrastructure in the project area. The disturbance of fine soil may lead to the mobilisation of additional dust when it is windy. Dust impacts will be dependent on the volume of dust as well as wind direction. Dust is likely to be generated from construction activities including drilling, grading of access tracks, trenching (to install connecting infrastructure such as pipelines), stockpiling of material and vehicle movements.

Several management activities can be undertaken during any construction to reduce the level of dust and therefore, reduce the risk of adversely impacting on surrounding vegetation. These include regularly watering access roads, grading and rolling of roads to keep surfaces as intact as possible and watering stockpiles.

Potential Impacts

- Reduced growth of juvenile plants
- Excessive dust deposition on plant foliage preventing absorption of nutrients (water, sunlight) by plants
- Long-term impact on fauna habitat quality

4.6 EPBC Implications

As outlined in section 3.5, the EPBC Protected Matters Report generated for this project lists eight species of national significance (Vulnerable and/or a Migratory or Marine species), as potentially utilising habitat within or around the study area.

This includes three nationally **vulnerable** fauna species, which are discussed in more detail below, and a further five Migratory and/or Marine species, which are generally unlikely to be directly affected by the project as they would not be reliant on habitat present within the project site.

The Grey Grasswren (*Amytornis barbatus barbatus*) is listed as nationally **vulnerable** and occurs on the floodplains of the Bulloo River, in south-western Queensland and north-western New South Wales (Barrett et al. 2003). The extent of the species' occurrence is estimated to be 100 km². Since the only known population occurs in a single location (the Bulloo River drainage basin), it is highly unlikely that the species would occur in the study area.

The Australian Painted Snipe (*Rostratula australis*), also listed as **vulnerable**, usually inhabits shallow inland wetlands, either freshwater or brackish, that are either permanently or temporarily filled (Morcombe 2003; Garnett & Crowley 2000), therefore the species would not utilise habitat within the project site. However, they may be a rare visitor to the nearby low lying *Muehlenbeckia florulenta* (Lignum) / *Chenopodium auricomum* (Queensland Bluebush) shrubland area when water is present. The project will not be impacting upon this vegetation community, consequently it is highly unlikely that the Painted Snipe will be affected.

Whilst the nationally rated **vulnerable** Dusky Hopping Mouse (*Notomys fuscus*) is unlikely to utilise habitat within the direct area of the geothermal energy pilot plant site, it could possibly utilise the nearby sand dune habitat (located approximately 250 metres to the east and south east). However, as the project will not be impacting upon this dune habitat it is considered that there will not be any significant impact upon this species.

It is unlikely that the geothermal energy pilot plant site will have any significant impacts on nationally threatened fauna species, migratory species or marine listed species. It is therefore

considered that a referral under the EPBC Act is not required in relation to threatened or migratory species.

5.0 Recommendations

The following recommendations have been made to reduce or avoid potential impacts of the construction and operation of the proposed geothermal energy pilot plant site on fauna species, their habitat, and vegetation in general. These recommendations include:

- Keep vegetation clearance and disturbance to an absolute minimum to minimise potential impacts on fauna species and their habitat;
- Implement weed and pest animal programs as required;
- Ensure dust (created by construction and operational activities) levels are minimised;
- Minimise free water by ensuring leaking water pipes are repaired immediately, regardless of the size of the leak;
- Ensure lights (such as rotating beacons and work flood lights), machinery and equipment are turned off when not being used, particularly overnight, to reduce area avoidance behaviours of fauna species;
- Undertake staff training sessions to promote the awareness of fauna species and fauna habitat within the project area and their reliance on undisturbed habitat. Additionally, reinforce the need to minimise impacts on these species through works undertaken on site. Ensure that all drivers are aware of speed limits and that animals regularly cross the roads;
- Ensure that all proposed works areas (including new drilling and access track development) are assessed for fauna. Although the current survey found no species of significance in the project area, there are a number of threatened species that occur in the region. Preferably, future surveys should be undertaken in spring which is the optimum time of year for the majority of fauna species.

6.0 References

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7.0 Appendices

Appendix 1 Site photos



INN001



INN002



INN003



INN004

Appendix 2 Fauna database search results (BDBSA 2008)

Class Name	Species Name	Common Name	Conservation Rating	
			AUS	SA
AMPHIBIA	<i>Crinia deserticola</i>	Desert Froglet		
AMPHIBIA	<i>Limnodynastes tasmaniensis</i>	Spotted Marsh Frog		
AMPHIBIA	<i>Litoria latopalmata</i>	Broad-palmed Frog		
AMPHIBIA	<i>Litoria rubella</i>	Desert Tree Frog		
AMPHIBIA	<i>Opisthodon spenceri</i>	Spencer's Burrowing Frog		
AVES	<i>Acanthagenys rufogularis</i>	Spiny-cheeked Honeyeater		
AVES	<i>Acanthiza uropygialis</i>	Chestnut-rumped Thornbill		
AVES	<i>Accipiter cirrhocephalus</i>	Collared Sparrowhawk		
AVES	<i>Accipiter fasciatus</i>	Brown Goshawk		
AVES	<i>Acrocephalus australis</i>	Australian Reed Warbler, (Clamorous Reed-Warbler)		
AVES	<i>Actitis hypoleucos</i>	Common Sandpiper		R
AVES	<i>Aegotheles cristatus</i>	Australian Owlet-nightjar		
AVES	<i>Amytornis goyderi</i>	Eyrean Grasswren		
AVES	<i>Anas gracilis</i>	Grey Teal		
AVES	<i>Anas superciliosa</i>	Pacific Black Duck		
AVES	<i>Anhinga melanogaster</i>	Darter		R
AVES	<i>Anthus novaeseelandiae</i>	Richard's Pipit		
AVES	<i>Aphelocephala leucopsis</i>	Southern Whiteface		
AVES	<i>Aprosmictus erythropterus</i>	Red-winged Parrot		R
AVES	<i>Aquila audax</i>	Wedge-tailed Eagle		
AVES	<i>Ardea alba</i>	Great Egret, (White Egret)		
AVES	<i>Ardea intermedia</i>	Intermediate Egret		R
AVES	<i>Ardea pacifica</i>	White-necked Heron		
AVES	<i>Ardeotis australis</i>	Australian Bustard		V
AVES	<i>Artamus cinereus</i>	Black-faced Woodswallow		
AVES	<i>Artamus leucorhynchus</i>	White-breasted Woodswallow		
AVES	<i>Artamus personatus</i>	Masked Woodswallow		
AVES	<i>Artamus superciliosus</i>	White-browed Woodswallow		
AVES	<i>Ashbyia lovensis</i>	Gibberbird		
AVES	<i>Aythya australis</i>	Hardhead (White-eyed Duck)		
AVES	<i>Barnardius zonarius</i>	Australian Ringneck, (Ring-necked Parrot)		
AVES	<i>Biziura lobata</i>	Musk Duck		R
AVES	<i>Cacatua leadbeateri</i>	Major Mitchell's Cockatoo		R
AVES	<i>Cacatua roseicapilla</i>	Galah		
AVES	<i>Cacatua sanguinea</i>	Little Corella		
AVES	<i>Calyptorhynchus banksii</i>	Red-tailed Black-Cockatoo	ssp	ssp
AVES	<i>Certhionyx variegatus</i>	Pied Honeyeater		
AVES	<i>Charadrius australis</i>	Inland Dotterel		
AVES	<i>Chenonetta jubata</i>	Australian Wood Duck, (Maned Duck)		
AVES	<i>Cheramoeca leucosternus</i>	White-backed Swallow		
AVES	<i>Chlidonias hybridus</i>	Whiskered Tern		
AVES	<i>Chrysococcyx basalis</i>	Horsfield's Bronze-cuckoo		
AVES	<i>Cincloramphus cruralis</i>	Brown Songlark		
AVES	<i>Cincloramphus mathewsi</i>	Rufous Songlark		

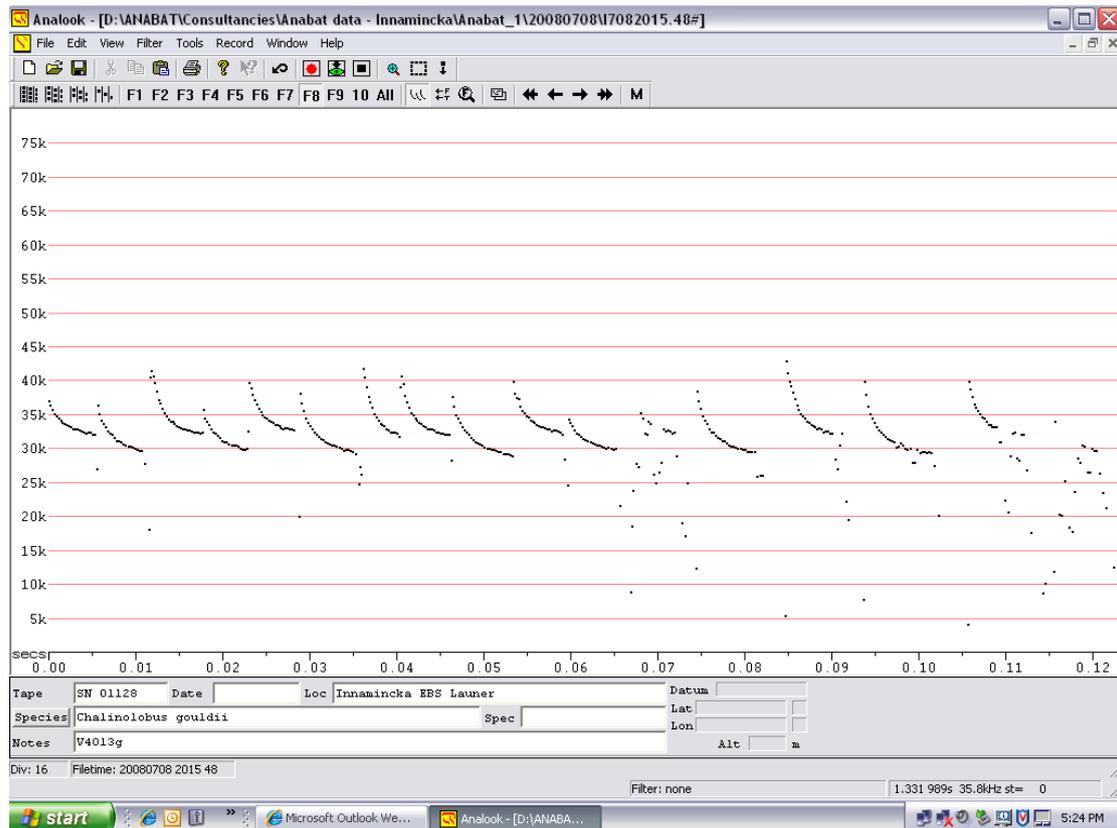
Class Name	Species Name	Common Name	Conservation Rating	
			AUS	SA
AVES	<i>Cincoloma cinnamomeum</i>	Cinnamon Quail-thrush		
AVES	<i>Climacteris picumnus</i>	Brown Treecreeper		
AVES	<i>Colluricincla harmonica</i>	Grey Shrike-thrush		
AVES	<i>Coracina maxima</i>	Ground Cuckoo-shrike		
AVES	<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		
AVES	<i>Corvus bennetti</i>	Little Crow		
AVES	<i>Corvus coronoides</i>	Australian Raven		
AVES	<i>Coturnix pectoralis</i>	Stubble Quail		
AVES	<i>Cracticus torquatus</i>	Grey Butcherbird		
AVES	<i>Cuculus pallidus</i>	Pallid Cuckoo		
AVES	<i>Cygnus atratus</i>	Black Swan		
AVES	<i>Dicaeum hirundinaceum</i>	Mistletoebird		
AVES	<i>Dromaius novaehollandiae</i>	Emu		
AVES	<i>Egretta garzetta</i>	Little Egret		R
AVES	<i>Egretta novaehollandiae</i>	White-faced Heron		
AVES	<i>Elanus scriptus</i>	Letter-winged Kite		R
AVES	<i>Elseyornis melanops</i>	Black-fronted Dotterel		
AVES	<i>Epthianura aurifrons</i>	Orange Chat		
AVES	<i>Epthianura tricolor</i>	Crimson Chat		
AVES	<i>Erythrogonys cinctus</i>	Red-kneed Dotterel		
AVES	<i>Falco berigora</i>	Brown Falcon		
AVES	<i>Falco cenchroides</i>	Nankeen Kestrel		
AVES	<i>Falco hypoleucos</i>	Grey Falcon		R
AVES	<i>Falco longipennis</i>	Australian Hobby		
AVES	<i>Falco peregrinus</i>	Peregrine Falcon		R
AVES	<i>Falco subniger</i>	Black Falcon		
AVES	<i>Fulica atra</i>	Eurasian Coot		
AVES	<i>Gallinula tenebrosa</i>	Dusky Moorhen		
AVES	<i>Gallinula ventralis</i>	Black-tailed Native-hen		
AVES	<i>Geopelia cuneata</i>	Diamond Dove		
AVES	<i>Geopelia placida</i>	Peaceful Dove		
AVES	<i>Grallina cyanoleuca</i>	Magpie-lark		
AVES	<i>Grantiella picta</i>	Painted Honeyeater		R
AVES	<i>Grus rubicunda</i>	Brolga		V
AVES	<i>Gymnorhina tibicen</i>	Australian Magpie		
AVES	<i>Haliastur sphenurus</i>	Whistling Kite		
AVES	<i>Hamirostra melanosternon</i>	Black-breasted Buzzard		R
AVES	<i>Hieraaetus morphnoides</i>	Little Eagle		
AVES	<i>Hirundo neoxena</i>	Welcome Swallow		
AVES	<i>Lalage tricolor</i>	White-winged Triller		
AVES	<i>Larus novaehollandiae</i>	Silver Gull		
AVES	<i>Lichenostomus penicillatus</i>	White-plumed Honeyeater		
AVES	<i>Lichenostomus virescens</i>	Singing Honeyeater		
AVES	<i>Lophoictinia isura</i>	Square-tailed Kite		E
AVES	<i>Malacorhynchus membranaceus</i>	Pink-eared Duck		
AVES	<i>Malurus lamberti</i>	Variiegated Fairy-wren		
AVES	<i>Malurus leucopterus</i>	White-winged Fairy-wren		
AVES	<i>Manorina flavigula</i>	Yellow-throated Miner	ssp	ssp

Class Name	Species Name	Common Name	Conservation Rating	
			AUS	SA
AVES	<i>Megalurus gramineus</i>	Little Grassbird		
AVES	<i>Melopsittacus undulatus</i>	Budgerigar		
AVES	<i>Merops ornatus</i>	Rainbow Bee-eater		
AVES	<i>Microeca fascinans</i>	Jacky Winter		ssp
AVES	<i>Milvus migrans</i>	Black Kite		
AVES	<i>Mirafra javanica</i>	Horsfield's Bushlark		
AVES	<i>Myiagra inquieta</i>	Restless Flycatcher		R
AVES	<i>Neopsephotus bourkii</i>	Bourke's Parrot		
AVES	<i>Ninox connivens</i>	Barking Owl		R
AVES	<i>Ninox novaeseelandiae</i>	Southern Boobook		
AVES	<i>Northiella haematogaster</i>	Blue Bonnet		ssp
AVES	<i>Nycticorax caledonicus</i>	Nankeen Night Heron		
AVES	<i>Nymphicus hollandicus</i>	Cockatiel		
AVES	<i>Ocyphaps lophotes</i>	Crested Pigeon		
AVES	<i>Oxyura australis</i>	Blue-billed Duck		R
AVES	<i>Pachycephala rufiventris</i>	Rufous Whistler		
AVES	<i>Pardalotus rubricatus</i>	Red-browed Pardalote		
AVES	<i>Pardalotus striatus</i>	Striated Pardalote		
AVES	<i>Passer domesticus</i>	House Sparrow		
AVES	<i>Pelecanus conspicillatus</i>	Australian Pelican		
AVES	<i>Petrochelidon ariel</i>	Fairy Martin		
AVES	<i>Petrochelidon nigricans</i>	Tree Martin		
AVES	<i>Petroica goodenovii</i>	Red-capped Robin		
AVES	<i>Phalacrocorax carbo</i>	Great Cormorant		
AVES	<i>Phalacrocorax melanoleucos</i>	Little Pied Cormorant		
AVES	<i>Phalacrocorax sulcirostris</i>	Little Black Cormorant		
AVES	<i>Phalacrocorax varius</i>	Pied Cormorant		
AVES	<i>Phaps chalcoptera</i>	Common Bronzewing		
AVES	<i>Phaps histrionica</i>	Flock Bronzewing		R
AVES	<i>Platalea flavipes</i>	Yellow-billed Spoonbill		
AVES	<i>Platalea regia</i>	Royal Spoonbill		
AVES	<i>Plegadis falcinellus</i>	Glossy Ibis		R
AVES	<i>Podargus strigoides</i>	Tawny Frogmouth		
AVES	<i>Podiceps cristatus</i>	Great Crested Grebe		R
AVES	<i>Poliocephalus poliocephalus</i>	Hoary-headed Grebe		
AVES	<i>Pomatostomus ruficeps</i>	Chestnut-crowned Babbler		
AVES	<i>Porphyrio porphyrio</i>	Purple Swamphen		
AVES	<i>Porzana fluminea</i>	Australian Spotted Crake		
AVES	<i>Psephotus haematonotus</i>	Red-rumped Parrot		
AVES	<i>Psophodes cristatus</i>	Chirruping Wedgebill		
AVES	<i>Rhipidura leucophrys</i>	Willie Wagtail		
AVES	<i>Sterna caspia</i>	Caspian Tern		
AVES	<i>Sterna nilotica</i>	Gull-billed Tern		
AVES	<i>Stictonetta naevosa</i>	Freckled Duck		V
AVES	<i>Stiltia isabella</i>	Australian Pratincole		
AVES	<i>Tachybaptus novaehollandiae</i>	Australasian Grebe, (Little Grebe)		
AVES	<i>Tadorna tadornoides</i>	Australian Shelduck		
AVES	<i>Taeniopygia guttata</i>	Zebra Finch		

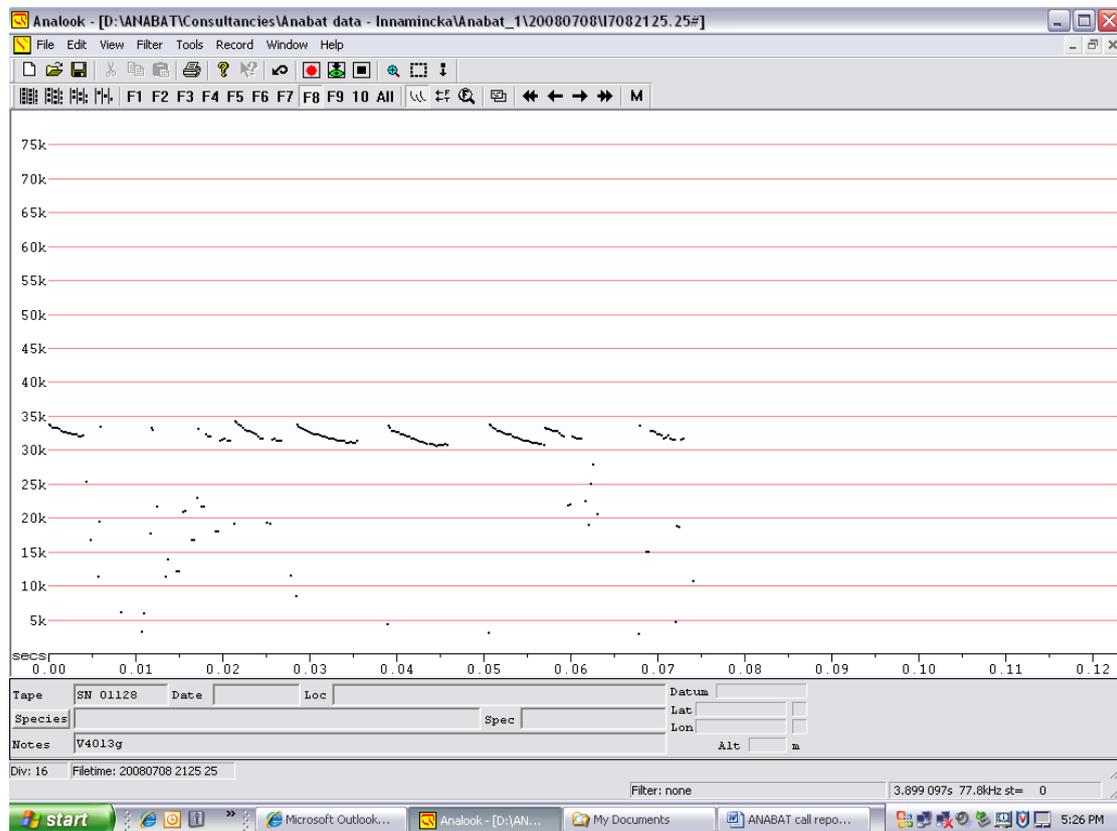
Class Name	Species Name	Common Name	Conservation Rating	
			AUS	SA
AVES	<i>Threskiornis molucca</i>	Australian White Ibis		
AVES	<i>Threskiornis spinicollis</i>	Straw-necked Ibis		
AVES	<i>Todiramphus pyrrhopygia</i>	Red-backed Kingfisher		
AVES	<i>Todiramphus sanctus</i>	Sacred Kingfisher		
AVES	<i>Turnix velox</i>	Little Button-quail		
AVES	<i>Tyto alba</i>	Barn Owl		
AVES	<i>Vanellus tricolor</i>	Banded Lapwing		
MAMMALIA	<i>Canis lupus dingo</i>	Dingo		
MAMMALIA	<i>Canis lupus familiaris</i>	Dog (domestic or feral)		
MAMMALIA	<i>Chalinolobus gouldii</i>	Gould's Wattled Bat		
MAMMALIA	<i>Leggadina forresti</i>	Forrest's Mouse		
MAMMALIA	<i>Mus musculus</i>	House Mouse		
MAMMALIA	<i>Notomys fuscus</i>	Dusky Hopping-mouse	VU	V
MAMMALIA	<i>Oryctolagus cuniculus</i>	Rabbit		
MAMMALIA	<i>Rattus villosissimus</i>	Long-haired Rat		
MAMMALIA	<i>Scotorepens greyii</i>	Little Broad-nosed Bat		
MAMMALIA	<i>Sminthopsis crassicaudata</i>	Fat-tailed Dunnart		
MAMMALIA	<i>Tadarida australis</i>	White-striped Freetail-bat		
REPTILIA	<i>Amphibolurus burnsi</i>	Cooper Creek Dragon		
REPTILIA	<i>Antaresia stimsoni</i>	Stimson's Python		
REPTILIA	<i>Cryptoblepharus australis</i>	Desert Wall skink		
REPTILIA	<i>Ctenophorus nuchalis</i>	Central Netted Dragon		
REPTILIA	<i>Ctenophorus pictus</i>	Painted Dragon		
REPTILIA	<i>Ctenotus schomburgkii</i>	Sandplain Ctenotus		
REPTILIA	<i>Ctenotus strauchii</i>	Short-legged Ctenotus		
REPTILIA	<i>Ctenotus taeniatus</i>	Eyrean Ctenotus		
REPTILIA	<i>Diplodactylus tessellatus</i>	Tessellated Gecko		
REPTILIA	<i>Egernia stokesii</i>	Gidgee Skink		
REPTILIA	<i>Emydura macquarii</i>	Macquarie Tortoise		V
REPTILIA	<i>Furina diadema</i>	Red-naped Snake		
REPTILIA	<i>Gehyra variegata</i>	Tree Dtella		
REPTILIA	<i>Heteronotia binoei</i>	Bynoe's Gecko		
REPTILIA	<i>Lialis burtonis</i>	Burton's Legless Lizard		
REPTILIA	<i>Menetia greyii</i>	Dwarf Skink		
REPTILIA	<i>Morethia adelaidensis</i>	Adelaide Snake-eye		
REPTILIA	<i>Morethia boulengeri</i>	Common Snake-eye		
REPTILIA	<i>Nephurus levis</i>	Smooth Knob-tailed Gecko		
REPTILIA	<i>Oxyuranus microlepidotus</i>	Inland Taipan		
REPTILIA	<i>Pogona vitticeps</i>	Central Bearded Dragon		
REPTILIA	<i>Pseudechis australis</i>	Mulga Snake		
REPTILIA	<i>Pseudonaja textilis</i>	Eastern Brown Snake		
REPTILIA	<i>Ramphotyphlops bituberculatus</i>	Rough-nosed Blind Snake		
REPTILIA	<i>Rhynchoedura ornata</i>	Beaked Gecko		
REPTILIA	<i>Suta suta</i>	Curl Snake		
REPTILIA	<i>Tympanocryptis intima</i>	Smooth-snouted Earless Dragon		
REPTILIA	<i>Tympanocryptis lineata</i>	Five-lined Earless Dragon		

Class Name	Species Name	Common Name	Conservation Rating	
			AUS	SA
REPTILIA	<i>Tympanocryptis tetraporophora</i>	Eyrean Earless Dragon		
REPTILIA	<i>Varanus gouldii</i>	Sand Goanna		
REPTILIA	<i>Varanus tristis</i>	Black-headed Goanna		

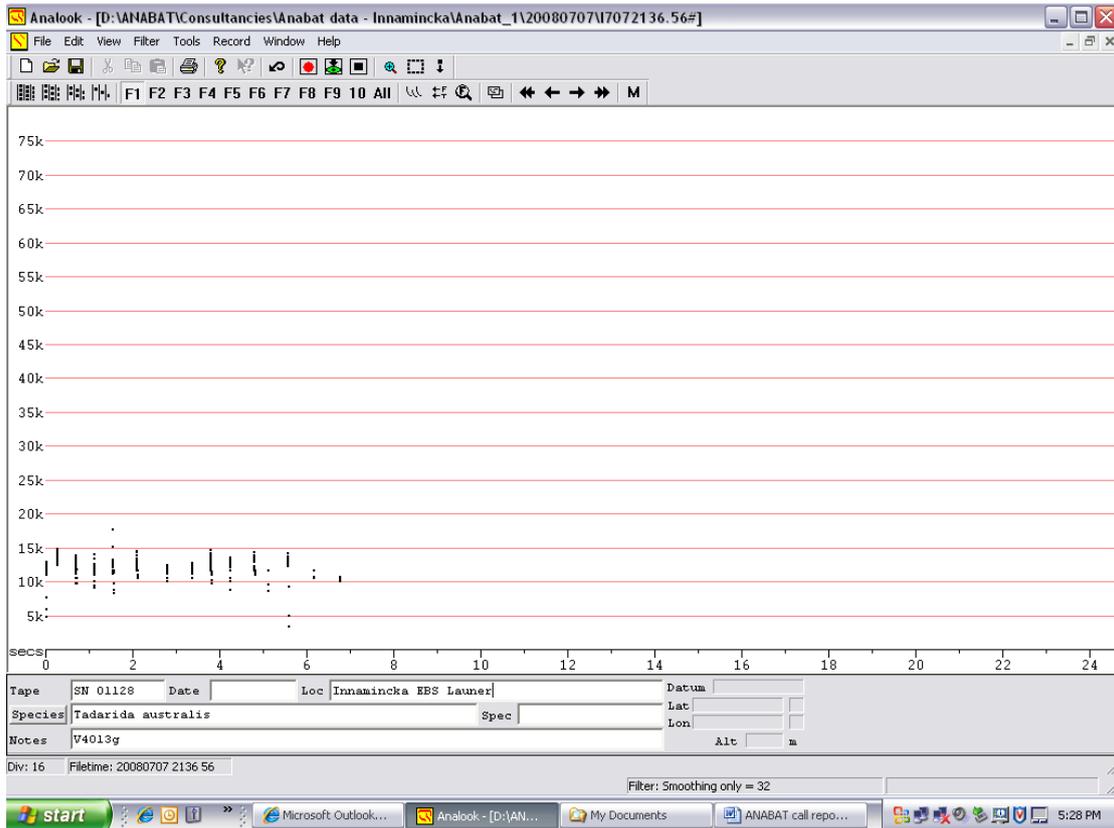
Appendix 3 Example calls from Anabat



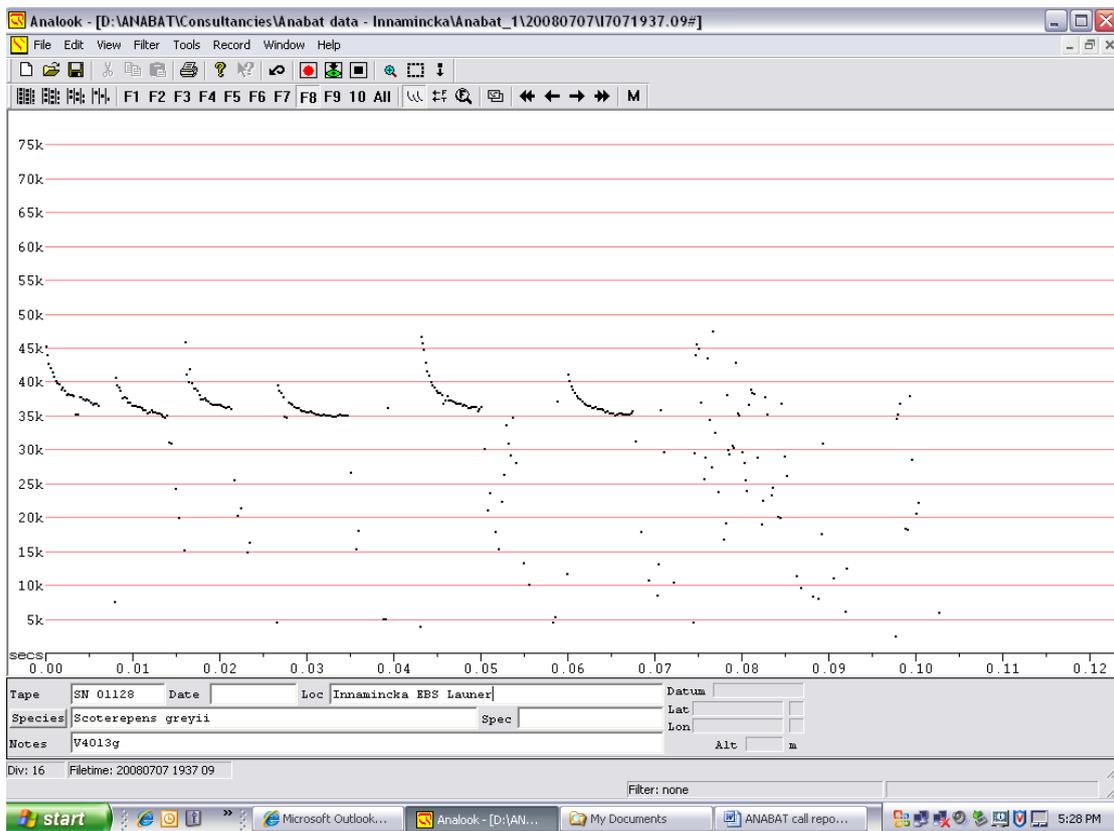
Gould's Wattled Bat (*Chalinolobus gouldii*)



Gould's Wattled Bat (*Chalinolobus gouldii*) or Southern Free-tail Bat (*Mormopterus* sp3)?



White-striped Freetail-bat (*Tadarida australis*)



Little Broad-nosed Bat (*Scotorepens greyii*)

Appendix C

Indigenous heritage – work area
clearance, ACHC 2002

Further Work Area Clearance of the proposed water pipeline route between Burlieburly Waterhole on Strzelecki Creek and Habanero 1 Well, south of Innamincka, South Australia

An Addendum Report to the
Yandruwandha/Yawarrawarrka Native Title Claimant Group
and
Geodynamics Limited

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Final Addendum Report

July 2003

Summary

A further field examination and Work Area Clearance of the areas to be affected by proposed Geodynamics Limited exploration activities, in the Cooper Basin near Innamincka, South Australia, has been conducted and is discussed in this report. This activity consisted of a total of approximately 3 kilometres (2.37 kilometres cross country) of water pipeline corridor that is to be used for the laying of temporary above-ground polythene pipes between Burlieburly Waterhole on the Strzelecki Creek and the Habanero 1 drilling site next to the Dillon's Highway. An earlier work area clearance, cultural heritage survey and archaeological assessment was undertaken during late March 2003 in order to examine the full pipeline route from the Cooper Creek near Innamincka to the Burlieburly Waterhole and then on to the drilling rig. There were a number of issues that arose about the route cleared during the first Work Area Clearance and Geodynamics decided to relocate the pipeline corridor from Burlieburly Waterhole to the drilling rig approximately 400 metres further to the south. The survey concentrated on the new proposed water pipeline route, the start and finish of which was located on the landscape with the assistance of a Geodynamics Limited representative (Eugene Iliescu) before the clearance. The cleared pipeline corridor was recorded by the consultant using a handheld GPS (Global Positioning System) unit as a GPS track log and as a series of waypoints taken at regular intervals along the cleared route.

The area was examined by the archaeologist and six representatives of the Yandruwandha/Yawarrawarrka Native Title Claimant Group, accompanied by Tony Agnew and Luke Martin of the SA National Parks and Wildlife Service on the 20/6/2003. Doone Wyborn had explained the practicalities of construction and operation for the proposed developments during the March Work Area Clearance. All of the proposed development locations were examined and suitable alignments were cleared for the nominated activities by those stakeholders present. There were a few areas that could not be examined effectively at the time of the site inspection because of poor ground visibility, due to the presence of native vegetation.

The June 2003 survey was undertaken with the permission and involvement of the Yandruwandha/Yawarrawarrka Native Title Claimant Group. The Native Title Claimant Group and their legal representative have been supplied copies of the draft of this report and have supplied an endorsement of its findings and recommendations to the consultant after they had examined it and discussed its contents.

A GIS search of the Register of Aboriginal Sites and Objects, maintained by Department for Aboriginal Affairs and Reconciliation, has been conducted and there are no legally protected (under the South Australian *Aboriginal Heritage Act* [1988] as amended) Aboriginal Sites included on the Register that are located in these development areas.

Recommendations

The Yandruwandha/Yawarrawarrka Native Title Claimant Group has recommended that the proposed developments should go ahead subject to Geodynamics Limited and their contractors' compliance with the locations and restrictions recommended in Appendix 1 to this report. The Aboriginal representatives conducting the Work Area Clearance state that the Geodynamics Limited Australia developments will cause no impacts on any areas or objects that are known to be of cultural importance if a strategy of site avoidance, based on the results of the Work Area Clearance survey, is implemented. Some cultural material and Aboriginal archaeological sites were discovered during the heritage assessment and work area clearance, most of these were located away from the development areas particularly in deflations at the edges of claypans on sand dunes and sand ridges. It is recommended that all activities and access are restricted only to those areas given clearance and that all personnel access the activity areas only using the cleared access tracks from established roads, tracks or fence lines. It is recommended that the all eroded areas, the edges of claypans, sand dunes and sand ridges be avoided, as much as possible, during exploration and development activities. A number of Aboriginal burials are located near Burlieburly Waterhole and it is strongly recommended that great care be taken not to disturb any human remains during any activity near the waterhole. It is recommended that the pumping station be accessed solely by the most easterly of the established tracks from the Santos rig road. It is also recommended that no vehicles should travel any further south than the pumping station location, with a maximum of 50 metres suggested for the turning of vehicles.

As the South Australian *Aboriginal Heritage Act (1988)* (as amended) provides possible protection for any previously unknown sites or archaeological material that may be discovered during the development process, it is advisable that any earthworks or excavations be conducted with the exercise of due care by the machine operators doing the work.

In the event of Aboriginal cultural material being exposed it is advised that all development work that could impact on any material of cultural or scientific significance should cease immediately. In South Australia an assessment must then be made by staff of the Heritage Team of the Department for Aboriginal Affairs and Reconciliation (DAARE) and the relevant Aboriginal Heritage organisation, in this instance the Yandruwandha/Yawarrawarrka Native Title Claimant Group. At that time a determination under Section 12 of the South Australian *Aboriginal Heritage Act (1988)* (as amended) can be made, in order to determine what appropriate action should be taken.

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Acknowledgments:

I would like to thank the following people for their help on the project:

Harold Brown, Snieder Brown, Lee Kirwan, Donald Paterson, Gloria Paterson and Adam Skinner; who are all members of the Yandruwandha/Yawarrawarrka Native Title Claimant Group who acted as field assistants and community consultants during the Work Area Clearance. Michael Steele, legal representative for the Native Title Claimant Group for assistance in liaising with Geodynamics Limited and organising the WAC.

Leonie Casey, Chair of the State Aboriginal Heritage Committee and the members of the State Aboriginal Heritage Committee for their help and assistance at various stages of this project.

Darren Hincks, Site Registrar, and other staff of the Heritage Team of the Department for Aboriginal Affairs and Reconciliation (DAARE).

Eugene Iliescu and Doone Wyborn (representatives of Geodynamics Limited) for their help in organising and facilitating the work area clearance; as well as help in the field and input in explaining the realities of the required infrastructure and all of the impacts of the project on the landscape.

1.0 Introduction

1.1 The Study Area

The study areas are located on Geothermal Exploration Lease (GEL) 98, located in the Cooper Basin, and consist of the proposed Geodynamics Limited development areas nearby to the Habanero 1 Well (on Innamincka Station). The focus of this study was a water pipeline corridor between Burlieburlie Waterhole and Habanero 1 which is situated in an area approximately ten kilometres to the south of the township of Innamincka, to the east of the Strzelecki Creek, in the far north eastern corner of South Australia (see Figures 1&2 and Plates 1-4).

1.2 Legislation

This Work Area Clearance and survey was carried out in accordance with a formal request from Geodynamics Limited under Schedule 2: Clearance Survey Request, of a Work Area Clearance Agreement signed for this project with the Claimant Group. The survey was conducted under the provisions of the South Australian *Aboriginal Heritage Act (1988)* (as amended) and with the involvement, advice and co-operation of the relevant Aboriginal organisation, in this instance the Yandruwandha/Yawarrawarrka Native Title Claimant Group (see Appendix 2: Relevant Communications). Advice was also sought from the Heritage Team of the Department for Aboriginal Affairs and Reconciliation, the government department charged with administering and enforcing this *Act*.

The South Australian *Aboriginal Heritage Act (1988)*[as amended] legally protects registered Aboriginal Sites or Objects and gives guidelines when dealing with possible items or areas of significance to Aboriginal Heritage.

Section 3 of the South Australian *Aboriginal Heritage Act (1988)* defines an Aboriginal site as being an area of land:

- a) that is of significance according to Aboriginal tradition;
- or
- b) that is of significance to Aboriginal archaeology, anthropology or history

Section 3 of the *Act* also defines an Aboriginal object as an object:

- a) that is of significance according to Aboriginal tradition;
- or
- b) that is of significance to Aboriginal archaeology, anthropology or history

Section 3 of the *Act* also defines Aboriginal tradition as

...traditions, observances, customs or beliefs of the people who inhabited Australia before European colonisation and includes traditions, observances, customs and beliefs that have evolved or developed from that tradition since European colonisation.

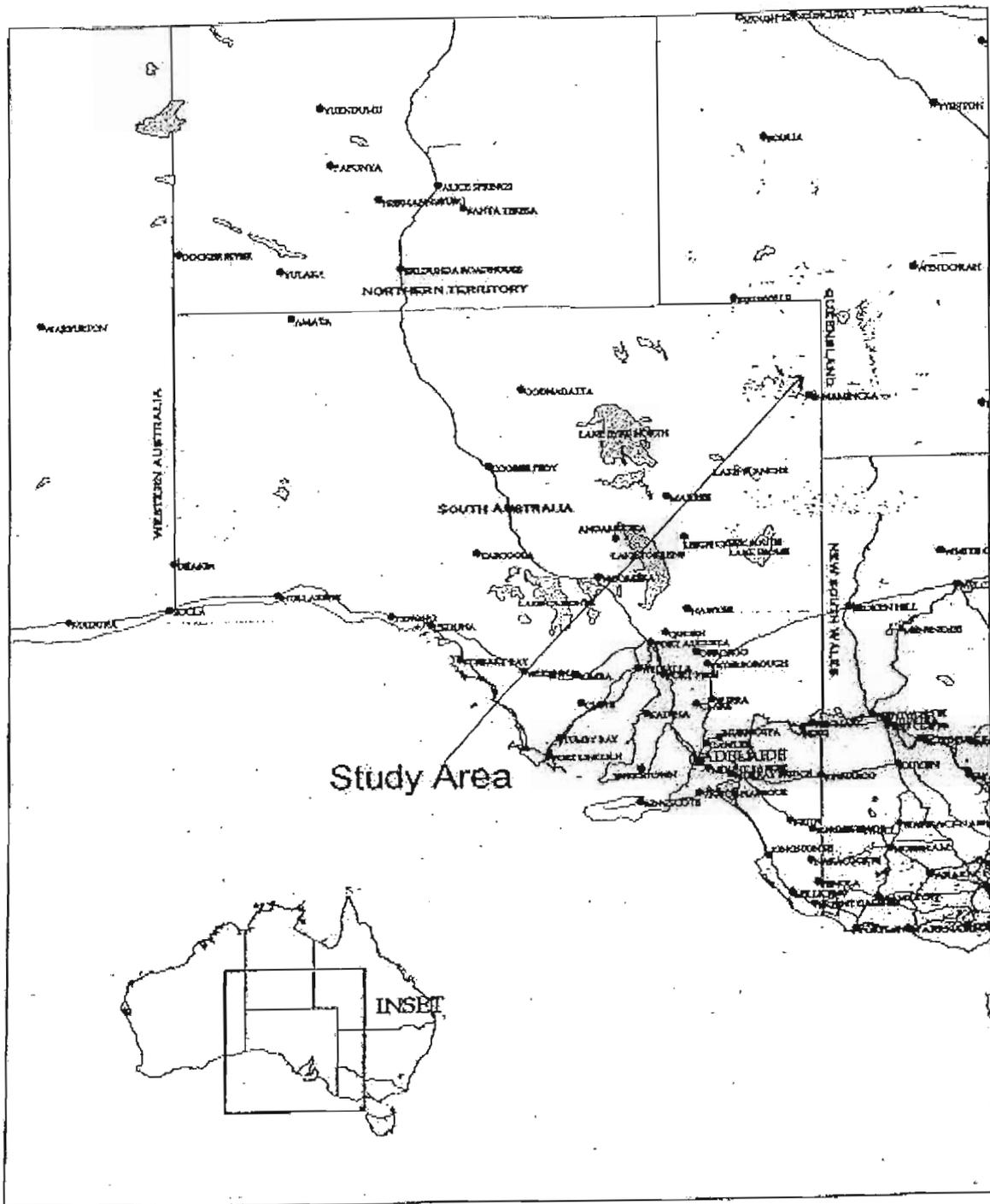


Figure 1: The location of study area

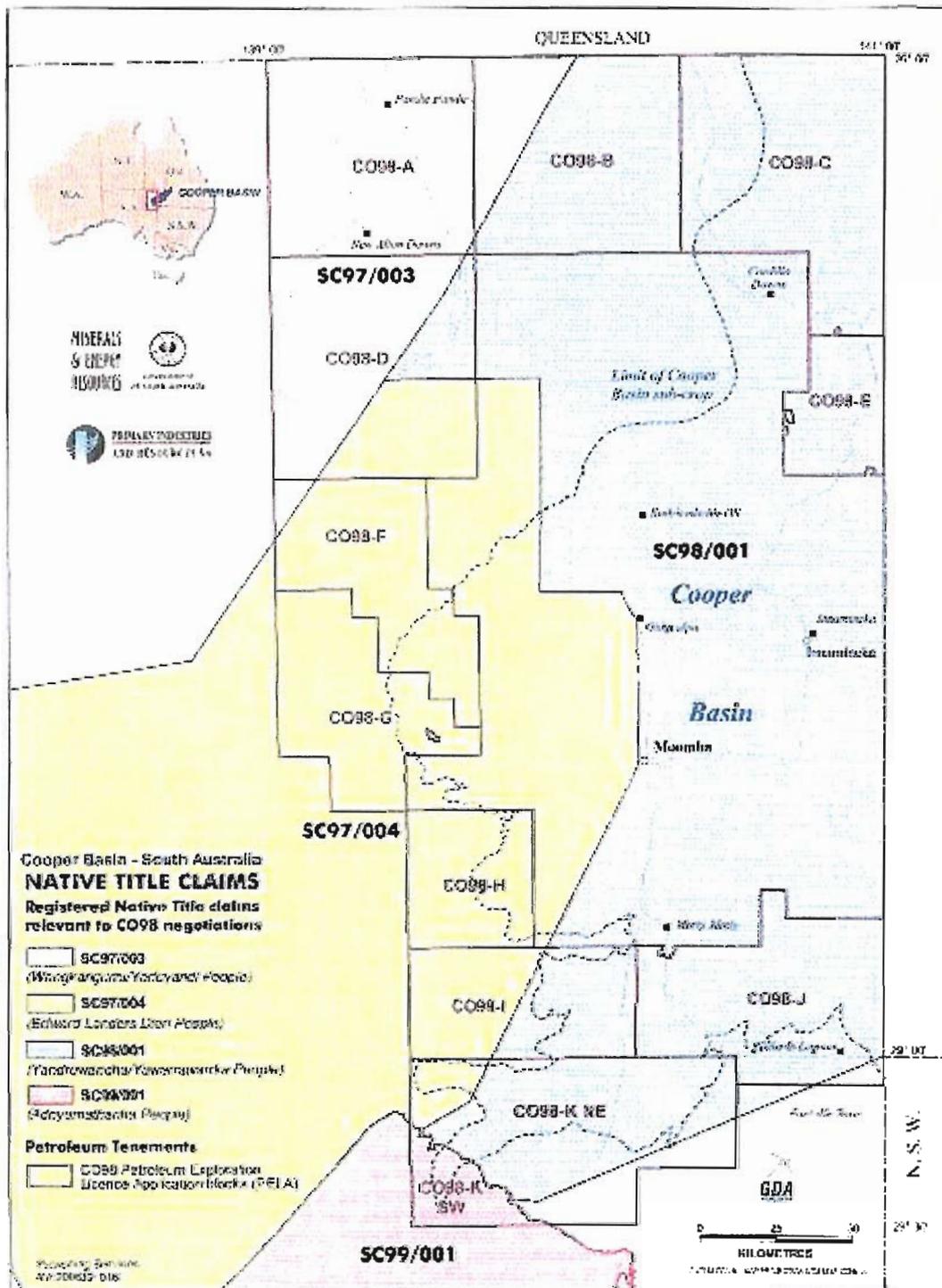


Figure 2: The Cooper Basin with the location of the study area



Plate 1: Burlieburly Waterhole at the location of the pumping station, looking south-south west from 472896 East / 6923877 North; Datum: GDA 1994



Plate 2: Work Area Clearance Team at the Burlieburly Waterhole, looking north from 472893/6923866 (from the left, Snieder Brown, Donald Paterson, Adam Skinner, Luke Martin and Tony Agnew, with Gloria Paterson and Lee Kirwan in the background)

Section 23 of the South Australian *Aboriginal Heritage Act (1988)* (as amended) gives legal protection to all registered Aboriginal sites and objects in South Australia. The *Act* makes it a legal offence attracting a fine and/or imprisonment to damage, disturb or interfere with Aboriginal sites or objects without the permission and written authorisation of the appropriate Minister.

This protection is accorded when the site or object has been determined to be of significance according to Aboriginal tradition, or of significance to Aboriginal archaeology, anthropology or history. If this has been determined, under Section 12 of the *Act*, then the site can be registered as an Aboriginal site on the Register of Aboriginal Sites and Objects, which is maintained by the Department for Aboriginal Affairs and Reconciliation.

Section 20 of the *Act* puts an onus of responsibility on landowners and occupiers of private land to inform the Minister if Aboriginal sites or objects are discovered on the landscape. Potential Aboriginal sites or objects (in regard to the definition set out in Section 3 of the *Act*) that may be discovered during a Work Area Clearance, Cultural Heritage survey or in site development work need to be assessed by the Minister in order to determine whether the newly discovered site or object should be included on the Register of Aboriginal Sites and Objects. A determination can be requested from the appropriate Minister under Section 12 of the *Act*, if the person (the developer in this instance) who proposes to take action in relation to the newly discovered site or object and feels that that action may constitute an offence under Section 23 of the *Act*.

If registered sites or objects are to be impacted upon or destroyed in the process of a development a permit to destroy (under Section 23 of the *Act*) must be gained from the Minister. The *Act* also could protect previously unknown sites or archaeological material that may be discovered during the development process if they are subsequently be determined to be an Aboriginal site or object under Section 12 of the *Act* and therefore eligible for inclusion on the Register of Aboriginal Sites and Objects. Therefore it is advisable that any earthworks or excavations be conducted with due care by the machine operators doing the work in order to prevent a possible breach of Section 23 of the *Act*.

The full text of some of the sections of the *Act* has been included as an appendix to this report for information and reference by the stakeholders in this process (see Appendix 3: Sections 12, 20, 21, 22 and 23 of the South Australian *Aboriginal Heritage Act 1988* [as amended]).

2.0 The Proposed Developments

2.1 Extent, nature and timing of the developments

Geodynamics Limited is currently planning for extra exploration activities connected to the experimental geothermal power project based on the Habanero 1 wellsite in the Cooper Basin south of the township of Innamincka, South Australia (see Figures 1&2 and Plates 1-4). These activities consist of the relocation of a total of approximately three kilometres of water pipeline corridor that was cleared in an earlier Work Area Clearance in March 2003. The route nominated at that time was considered to have the potential to cause future erosional problems in the area. The new pipeline corridor will follow a cross country route between the Burlieburly Waterhole and an existing Santos rig road for a distance of 2.37 kilometres and then along the track edge to the Habanero 1 wellsite.

The March and June 2003 studies are an extension of the main Work Area Clearance that was conducted during October 2002. The original intention by Geodynamics at that time was to use the already existing Santos oil/gas drill hole at McLeod 1 as source of water for all drilling operations. There have been difficulties in drawing water from McLeod 1 and Geodynamics applied for a water licence to draw water from the Cooper Creek in March 2003. One of the requirements for the issuing of the water licence was to assess the environmental impacts of the pipeline proposal, including an Aboriginal cultural heritage assessment. Geodynamics Ltd. has installed a six kilometre length of temporary above ground polythene pipe (the pipe was buried where it crossed any roads or tracks) from the back of a four wheel drive vehicle from the Cooper Creek near the Innamincka Town Common to Burlieburly Waterhole in order to fill the waterhole to capacity. The water was pumped from the creek using a trailer mounted pump which was parked adjacent to the creek. The pump and pipeline is to be moved, with the pump being relocated to the eastern bank of Burlieburly Waterhole and the polythene pipe will then be used for a quadruple three kilometre pipeline in order to pump the water from the waterhole to the Habanero 1 wellsite for use in drilling activities.

The overall pipeline route alignment consisted of two different sections, which was chosen in the field at the time of the work Area Clearances. The first section, approximately six kilometres in length, started at the edge of the Cooper Creek adjacent to the Innamincka town common. It was mostly situated on the eastern side of the Strzelecki Track for the majority of the alignment to the Burlieburly Waterhole on the Strzelecki Creek. The second section of the pipeline corridor is proposed to exit Burlieburly Waterhole and run for three kilometres in a south easterly direction to the Habanero 1 drilling site to be used in the current drilling program.

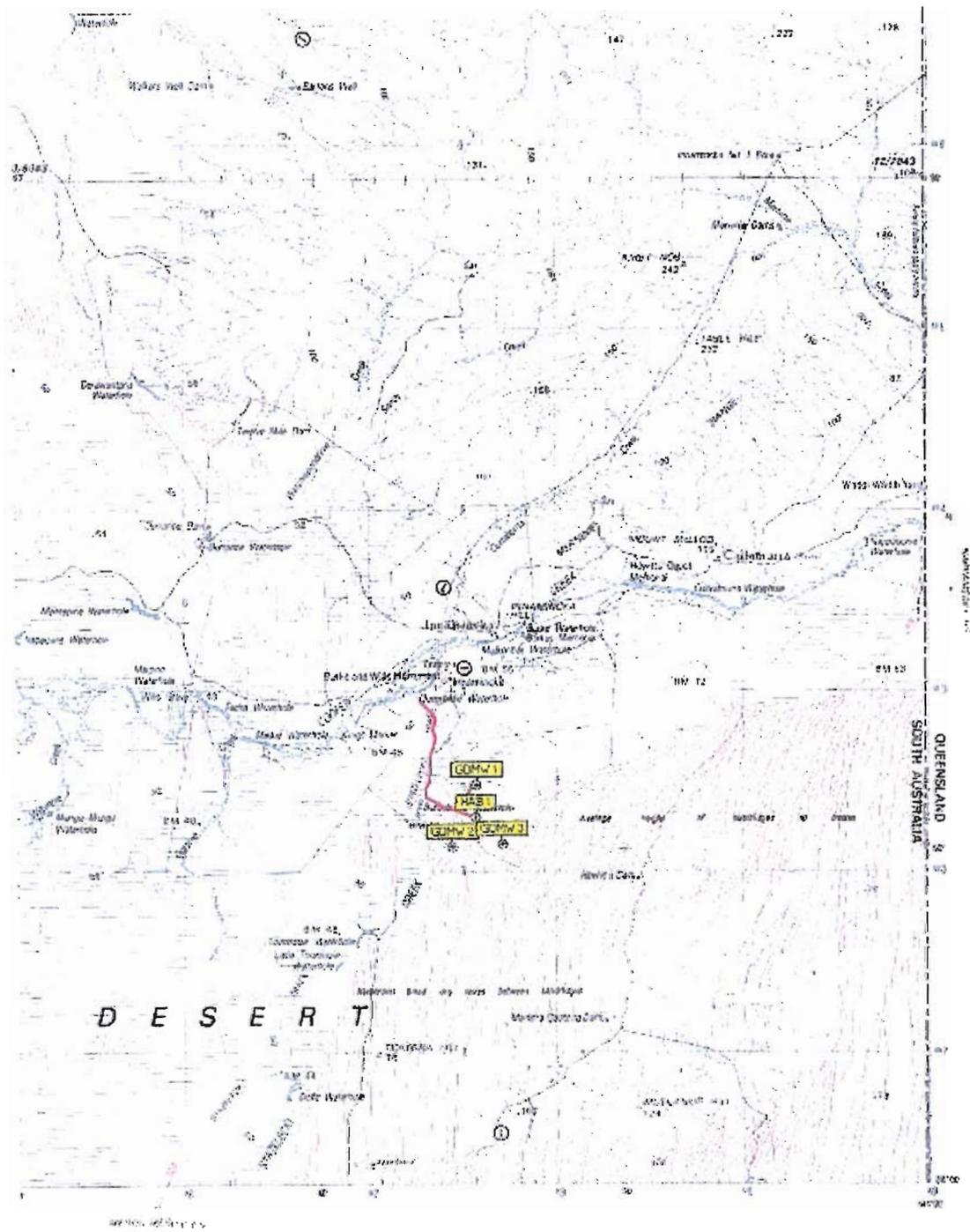


Figure 3: The study area with the location of the proposed Geodynamics Limited developments



Plate 3: Donald Paterson at star picket on dune crest, looking south east from 474810/6923395



Plate 4: The eastern end of the pipeline route near the junction of the existing Santos rig road, looking from 475112/6923230

The scope of this Work Area Clearance program was limited to the areas associated with the areas of impact of the above developments.

The following is taken from the request for this Work Area Clearance by Geodynamics Limited to the Native Title Claimants legal representative and describes the scope of the clearance:

“Geodynamics Ltd wish to alter the water pipeline route from Burlie Burlie Waterhole to the Habanero 1 drillsite. This is an extension to the Work Area Clearance that is described in the March 2003 Work Area Clearance Agreement which was signed by myself and the Native Title Claimants.

The changes to the route are as follows: the water outlet pumping station is to be moved approximately 400 metres to the south of the currently cleared location and will then run in a straight line to the drilling rig site joining up with an existing Santos rig road close the Habanero 1 drillsite.”

Letter from Doone Wyborn to Michael Steele, 20/6/2003

The following is taken from the original request for the Work Area Clearance by Geodynamics Limited to the Native Title Claimants legal representative and describes the scope of the March 2003 clearance, as well as the nature and impact of the pipeline project:

Association: The Yandruwandha Yawarrawarrka Native Title Claimants (Claimants)
Explorer: Geodynamics Limited (Geodynamics)

Licence Area: GEL 98

Date: 26 March 2003

In accordance with Section 4 of the Work Area Clearance Agreement, Geodynamics Limited requests a Clearance of the following operations for GEL 98.

Operation	Description	Comment
Water abstraction from Cooper Creek	Laying of surface pipe between Cooper Creek and Habanero 1, and pumping over several months.	Clearance of route including intermediate storage at Burley Waterhole

The following information in regard to these proposed operations is supplied in accordance with the original Agreement:

a/ Outline of operation

Geodynamics requires clearance of the pipeline route between Cooper Creek and Habanero 1 adjacent to the Strezlecki Track between Cooper Creek and Burley Waterhole, a distance of approximately 6.4 km, and between Burley Waterhole and Habanero 1, a distance of 3.2 km.

b/ Detailed requirement

The worksites encompass,

- (i) pump location adjacent to Cooper Creek close to the Strezlecki Creek confluence (approximately $-27.7397, 140.7339$)
- (ii) pipe route adjacent to the Strezlecki Track to Burley Waterhole (approximately $-27.8065, 140.7240$)
- (iii) Entry point and exit point of pipeline from Burley Waterhole
- (iv) Direct route of pipeline between Burley Waterhole and Habanero 1 drill site ($-27^{\circ} 48.973' S 140^{\circ} 45.248' E$)

Clearance of these sites will all be required at the same time. The pipeline is expected to be 4 inch black polypipe or similar laid on the ground surface. No disturbance of the land is expected.

C/ Major Items of Equipment proposed to be used

The pump is likely to be diesel powered and mounted on wooden skids adjacent to the Cooper Creek. Another similar pump is required adjacent to Burley Waterhole The pipe will be laid off the back of a light 4x4 utility vehicle.

Work Area Clearance request from Geodynamics to Michael Steele 26/3/03

3.0 Archaeology

3.1 The Site Register

An examination of the Central Archive (including the Register of Aboriginal Sites and Objects), which is maintained by the Department for Aboriginal Affairs and Reconciliation (DAARE) is usually conducted prior to embarking on field work in this type of Aboriginal Heritage survey.

The Central Archive houses site cards, consultancy reports and other documentation for over 4,000 registered and 1,400 reported Aboriginal sites. It contains information about the types of Heritage sites that have been recorded in the state of South Australia are protected by the *Aboriginal Heritage Act (1988)*(as amended). A study of these records indicates whether a registered site or object is present in a proposed development area and also helps to predict the types of Aboriginal sites that might be found in an area of proposed developments. This information is then used in determining the potential of a proposed development to impact on registered or previously unrecorded Aboriginal sites and other areas of cultural significance.

Access to non-confidential reports held in the Central Archive and access to non-confidential site cards is available on application, with the written approval of the relevant Aboriginal heritage committee.

Under Section 12(3) of the *Act* on application for activities that may impact on Aboriginal sites the Minister must provide the applicant the location of sites that may be impacted by the development. The Minister must also provide sufficient information on confidential sites to the applicant in order to avoid damage to sites but does not necessarily have to provide the exact location of the site (under Section 10 [1c] of the *Act*).

A GIS search of the Register of Sites and Objects has been conducted in order to determine whether the proposed Geodynamics Limited development works will affect any Registered Aboriginal Sites; there are no Registered Sites in the development areas.

4.0 Consultation with the Yandruwandha/Yawarrawarrka Native Title Claimant Group

Geodynamics Limited consulted with the Yandruwandha/Yawarrawarrka Native Title Claimant Group and their legal representative prior to the archaeologist being awarded the consultancy for this project. This Work Area Clearance was formally requested by Geodynamics Limited under Schedule 2: Clearance Survey Request, of a Work Area Clearance Agreement signed for this project with the Claimant Group. The current Work Area Clearance was conducted under the same terms and conditions as the March 2003 Clearance (see Appendix 2: Relevant Communications for the details).

A Work Area Clearance Agreement must be entered into by Geodynamics Limited and the Yandruwandha/Yawarrawarrka Native Title Claimant Group prior to any works commencing. This Agreement outlines the rights and responsibilities of all parties involved in the Work Area Clearance process. This process included consultation which was conducted in order to explain the exact nature of the development, to organise the survey and the participation of representatives of the Yandruwandha /Yawarrawarrka Native Title Claimant Group to act as community consultants in regard to the impacts (if any) of this project on Aboriginal cultural heritage. The consultation process also allows the Aboriginal stakeholders to inform, as far as possible, the consultant and the developers whether there are any Aboriginal sites in the development area that are identified by Tradition or have other cultural significance and therefore not cleared for development activities.

Prior to, and during, the site clearance maps, aerial photographs and the Geodynamics Limited site plans of the proposed development areas were shown to the community representatives and the exact nature of the developments in each area was discussed. The nature and impacts of the development in each area surveyed was discussed during the survey and its potential impacts on the archaeology of the area was considered as a part of this process. Six community representatives (Harold Brown, Snieder Brown, Lee Kirwan, Donald Paterson, Gloria Paterson and Adam Skinner) with a male archaeologist formed the survey team. The Yandruwandha/Yawarrawarrka Native Title Claimant Group have been supplied copies of the draft of this report and have endorsed the findings and recommendations of the draft report and have supplied notification to the consultant stating this.

This response from the Aboriginal stakeholders is usually supplied to the consultant concerning the draft report, in order to state their opinion concerning the proposed development and its impact (if any) on the Aboriginal heritage of an area. This information is then included in the final report to the developer so that all activities on the ground will not impact on any areas of significance found during the Work Area Clearance surveys.

5.0 The Survey

5.1 Survey design and method

Prior to the site inspection the project brief, maps, design plans (supplied by Geodynamics Limited) and aerial photographs showing the areas of the Geodynamics Limited developments that are to be modified. The nature and extent of the developments were also discussed. The clearance team was accompanied for the work area clearance by Tony Agnew and Luke Martin of the SA National Parks and Wildlife Service at Innamincka. The clearance team examined the locations of the pipeline alignment and the proposed access track for the pumping station.

A work area clearance, cultural heritage survey and archaeological assessment was undertaken on the 20th of June 2003 in order to examine the areas that are to be affected by these proposed developments. The survey concentrated on the proposed water pipeline and access routes which were located on the landscape with the assistance of a handheld GPS (Global Positioning System) unit. The cleared pipeline corridor and access route were recorded by the consultant as a GPS track log and as a series of waypoints taken at regular intervals along the cleared route, utilising UTM coordinates Datum: GDA 1994 (see Appendix 1: Geodynamics Limited Work Area Clearance Results).

The survey strategy used was to examine 100% of the exposed ground surface by foot with all areas being examined on foot for the 2.37km cross country section of the pipeline corridor. In this type of foot survey a maximum distance of 10 metres is usually maintained between each of the observers, this is the accepted optimum distance for the most efficient and effective coverage for site surveys. Some of the areas that had greater ground cover were examined using a closer spacing of the observers (between 5-10 metres). The road corridor section of the pipeline corridor was examined by vehicle to ensure that there was no cultural material present in that area.

Photographs were taken at all places where archaeological material was found, photographs were also taken at all of the development site locations in order to document the area of impact given clearance, the present ground surface and the vegetation present at the time of the field inspections.

Discussions were held with the Aboriginal community representatives at the development sites during the surveys in order to gain their opinion concerning the importance of the proposed development areas to Aboriginal Heritage and effects that the development would have of on the archaeological material discovered during the clearance. The results of ground surface survey were also discussed as well as the potential of sub-surface material being present in any of these areas.

5.2 Constraints on the surveys

The ground surface in a small number of the development locations in the study areas was partially to completely obscured (varying from 0%-100% cover) by vegetation cover. It is possible that some archaeological material may have been present in the study area but may have been obscured from view because of the vegetation cover in the area at the time of the survey.

6.0 Survey Results

There were places that were identified during the Work Area Clearance Program that contained archaeological material and/or were places of significance to the Aboriginal representatives on the site inspections found in, or adjacent to, the study area locations. Some of these areas were located away from the development areas and were associated with the sand dunes and sand ridges at the edges of the claypans. Other sites were located within the proposed development locations and the proposed areas of impact were modified at the time of the Work Area Clearance so that these identified areas would be avoided during all exploration activities.

The archaeological material found consisted predominantly of flaked and/or ground stone artefacts, which will be avoided during the development process.

The Yandruwandha/Yawarrawarrka Native Title Claimant Group have recommended that the development can proceed in the areas that were inspected and cleared during the Work Area Clearance, providing that all of those areas that were not cleared are completely avoided during any future activities.

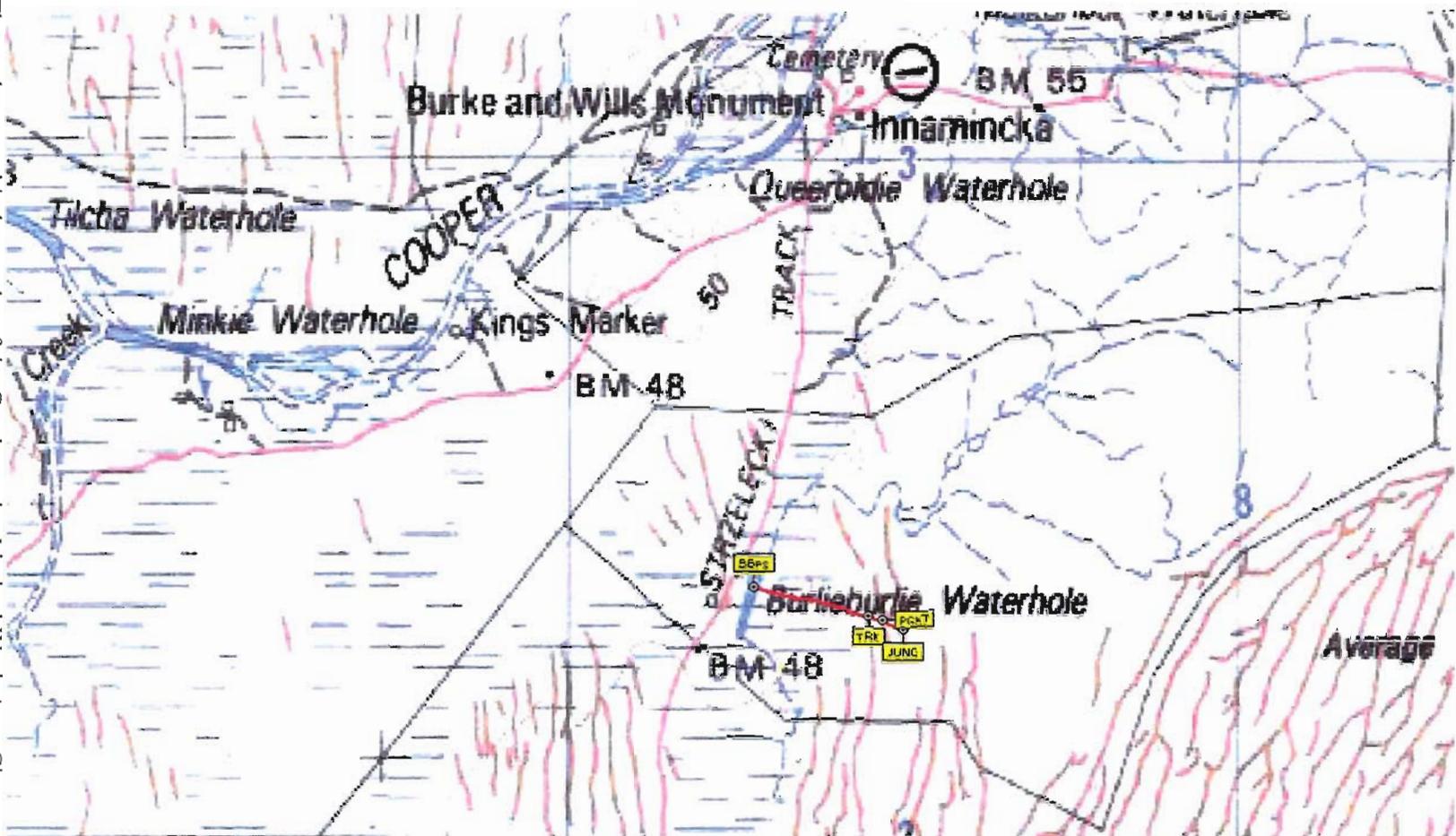


Figure 4: The study area with the results of the Geodynamics Limited Work Area Clearance 6/03

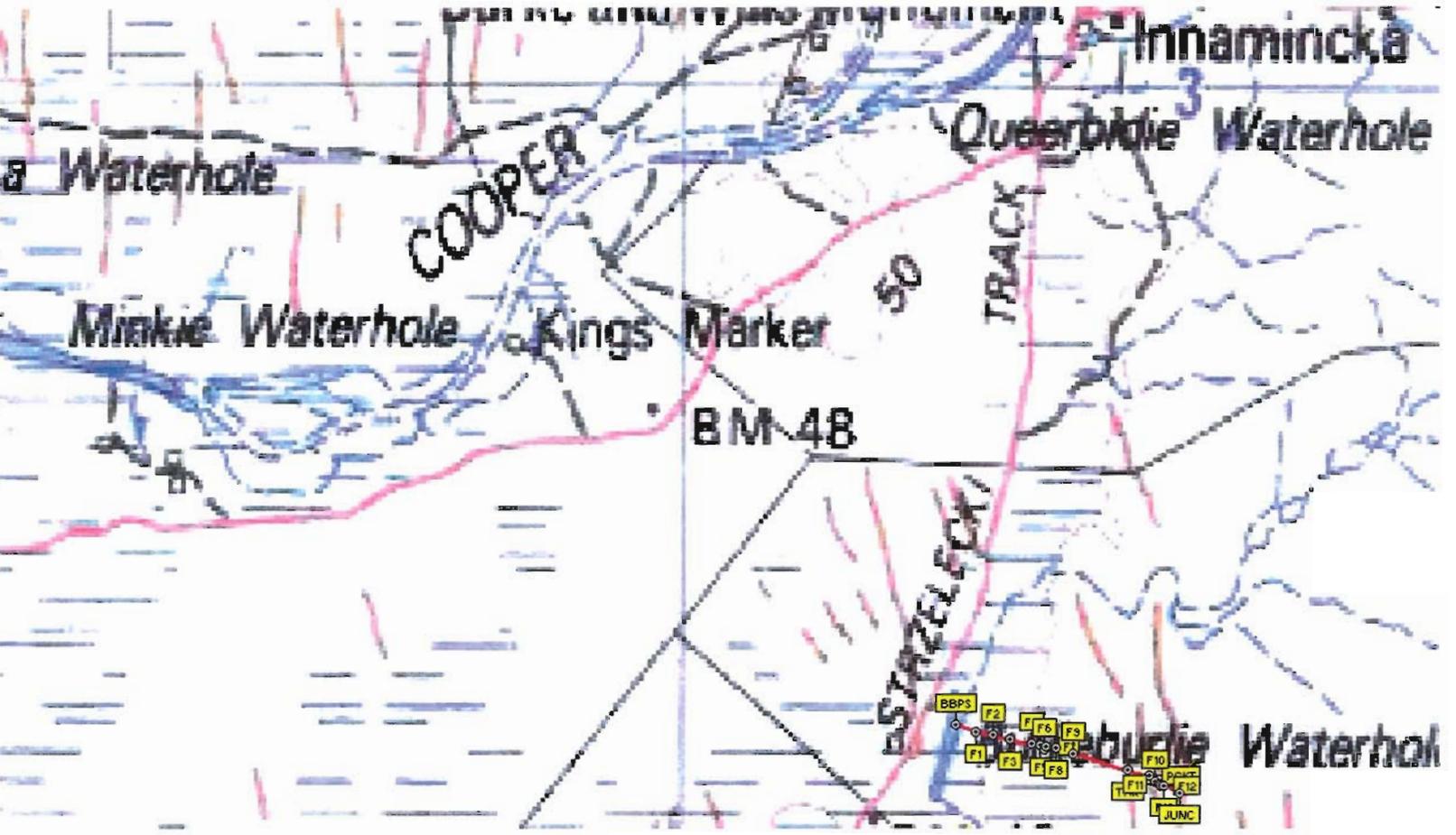


Figure 5: The study area showing the waypoints for the cleared water pipeline route (see Appendix 1 for full details)

7.0 Assessment of significance

There were a number of places discovered during this survey that can be assessed in terms of cultural or scientific significance. It is therefore useful to include a brief summary of the terminology and the process for reference for all of the stakeholder parties.

It is possible that other previously unknown Aboriginal sites or cultural material may be discovered during the development process and if this occurs the following set of criteria will also need to be applied.

7.1 Criteria for significance assessment

The South Australian *Aboriginal Heritage Act (1988)* defines a site as being an area of land:

"a) that is of significance according to Aboriginal tradition;

or

b) that is of significance to Aboriginal archaeology, anthropology or history"

The *Act* defines 'Aboriginal tradition' as

"...traditions, observances, customs or beliefs of the people who inhabited Australia before European colonisation and includes traditions, observances, customs and beliefs that have evolved or developed from that tradition since European colonisation."

There are a number of different considerations that affect the assessment of the significance of cultural heritage:

Aboriginal significance - how the site/area is viewed in terms of significance by the local Aboriginal community, in this case the Yandruwandha/Yawarrawarrka Native Title Claimant Group

Research/scientific potential of a site or an area, this is based on a number of considerations including the site's contents, structure and integrity

Heritage value - the value that a site has to benefit the general public aesthetically or educationally

7.2 Effects of proposed Geodynamics Limited developments on Cultural Heritage

There will be no impacts by this project on known areas or sites, if the strategy of site avoidance is fully implemented. There is a slight possibility that previously undiscovered Aboriginal sites or cultural material may be affected during the construction of these proposed Geodynamics Limited developments.

If an archaeological site or cultural material is encountered during the construction of this development it will then be necessary for the developer to inform the Yandruwandha and the Yawarrawarrka Native Title Claimant Group and to apply to the Minister of Aboriginal Affairs for a determination under Section 12 of the South Australian *Aboriginal Heritage Act (1988)* (as amended). If the site is determined to be an Aboriginal Site and subsequently registered it is still possible to continue development activities if an authorisation by the Minister under Section 23 of the *Act* is issued in order to continue activities that may damage or destroy that site.

8.0 Recommendations

The Yandruwandha/Yawarrawarrka Native Title Claimant Group has recommended that the proposed developments should go ahead subject to Geodynamics Limited and their contractors' compliance with the locations and restrictions recommended in Appendix 1 to this report. The Aboriginal representatives conducting the Work Area Clearance state that the Geodynamics Limited Australia developments will cause no impacts on any areas or objects that are known to be of cultural importance if a strategy of site avoidance, based on the results of the Work Area Clearance survey, is implemented. Some cultural material and Aboriginal archaeological sites were discovered during the heritage assessment and work area clearance, most of these were located away from the development areas particularly in deflations at the edges of claypans on sand dunes and sand ridges. It is recommended that all activities and access are restricted only to those areas given clearance and that all personnel access the activity areas only using the cleared access tracks from established roads, tracks or fence lines. It is recommended that the all eroded areas, the edges of claypans, sand dunes and sand ridges be avoided, as much as possible, during exploration and development activities. A number of Aboriginal burials are located near Burlieburly Waterhole and it is strongly recommended that great care be taken not to disturb any human remains during any activity near the waterhole. It is recommended that the pumping station be accessed solely by the most easterly of the established tracks from the Santos rig road. It is also recommended that no vehicles should travel any further south than the pumping station location, with a maximum of 50 metres suggested for the turning of vehicles.

As the South Australian *Aboriginal Heritage Act (1988)* (as amended) provides possible protection for any previously unknown sites or archaeological material that may be discovered during the development process, it is advisable that any earthworks or excavations be conducted with the exercise of due care by the machine operators doing the work.

In the event of Aboriginal cultural material being exposed it is advised that all development work that could impact on any material of cultural or scientific significance should cease immediately. In South Australia an assessment must then be made by staff of the Heritage Team of the Department for Aboriginal Affairs and Reconciliation (DAARE) and the relevant Aboriginal Heritage organisation, in this instance the Yandruwandha/Yawarrawarrka Native Title Claimant Group. At that time a determination under Section 12 of the South Australian *Aboriginal Heritage Act (1988)* (as amended) can be made, in order to determine what appropriate action should be taken.

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State Aboriginal Heritage Committee

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Contact Person: Leonie Casey (Chairperson)

Appendix 1:

Geodynamics Ltd. Work Area Clearance Results:

Cleared Water Pipeline Corridor Location

Geodynamics Ltd. Work Area Clearance Results: Cleared Water Pipeline Corridor Location

Datum: Australian Geocentric 1994 (GDA94)

Projection: Universal Transverse Mercator (UTM) Map Zone: 54J

Waypoint/feature Name	Easting GDA94	Northing GDA94	Comment
BBPS	472883	6923881	BurlieBurlie pump station
TRK	474599	6923455	track crossing
F1	473074	6923823	pink flagging
F2	473243	6923787	pink flagging
F3	473414	6923748	pink flagging
F4	473629	6923703	pink flagging
F5	473719	6923691	keep left of pink flagging
F6	473769	6923655	keep left of pink flagging
F7	473773	6923678	keep left of pink flagging
F8	473872	6923657	pink flagging
F9	474049	6923610	pink flagging
PCKT	474809	6923395	Star picket on dune crest
F10	474865	6923345	pink flagging keep to sandy rise
F11	474910	6923307	pink flagging keep to sandy rise
F12	474920	6923305	pink flagging keep to sandy rise
F13	474951	6923295	pink flagging keep to sandy rise
JUNC	475112	6923230	Junction of pipeline and Santos track

Recommended Access Route to Burlieburle Waterhole Pumping Station Location

Datum: Australian Geocentric 1994 (GDA94)

Projection: Universal Transverse Mercator (UTM) Map Zone: 54J

Description	Easting GDA94	Northing GDA94	Comment
Access to Burlieburle pumping station	473405	6924622	Near Burlieburle Waterhole pumping station
Access to Burlieburle pumping station	473351	6924533	
Access to Burlieburle pumping station	473298	6924473	
Access to Burlieburle pumping station	473232	6924366	
Access to Burlieburle pumping station	473182	6924271	
Access to Burlieburle pumping station	473102	6924206	
Access to Burlieburle pumping station	473024	6924119	
Access to Burlieburle pumping station	473009	6924092	
Access to Burlieburle pumping station	472961	6923999	
Access to Burlieburle pumping station	472923	6923937	
Access to Burlieburle pumping station	472919	6923911	
Access to Burlieburle pumping station	472908	6923895	
Access to Burlieburle pumping station	472892	6923868	Junction with Santos rig road

Appendix 2:

Relevant Communications

Doone Wyborn

Executive Director

**Geodynamics Ltd
PO BOX 2046 Milton QLD 4064**

**Level 2, 349 Coronation Drive, Milton
Queensland 4064 Australia.**

**TELEPHONE NUMBER: +61 7 3876 8955
FACSIMILE NUMBER: +61 7 3876 8966**

20/6/03

Performing Yandruwandha/Yawarrawarrka - Geodynamics Work Area Clearance June 2003

Dear Michael,

Geodynamics Ltd wish to alter the water pipeline route from Burlie Burlie Waterhole to the Habanero 1 drillsite. This is an extension to the Work Area Clearance that is described in the March 2003 Work Area Clearance Agreement which was signed by myself and the Native Title Claimants.

The changes to the route are as follows: the water outlet pumping station is to be moved approximately 400 metres to the south of the currently cleared location and will then run in a straight line to the drilling rig site joining up with an existing Santos rig road close the Habanero 1 drillsite.

Geodynamics Ltd. recognises that these changes to the Work Area Clearance programme are to be covered by all of the terms and conditions agreed to in the March 2003 Work Area Clearance Agreement.

Signed

**Doone Wyborn
Geodynamics**

**Snieder Brown
Yandruwandha/Yawarrawarrka representatives**

**Gloria Paterson
Yandruwandha/Yawarrawarrka representatives**

Work area clearance agreement

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Details

Date

March 27 2003

Parties

Name	Geodynamics Limited
ABN	55 095 006 090
Short form name	Geodynamics
Notice details	Level 2, 349 Coronation Drive, Milton Queensland 4064 Facsimile: (07) 3876 8966 Attention: Dr Bertus de Graaf
Name	The Yandruwandha/Yawarrawarrka People
Short form name	Claimants
Notice details	c/o Hunt & Hunt Solicitors, 12th Floor, 26 Flinders Street, Adelaide SA 5000 Facsimile (08) 8211 7362 Attention: Mr Michael Steele

Background

- A Members of the Claimants claim native title in all of the Claimed Land and have filed a Native Title Application under section 13(1) of the Native Title Act 1993 (Commonwealth) (as amended) with the Federal Court of Australia in proceeding Number SG/ 6024/98 for a determination of native title in respect of the Claimed Land.
- B Geodynamics by itself and its subsidiaries has been granted GEL 97 and GEL 98 by the South Australian Minister for Minerals and Energy under the provisions of the Petroleum Act which interests are located within the boundary of the Claimed Land.
- C The grant of the Licences to Geodynamics was not subject to the right to negotiate provisions of the Native Title Act.
- D Geodynamics has a proposal as set out in **Schedule 2**.
- E Geodynamics and Claimants acknowledge that there may be Areas of Significance affected by Geodynamics proposal and this Agreement is intended to:
- (i) assist Geodynamics to avoid damage, disturbance or inference to Areas of Significance by identifying and recording the areas on the Land which are cleared or not cleared by Survey Team in accordance with **clause 5(d)(iii)**;
 - (ii) set out the procedures which must be followed by Geodynamics to obtain Clearance from the Claimants; and
 - (iii) ensure that Geodynamics meets its obligations under laws relating to Aboriginal Heritage including the *Aboriginal Heritage Act* and the *Aboriginal and Torres Strait Islander Heritage Protection Act (1984)* Cth.

Schedule 1: Land

See attached maps, Map 1 (regional location) and Map 2 (location of project components in Schedule 2).

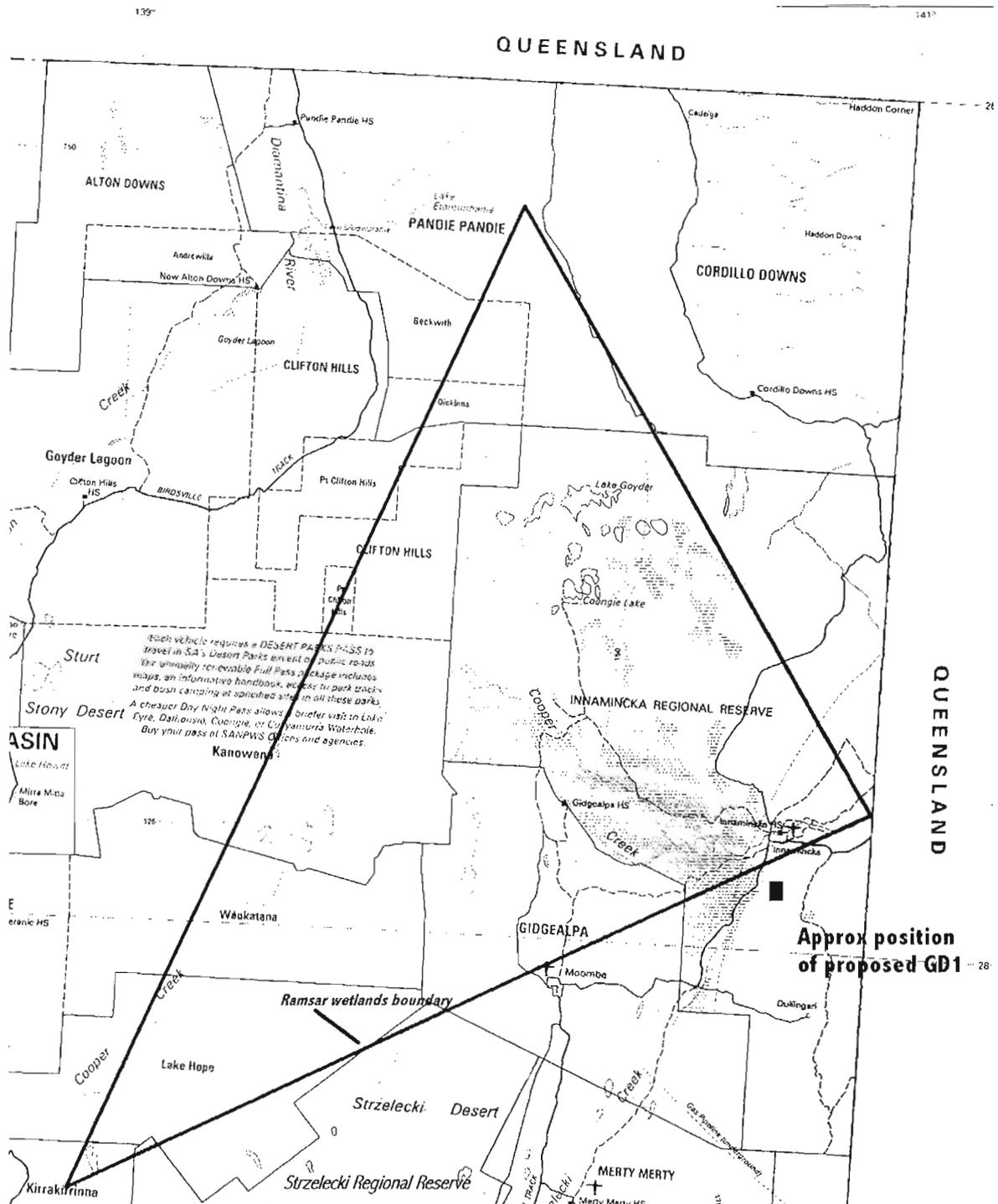


Figure 1. General location of Geodynamics GD1 wellsite in relation to Innamincka Regional Reserve, Ramsar Wetlands and local infrastructure. (Map base: DENR Pastoral areas 1:250000, 1993)

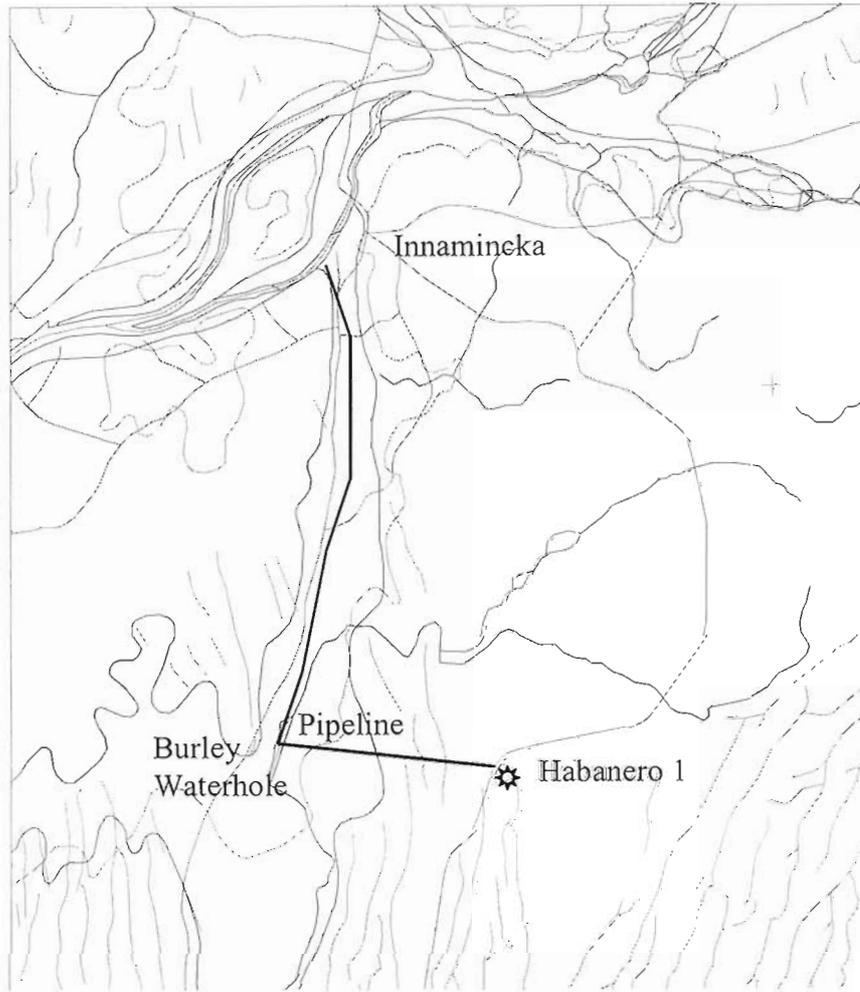


Figure 2. Location of Proposed water pipeline

Schedule 2 - Clearance survey request

A Clearance Survey Request by Geodynamics must include the following materials:

1. Two copies of a 1:25000 scale or other appropriate and general available map and other additional maps and aids (if any) as may be reasonably required clearly identifying the location of each of the Nominated Area to be inspected during the conduct of the Clearance Survey.
2. Particulars of:
 - (a) the nature, scope and objectives of Geodynamics activities to be carried out at each Nominated Area;
 - (b) the estimated duration and timetable for the proposal specified in 2(a) hereof in respect of:
 - (i) planning stage; and
 - (ii) development stage.
 - (c) any surface water, timber or other surface resources proposed to be obtained or cleared from the Nominated Areas;
 - (d)

The current clearance program is shown below:

Geodynamics Limited – Aboriginal Heritage Clearance Survey - GEL 98

Clearance request

Association: The Yandruwandha Yawarrawarrka Native Title Claimants
(Claimants)

Explorer: Geodynamics Limited (Geodynamics)

Licence Area: GEL 98

Date: 26 March 2003

In accordance with Section 4 of the Work Area Clearance Agreement, Geodynamics Limited requests a Clearance of the following operations for GEL 98.

Operation	Description	Comment
Water abstraction from Cooper Creek	Laying of surface pipe between Cooper Creek and Habanero 1, and pumping over several months.	Clearance of route including intermediate storage at Burley Waterhole

The following information in regard to these proposed operations is supplied in accordance with the original Agreement:

a/ Outline of operation

Geodynamics requires clearance of the pipeline route between Cooper Creek and Habanero 1 adjacent to the Strezlecki Track between Cooper Creek and Burley Waterhole, a distance of approximately 6.4 km, and between Burley Waterhole and Habanero 1, a distance of 3.2 km.

b/ Detailed requirement

The worksites encompass,

- (i) pump location adjacent to Cooper Creek close to the Strezlecki Creek confluence (approximately -27.7397, 140.7339)
- (ii) pipe route adjacent to the Strezlecki Track to Burley Waterhole (approximately -27.8065, 140.7240)
- (iii) Entry point and exit point of pipeline from Burley Waterhole
- (iv) Direct rout of pipeline between Burley Waterhole and Habanero 1 drill site (-27° 48.973' S 140° 45.248' E

Clearance of these sites will all be required at the same time. The pipeline is expected to be 4 inch black polypipe or similar laid on the ground surface. No disturbance of the land is expected.

c/ Major Items of Equipment proposed to be used

The pump is likely to be diesel powered and mounted on wooden skids adjacent to the Cooper Creek. Another similar pump is required adjacent to Burley Waterhole The pipe will be laid off the back of a light 4x4 utility vehicle.

The person attending the heritage clearance survey will be

Dr Doone Wyborn
Executive Director - Science and Exploration
Geodynamics Limited
PO Box 2046
Milton, Qld 4064
Ph 07-38768955
Fax 07-38768966
Mobile 0407 608 692
Email dwyborn@geodynamics.com.au

Appendix 3:

**Sections 12, 20, 21, 22 and 23 of the
South Australian *Aboriginal Heritage Act*
1988 (as amended)**

ABORIGINAL HERITAGE ACT 1988 - SECTION 12

Determination of whether site or object is an Aboriginal site or object

12. (1) If a person proposes to take action in relation to a particular object and that action may constitute an offence against this Act if the object is an Aboriginal object, the person may apply to the Minister under this section.

(2) On an application under subsection (1), the Minister must

(a) if the object is entered in the Register of Aboriginal Sites and Objects, give the applicant written notice that it is so entered;

(b) if the object is not entered in the Register, determine whether it should be so entered and give the applicant written notice of the determination.

(3) If a person proposes to take action in relation to a particular area and that action may constitute an offence against this Act if the area is, is part of or includes an Aboriginal site or if an Aboriginal object is located in the area, the person may apply to the Minister under this section.

(4) On an application under subsection (3), the Minister must

(a) determine whether any entries should be made in the Register of Aboriginal Sites and Objects in relation to sites or objects in the area that are not so entered and give the applicant written notice of the determination; or

(b) subject to subsection (5), give the applicant written notice of the location of each Aboriginal site or object in the area that is entered, or that the Minister has determined should be entered, in the Register.

(5) The Minister must not disclose the exact location of a site or object if, in the Minister's opinion, the disclosure is likely to be detrimental to the protection or preservation of the site or object or to be in contravention of Aboriginal tradition.

(6) The Minister may, within 20 working days after receiving an application, require an applicant to provide information in connection with the application or to engage an expert acceptable to the Minister to do so.

(7) Where the Minister requires information to be provided under subsection (6), the Minister must determine the application within 30 working days of receiving that information.

(8) The Minister may refuse to entertain an application under this section on the grounds

(a) that the area or object is insufficiently identified; or

(b) that the application is not genuine; or

(c) that the Minister does not have the resources to determine the application.

ABORIGINAL HERITAGE ACT 1988 - SECTION 20

Discovery of sites, objects or remains

20. (1) An owner or occupier of private land, or an employee or agent of such an owner or occupier, who discovers on the land

- (a) an Aboriginal site; or
- (b) an Aboriginal object or remains,

must, as soon as practicable, report the discovery to the Minister giving particulars of the nature and location of the site, object or remains.

Penalty: (a) in the case of a body corporate \$50 000;
(b) in any other case \$10 000 or imprisonment for 6 months.

(2) This section does not apply to the traditional owner of the site or object or to an employee or agent of the traditional owner.

(3) The Minister may direct a person making a report to take such immediate action for the protection or preservation of the remains as the Minister considers appropriate.

(4) A person must not, without reasonable excuse, fail to comply with a direction of the Minister under this section.

Penalty: \$2 000 or imprisonment for 3 months.

ABORIGINAL HERITAGE ACT 1988 - SECTION 21

Excavating sites, objects or remains

21. A person must not, without the authority of the Minister, excavate land for the purpose of uncovering any Aboriginal site, object or remains.

Penalty: (a) in the case of a body corporate \$50 000;
(b) in any other case \$10 000 or imprisonment for 6 months.

ABORIGINAL HERITAGE ACT 1988 - SECTION 22

Access to and excavation of land by authorised persons

22. (1) Where the Minister has reason to believe that any Aboriginal site, object or remains have been or may be found on or under any land (including private land), the Minister may authorise a person

- (a) to enter the land; and
- (b) to search for the site, object or remains; and
- (c) to excavate the land.

(2) Before entering any land pursuant to an authorisation under this section, the authorised person must give reasonable notice in writing to the owner and occupier (if any) of the land identifying the land affected.

(3) Where any Aboriginal object or remains, or any object or remains that may be an Aboriginal object or Aboriginal remains, is or are found on the land, the Minister, if satisfied that it is necessary to do so for the protection or preservation of the object or remains, may take possession of the object or remains.

(4) The Minister must make good any damage done to land by a person acting in pursuance of this section.

(5) A person must not, without reasonable excuse, hinder or obstruct a person acting pursuant to an authorisation under this section.
Penalty: \$2 000 or imprisonment for 3 months.

ABORIGINAL HERITAGE ACT 1988 - DIVISION 2

DIVISION 2 PROTECTION OF ABORIGINAL SITES, OBJECTS AND REMAINS

ABORIGINAL HERITAGE ACT 1988 - SECTION 23

Damage, etc., to sites, objects or remains

23. A person must not, without the authority of the Minister
- (a) damage, disturb or interfere with any Aboriginal site; or
 - (b) damage any Aboriginal object; or
 - (c) where any Aboriginal object or remains are found
 - (i) disturb or interfere with the object or remains; or
 - (ii) remove the object or remains.

Penalty: (a) in the case of a body corporate \$50 000;
(b) in any other case \$10 000 or imprisonment for 6 months.

Work Area Clearance of the proposed activities in the vicinity of Habanero 1 Well on GEL 98, south of Innamincka, South Australia

A Report to the

Yandruwandha/Yawarrawarrka Native Title Claimant Group

and

Geodynamics Limited

Level 2, 349 Coronation Drive
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Queensland 4064

A Report prepared by:

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Final Report

October 2002

Summary

An examination and Work Area Clearance of the proposed Geodynamics Limited development areas on Geothermal Exploration Licence (GEL) 98 south of Innamincka, South Australia has been conducted and is discussed in this report. A work area clearance, cultural heritage survey and archaeological assessment was undertaken during October 2002 in order to examine the areas that are to be affected by these proposed developments. The survey concentrated on the four proposed drilling locations, an existing drill hole, McLeod 1, which is to be used as a water bore for the drilling activities, access routes and a water dam location which were located on the landscape with the assistance of the Geodynamics Limited representative using a handheld GPS (Global Positioning System) utilising coordinates supplied by Geodynamics Limited.

The area was examined by the archaeologist and two Yandruwandha representatives and two Yawarrawarrka representatives of the Yandruwandha/Yawarrawarrka Native Title Claimant Group, accompanied by Doone Wyborn of Geodynamics Limited on the 13/10/2002. Doone Wyborn explained the practicalities of construction and operation for the proposed drilling sites and indicated at each location the suggested position of all access routes and infrastructure. All of the proposed drilling areas, access routes and associated water dam location were examined and cleared for the proposed developments by those stakeholders present.

The October 2002 survey was undertaken with the permission and involvement of the Yandruwandha/Yawarrawarrka Native Title Claimant Group. The Yandruwandha/Yawarrawarrka Native Title Claimant Group were supplied with copies of the draft of this report and have supplied an endorsement of its findings and recommendations to the consultant after they had examined it and discussed its contents.

A Geographic Information System (GIS) search of the Register of Aboriginal Sites and Objects, maintained by Department of State Aboriginal Affairs, has been conducted and there are no legally protected (under the South Australian *Aboriginal Heritage Act* [1988] as amended) Aboriginal Sites included on the Register that are located in any of these development areas. There are a number of Reported Aboriginal Sites in the vicinity of this development. The closest of these is located 200 metres to the south of the Habanero 1 drilling site. The recommendations for access routes in this report take into account these locations and the proposed development activities will not have any impact on these protected areas as long as the recommended access routes only are used and all other recommendations contained in this report are adhered to.

Recommendations

The Yandruwandha/Yawarrawarrka Native Title Claimant Group has recommended that the proposed developments should go ahead subject to Geodynamics Limited and their contractors' full compliance with the restrictions recommended in *Appendix 1: Recommended access routes and other restrictions*, which forms a part of this report. The Aboriginal representatives conducting the Work Area Clearance state that the Geodynamics Limited developments will cause no impacts on any areas or objects that are known to be of cultural importance if a strategy of site avoidance, based on these recommendations and the results of the Work Area Clearance survey, is implemented. Some cultural material and Aboriginal archaeological sites were discovered during the heritage assessment and work area clearance, these were located away from the negotiated development areas on rocky outcrops, in deflations at the edges of claypans, sand dunes and sand ridges. It is recommended that all activities and access are restricted to those areas given clearance and that all personnel should not disturb any Aboriginal cultural sites or cultural material. It is recommended that all personnel should access all development areas from seismic lines or established roads, tracks or fence lines, or recommended access routes. Access routes to the proposed drilling sites have been nominated in order to restrict possible impacts to cultural sites. It is recommended that the all rocky outcrops, eroded areas, the edges of claypans, sand dunes and sand ridges be avoided, as much as possible, during all development activities and any future activities.

As the South Australian *Aboriginal Heritage Act (1988)* (as amended) provides possible protection for any previously unknown sites or archaeological material that may be discovered during the development process, it is advisable that any earthworks or excavations be conducted with the exercise of due care by the machine operators doing the work.

In the event of Aboriginal cultural material being exposed it is advised that all development work that could impact on any material of cultural or scientific significance should cease immediately. In South Australia an assessment must then be made by staff of the Heritage Team of the Department of State Aboriginal Affairs (DoSAA) and the relevant Aboriginal Heritage organisation, in this instance the Yandruwandha/Yawarrawarrka Native Title Claimant Group. At that time a determination under Section 12 of the South Australian *Aboriginal Heritage Act (1988)* (as amended) can be made, in order to determine what appropriate action should be taken.

Telephone Contacts:

Yandruwandha and Yawarrawarrka Native Title	(08) 8414 3382
Claimants Legal Representative	Contact Person: Michael Steele
State Aboriginal Heritage Committee	(08) 8226 8900
	Contact Person: Leonie Casey (Chairperson)

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Plate 2: Work Area Clearance team on site at GDMW 1, at 475827E/6925004N

Plate 3: Work Area Clearance team on site at GDMW 2, at 474585E/6921571N, with (from left to right) Doone Wyborn, Aaron Paterson and Sneider Brown (in the background)

Plate 4: Work Area Clearance team on site at GDMW 3, at 477186E/6921720N, with (from left to right) Doone Wyborn, Sneider Brown and Aaron Paterson

Plate 5: Work Area Clearance team on site at McLeod 1, with (from left to right) Aaron Paterson, Patrick Ferguson, Doone Wyborn, Sneider Brown and Donald Paterson

Plate 6: Proposed dam site, taken from 476870E/6922468, looking east

Plate 7: Yandruwandha/Yawarrawarrka Native Title Claimant Group examining the Work Area Clearance Agreement, with (from left to right) Patrick Ferguson, Donald Paterson, Aaron Paterson, and Sneider Brown

Plate 8: Patrick Ferguson and Aaron Paterson (from left to right) signing the Work Area Clearance Agreement on behalf of the Yandruwandha/Yawarrawarrka Native Title Claimant Group

Acknowledgments:

I would like to thank the following people for their help on the project:

Yandruwandha representatives Aaron Paterson (Public Officer and Work Area Clearance Coordinator), and Donald Paterson; with Yawarrawarrka representatives Sneider Brown and Patrick Ferguson (Work Area Clearance Coordinator) of the Yandruwandha /Yawarrawarrka Native Title Claimant Group who acted as field assistants and community consultants during the Work Area Clearance (WAC).

Michael Steele and Shaun Berg, of Hunt and Hunt, legal representatives for the Native Title Claimant Group for their assistance in liaising with Geodynamics Limited and organising the WAC. Ewan Vickery, of Minter Ellison, legal representative for Geodynamics Limited, for his prompt attention to the communications required to organise this WAC.

Leonie Casey, Chair of the State Aboriginal Heritage Committee and the members of the State Aboriginal Heritage Committee for their help and assistance at various stages of this project.

Darren Hincks, Site Registrar, and other staff of the Heritage Team of the Department of State Aboriginal Affairs (DoSAA).

Doone Wyborn, Executive Director-Science and Exploration, Geodynamics Limited, for his help in organising and facilitating the work area clearance and his input on explaining the realities of the proposed geothermal power generation project and the required infrastructure and all of the impacts of the first stage of the project on the landscape.

1.0 Introduction

1.1 The Study Area

The study areas are located on Geothermal Exploration Lease (GEL) 98, located in the Cooper Basin, and consist of the proposed Geodynamics Limited development areas at, and nearby to, the proposed Habanero 1 Well (on Innamincka Station). There are three other drilling locations and a water dam location all of which are located in close proximity to Habanero 1 and are situated in an area approximately between six and ten kilometres due south of the township of Innamincka, east of the Strzelecki Creek, in the far north eastern corner of South Australia (see Figures 1&2 and Plate 1).

1.2 Legislation

This Work Area Clearance and survey was carried out in accordance with the Work Area Clearance Agreement between the Yandruwandha/Yawarrawarrka Native Title Claimant Group and Geodynamics Limited. It was conducted under the provisions of the South Australian *Aboriginal Heritage Act (1988)* (as amended) and with the involvement, advice and co-operation of the relevant Aboriginal organisation, in this instance the Yandruwandha/Yawarrawarrka Native Title Claimant Group (see Appendix 2: Relevant Communications). Advice was also sought from the Heritage Team of the Department of State Aboriginal Affairs, the government department charged with administering and enforcing this *Act*.

The South Australian *Aboriginal Heritage Act (1988)*[as amended] legally protects registered Aboriginal Sites or Objects and gives guidelines when dealing with possible items or areas of significance to Aboriginal Heritage.

Section 3 of the South Australian *Aboriginal Heritage Act (1988)* defines an Aboriginal site as being an area of land:

- a) that is of significance according to Aboriginal tradition;
- or
- b) that is of significance to Aboriginal archaeology, anthropology or history

Section 3 of the *Act* also defines an Aboriginal object as an object:

- a) that is of significance according to Aboriginal tradition;
- or
- b) that is of significance to Aboriginal archaeology, anthropology or history

Section 3 of the *Act* also defines Aboriginal tradition as

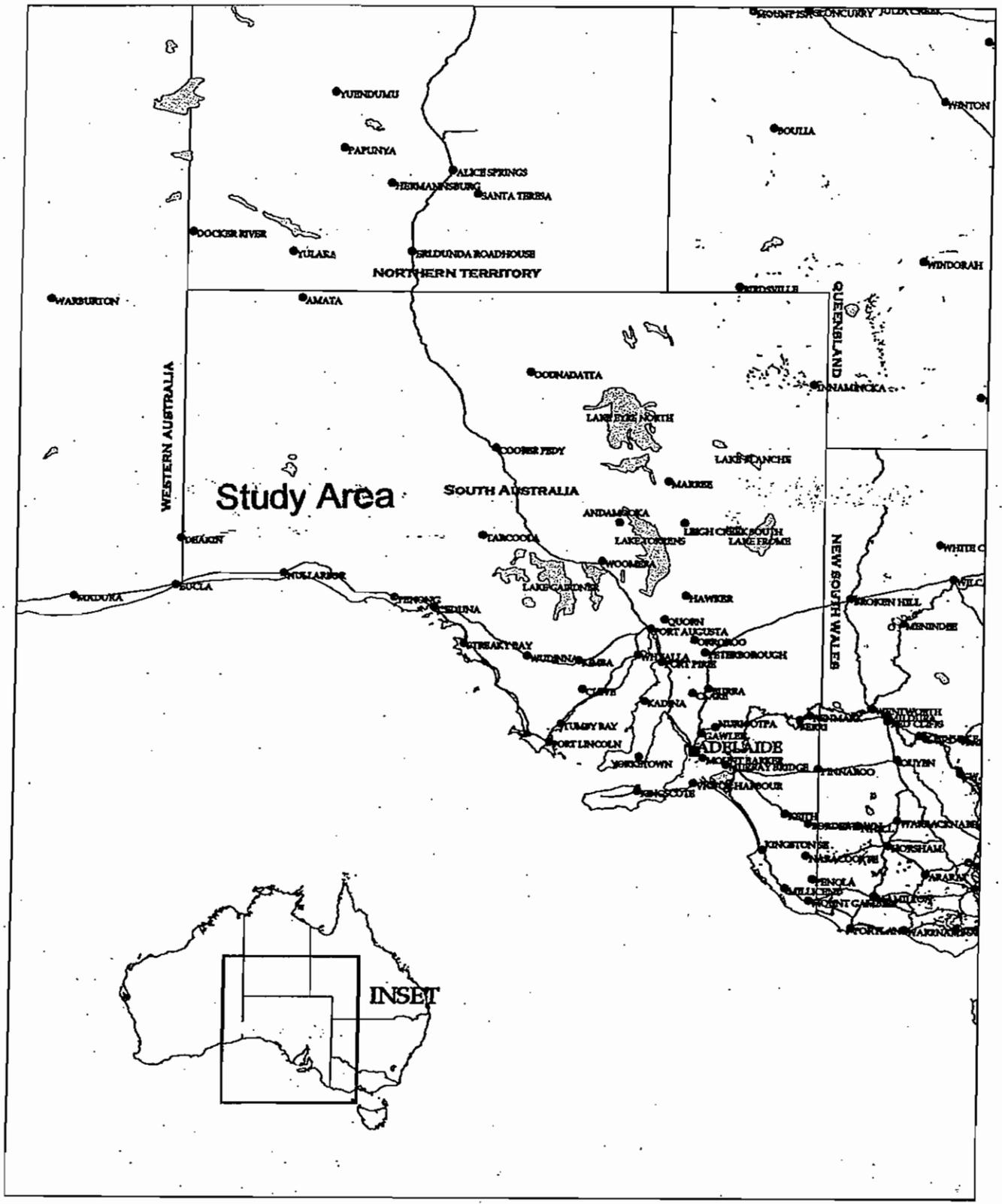


Figure 1: Location of study area

Schedule 1 - Land

See attached maps, Map 1 (regional location) and Map 2 (location of project components in Schedule 2).

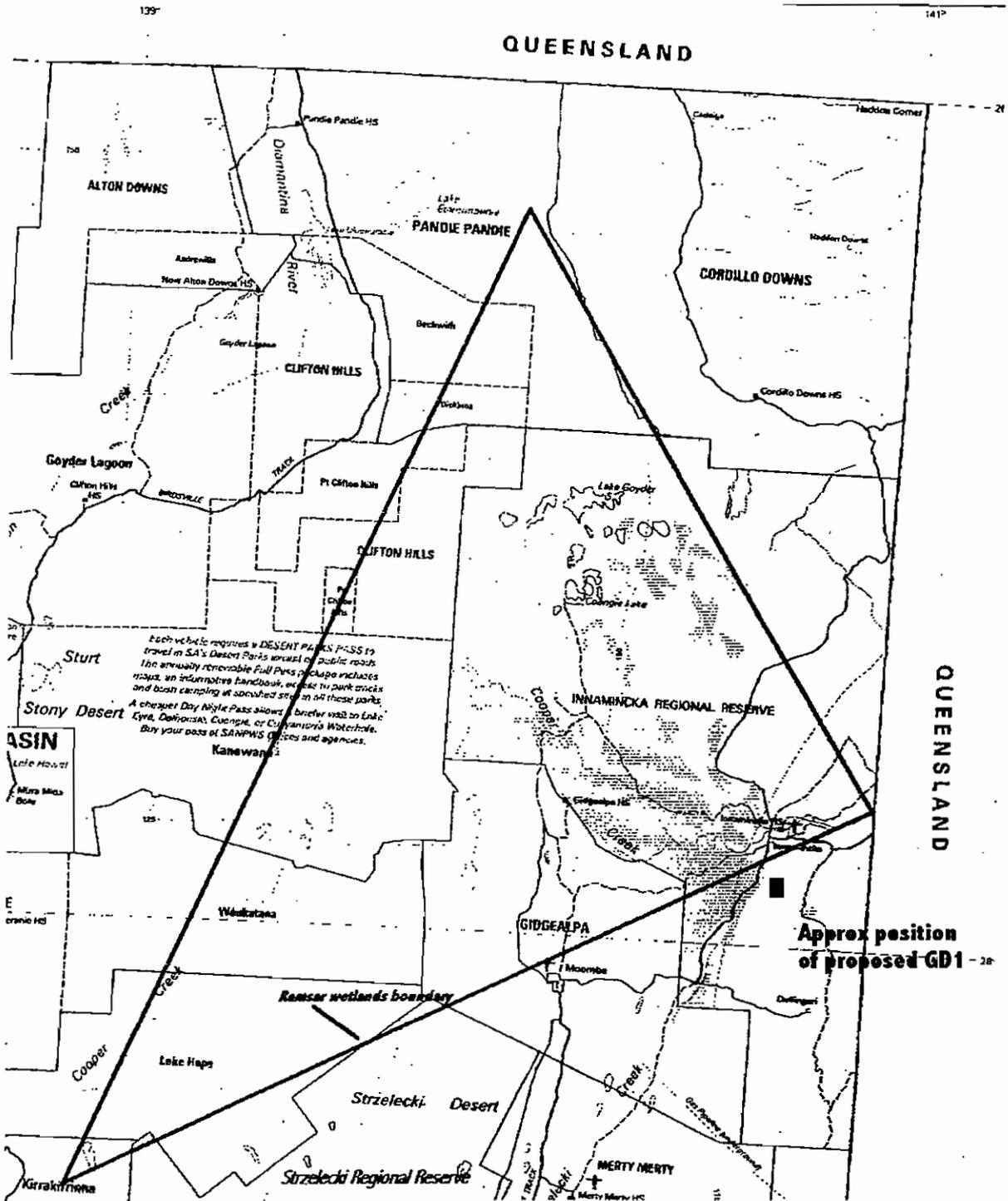


Figure 1. General location of Geodynamics GD1 wellsite in relation to Innamincka Regional Reserve, Ramsar Wetlands and local infrastructure. (Map base: DENR Pastoral areas 1:250000, 1993)

Figure 2: The Innamincka area with the location of study area



Plate 1: Aaron Paterson, Doone Wyborn, Donald Paterson (in the background), Sneider Brown and Patrick Ferguson (from left to right) on survey at Habanero 1, from 475846E/6923167, looking east



Plate 2: Work Area Clearance team on site at GDMW 1, at 475827E/6925004N

...traditions, observances, customs or beliefs of the people who inhabited Australia before European colonisation and includes traditions, observances, customs and beliefs that have evolved or developed from that tradition since European colonisation.

Section 23 of the South Australian *Aboriginal Heritage Act (1988)* (as amended) gives legal protection to all registered Aboriginal sites and objects in South Australia. The *Act* makes it a legal offence attracting a fine and/or imprisonment to damage, disturb or interfere with Aboriginal sites or objects without the permission and written authorisation of the appropriate Minister.

This protection is accorded when the site or object has been determined to be of significance according to Aboriginal tradition, or of significance to Aboriginal archaeology, anthropology or history. If this has been determined, under Section 12 of the *Act*, then the site can be registered as an Aboriginal site on the Register of Aboriginal Sites and Objects, which is maintained by the Department of State Aboriginal Affairs.

Section 20 of the *Act* puts an onus of responsibility on landowners and occupiers of private land to inform the Minister if Aboriginal sites or objects are discovered on the landscape. Potential Aboriginal sites or objects (in regard to the definition set out in Section 3 of the *Act*) that may be discovered during a Work Area Clearance, Cultural Heritage survey or in site development work need to be assessed by the Minister in order to determine whether the newly discovered site or object should be included on the Register of Aboriginal Sites and Objects. A determination can be requested from the appropriate Minister under Section 12 of the *Act*, if the person (the developer in this instance) who proposes to take action in relation to the newly discovered site or object and feels that that action may constitute an offence under Section 23 of the *Act*.

If registered sites or objects are to be impacted upon or destroyed in the process of a development a permit to destroy (under Section 23 of the *Act*) must be gained from the Minister. The *Act* also could protect previously unknown sites or archaeological material that may be discovered during the development process if they are subsequently be determined to be an Aboriginal site or object under Section 12 of the *Act* and therefore eligible for inclusion on the Register of Aboriginal Sites and Objects. Therefore it is advisable that any earthworks or excavations be conducted with due care by the machine operators doing the work in order to prevent a possible breach of Section 23 of the *Act*.

The full text of some of the sections of the *Act* has been included as an appendix to this report for information and reference by the stakeholders in this process (see Appendix 3: Sections 12, 20, 21, 22 and 23 of the South Australian *Aboriginal Heritage Act 1988* [as amended]).

2.0 The Proposed Development

2.1 Extent, nature and timing of the development

Geodynamics Limited is currently planning for works at an experimental geothermal drilling lease on GEL 98, located in an area six to ten kilometres to the south of the township of Innamincka, in the far north east of South Australia (see Figures 2&3).

The scope of this Work Area Clearance program was limited to a number of areas associated with the development of the above experimental well sites. These areas included one proposed deep drill hole location, Habanero 1 (see Plate 1); as well as three shallow monitoring drill hole locations GDMW 1, 2&3 (see Plates 2, 3&4); an already existing Santos oil/gas drill hole at McLeod 1 (see Plate 5) which will be utilised during drilling and experimental activities as a water bore; a water dam location (see Plate 6) and all necessary associated access routes.

The following is taken from Schedule 2 - Clearance Survey Request of the Work Area Clearance Agreement between Geodynamics Limited and the Yandruwandha/Yawarrawarrka Native Title Claimant Group, signed on 13 October 2002 (see Plate 7), and describes the scope of the project and the requirements for the Work Area Clearance:

Geodynamics Limited – Aboriginal Heritage Clearance Survey - GEL 98

Proposed drilling and requirements

Geodynamics Ltd proposes deep drilling within the Cooper Basin at GD1 (27° 48.973' S 140° 45.248' E), approximately 450m WSW of the suspended McLeod 1 well. The well site immediately adjoins the new Strzelecki Track ("Dillon's Highway") approximately 8 km south of Innamincka. Three additional shallow monitoring wells are proposed, currently at GDMW1 (27° 47.956' S 140° 45.283' E), GDMW2 (27° 49.902' S 140° 44.508' E) and GDMW3 (27° 49.739' S 140° 46.101' E).

The primary well, GD1, will require the equivalent of a 1.5 ha petroleum drilling lease, and pad development to permit a large rig. In this respect, the requirements of the lease and pad (sumps, rubbish disposal, muds and liquids handling) will be equivalent to that for petroleum exploration. Some fill may be required to cover the gibber surface to make level. The fill will be sourced from the sump or from an adjacent Transport SA borrow pit.

The monitoring wells will require only minor pad development, as these will be drilled using water well rigs rather than full-scale petroleum drilling equipment. Accordingly, both access to, and any pad construction associated with monitoring wells will be low-key. The suspended Santos McLeod 1 well will also be used for monitoring purposes, and is also expected to be used as a supply of water pending agreement from Santos.

Proposed dam and requirements

A dam of maximum cubic volume 20,000 m³ (100m x 100m x 2m) is required within a few hundred metres of the primary well. The site requires a reasonable clay seal will minimal earthmoving needed

for construction. These conditions locally are met in clay swales within the dunefield adjoining the proposed GD1 well. The proposed location, is a clay pan approximately 500m south of the McLeod 1 well at 27° 49.203' S 140° 45.564' E . The dam will be constructed with a scraper and grader with access south from McLeod 1 well. A connection pipe will be required between the well and the dam and the dam and GD1. The pipeline is temporary and will be laid on the surface.

Proposed Camp Site

The camp site required for the drilling of the deep well and associated activities is proposed immediately north of the well site GD1 also adjacent to the Dillon's Highway.

Proposed Access Routes

There is no requirement for road construction. The main well, camp and dam are all accessible without requirement to form an access track.

Access to the three monitoring wells will require minimal disturbance. Only a truck mounted water rig is needed to drill these wells. Access to GDMW1 will require some rolling of the gibber surface on slopes of approximately 2 degrees. Access to GDMW2 is along an existing seismic line (Line 83-NCS). Access to GDMW3 is across flat land in a swale and requires no surface preparation.

The location of the various sites is shown in the diagram below (See Figure 3).

The grid coordinates of the main sites are listed in the following Table.

Feature	Easting (GDA grid)	Northing (GDA grid)
GD1	475823	6923108
Dam	476320	6922770
GDMW1	475840	6925006
GDMW2	474575	6921560
GDMW3	477187	6921717

The person attending the heritage clearance survey will be

Dr Doone Wyborn
 Executive Director - Science and Exploration
 Geodynamics Limited
 PO Box 2046
 Milton, Qld 4064
 Ph 07-38768955
 Fax 07-38768966
 Mobile 0407 608 692
 Email dwyborn@geodynamics.com.au

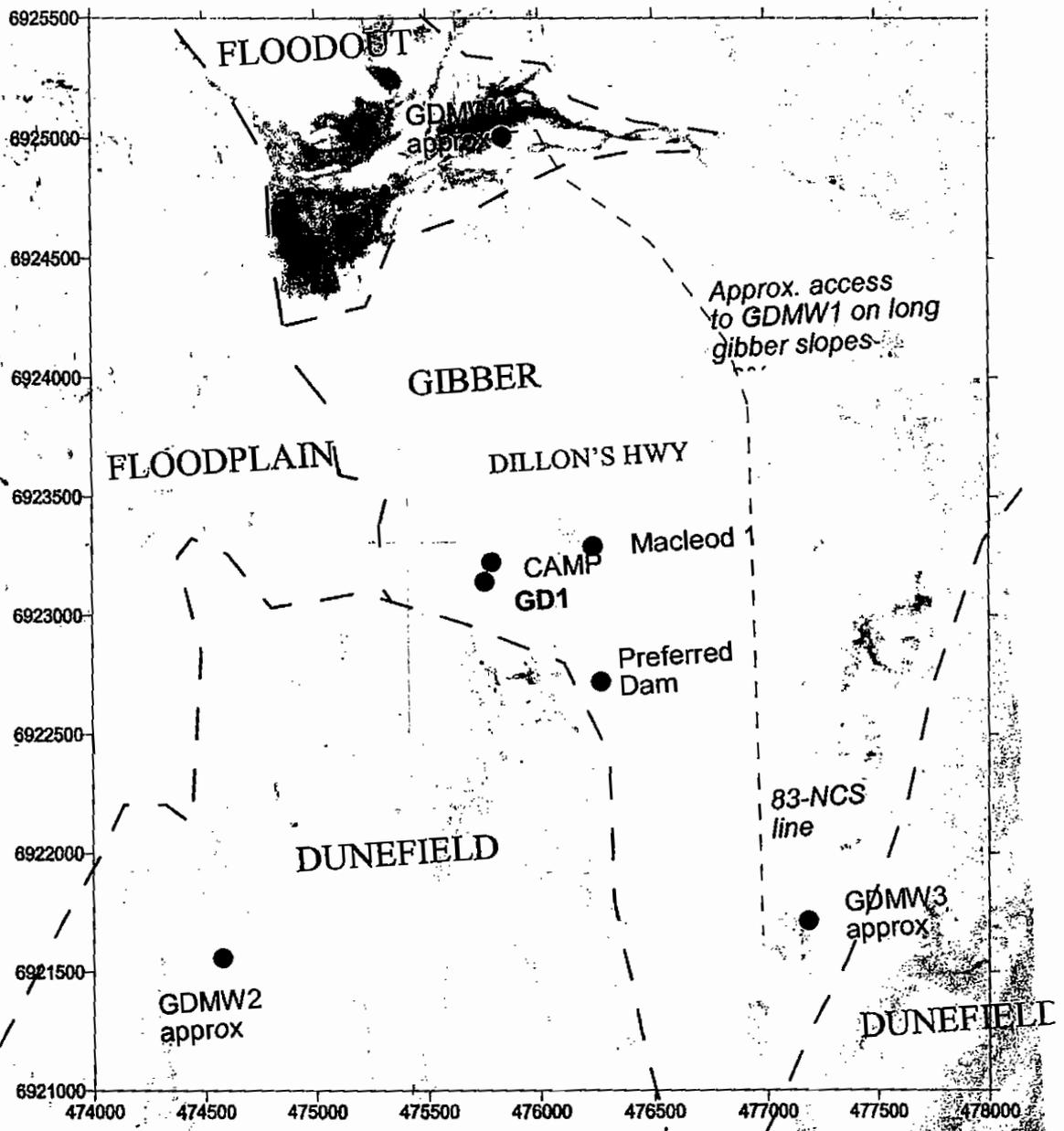


Figure 3: Aerial photography of the study area with the location of the proposed Geodynamics Limited developments



Plate 3: Work Area Clearance team on site at GDMW 2, at 474585E/6921571N, with (from left to right) Doone Wyborn, Aaron Paterson and Sneider Brown (in the background)



Plate 4: Work Area Clearance team on site at GDMW 3, at 477186E/6921720N, with (from left to right) Doone Wyborn, Sneider Brown and Aaron Paterson

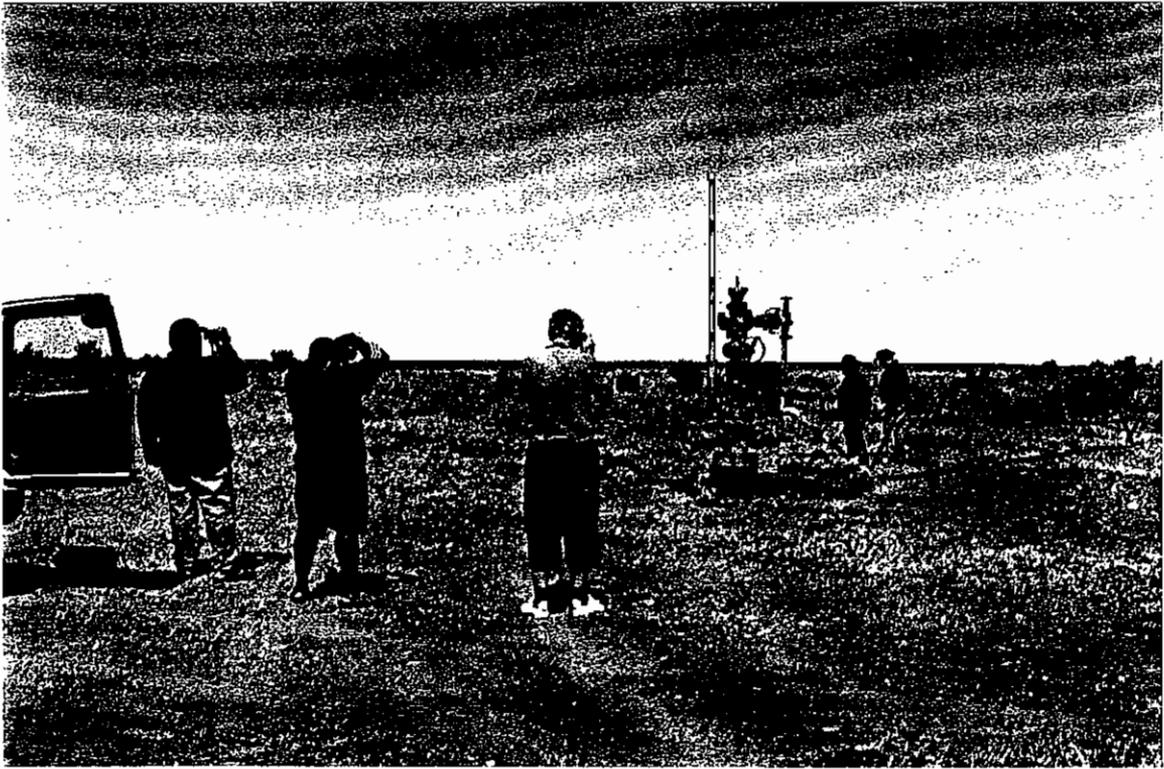


Plate 5: Work Area Clearance team on site at McLeod 1, with (from left to right) Aaron Paterson, Patrick Ferguson, Doone Wyborn, Sneider Brown and Donald Paterson



Plate 6: Proposed dam site, taken from 476870E/6922468, looking east

3.0 Archaeology

3.1 The Central Archive

An examination of the Central Archive (including the Site Register), which is maintained by the Department of State Aboriginal Affairs (DoSAA) is usually conducted in this type of Aboriginal Heritage survey.

The Central Archive houses site cards, consultancy reports and other documentation for over 4,000 registered and 1,400 reported Aboriginal sites. It contains information about the types of Heritage sites that have been recorded in the state of South Australia are protected by the *Aboriginal Heritage Act (1988)*(as amended). A study of these records indicates whether a registered site or object is present in a proposed development area and also helps to predict the types of Aboriginal sites that might be found in an area of proposed developments. This information is then used in determining the potential of a proposed development to impact on registered or previously unrecorded Aboriginal sites and other areas of cultural significance.

Access to non-confidential reports held in the Central Archive is on application and access to non-confidential site cards is available on application, with the written approval of the relevant Aboriginal heritage committee.

Under Section 12(3) of the *Act* on application for activities that may impact on Aboriginal sites the Minister must provide the applicant the location of sites that may be impacted by the development. The Minister must also provide sufficient information on confidential sites to the applicant in order to avoid damage to sites but does not necessarily have to provide the exact location of the site (under Section 10 [1c] of the *Act*).

A Geographic Information System (GIS) search of the Register of Aboriginal Sites and Objects, maintained by Department of State Aboriginal Affairs, has been conducted and there are no legally protected (under the South Australian *Aboriginal Heritage Act* [1988] as amended) Aboriginal Sites included on the Register that are located in any of these development areas. There are a number of Reported Aboriginal Sites in the vicinity of this development. The closest of these reported Aboriginal sites is located 200 metres to the south of the Habanero 1 drilling site and the proposed development activities should have no impact on this site. The recommendations for access routes in this report take into account these locations and development activities will not have any impact on these protected areas as long as the recommended access routes only are used and all other recommendations in this report are adhered to.

4.0 Consultation with the Yandruwandha/Yawarrawarrka Native Title Claimant Group

Geodynamics Limited consulted with the Yandruwandha/Yawarrawarrka Native Title Claimant Group and their legal representative prior to the archaeologist being awarded the consultancy for this project. The Work Area Clearance was requested by Geodynamics Limited in accordance with the Work Area Clearance Agreement between the Yandruwandha/Yawarrawarrka Native Title Claimant Group and Geodynamics Limited.

A Work Area Clearance Agreement has been entered into between Geodynamics Limited and the Yandruwandha/Yawarrawarrka Native Title Claimant Group. The Agreement was signed at the site of the deep drill hole site on the 13/10/2002 by Aaron Paterson and Patrick Ferguson for the Native Title Claimants (see Plates 7&8) and by Doone Wyborn on behalf of Geodynamics Limited before the Work Area Clearance was conducted. The Agreement outlined the rights and responsibilities of all parties involved in the Work Area Clearance process. This process included consultation which was conducted in order to explain the exact nature of the development, to organise the survey and the participation of representatives of the Yandruwandha/Yawarrawarrka Native Title Claimant Group to act as community consultants. The consultation process also allows the Aboriginal stakeholders to inform, as far as possible, the consultant and the developers whether there are any Aboriginal sites in the development area that are identified by Tradition or have other cultural significance and therefore not cleared for development activities.

Prior to, and during, the site clearance maps, aerial photographs and the Geodynamics Limited site plans of the proposed development areas were shown to the community representatives and the exact nature of the developments in each area was discussed. The nature and impacts of the development in each area surveyed was discussed during the survey and its potential impacts on the archaeology of the area was considered as a part of this process. Four community representatives with a male archaeologist formed the survey team. The Yandruwandha/Yawarrawarrka Native Title Claimant Group have been supplied copies of the draft of this report and have endorsed the findings and recommendations of the draft report and have supplied feedback to the consultant stating this.

This response from the Aboriginal stakeholders is supplied to the consultant concerning the draft report, in order to state their opinion concerning the proposed development and its impact (if any) on the Aboriginal heritage of an area; as well as the Work Area Clearance and associated draft report.



Plate 7: Yandruwandha/Yawarrawarrka Native Title Claimant Group examining the Work Area Clearance Agreement, with (from left to right) Patrick Ferguson, Donald Paterson, Aaron Paterson, and Sneider Brown



Plate 8: Patrick Ferguson and Aaron Paterson (from left to right) signing the Work Area Clearance Agreement on behalf of the Yandruwandha/Yawarrawarrka Native Title Claimant Group

5.0 The Survey

5.1 Survey design and method

Prior to the site inspection the project brief, maps, design plans (supplied by Geodynamics Limited) and detailed aerial photographs showing the areas of the Geodynamics Limited proposed developments on GEL 98 that are to be modified. The nature and extent of the development was also discussed. The clearance team was accompanied for the work area clearance by Doone Wyborn, Executive Director-Science and Exploration, Geodynamics Limited, who showed the clearance team the locations of the four proposed drilling locations, suggested access routes, water dam and associated infrastructure. Mr Wyborn also discussed the exact nature of the geothermal power generation process as well as all of the impacts of the construction with the archaeologist and the Yandruwandha/Yawarrawarrka Native Title Claimant Group's representatives.

The survey strategy used was to examine 100% of the exposed ground surface at all of the proposed development sites associated with the developments. In this type of foot survey a distance of 10 metres is usually maintained between each of the observers, this is the accepted optimum distance for the most efficient and effective coverage for site surveys. Some of the areas that had greater ground cover were examined using a closer spacing of the observers (between 5-10 metres). All areas were examined with the aid of Geodynamics Limited site plans and with the assistance of the Geodynamics Limited representative (see Plates 1-6).

Photographs were taken at all places where archaeological material was found, photographs were also taken at some of the development site locations in order to document the present ground surface and the vegetation present at the time of the field inspections.

Discussions were held with the Native Title Claimant Group representatives at the development site during the surveys in order to gain their opinion concerning the proposed development areas to Aboriginal Heritage and effects that the development would have on the archaeological material discovered during the clearance. The WAC team also decided on alternative access routes and restrictions on the developments that would ensure that all cultural sites and material would not be impacted by the proposed activities. The results of ground surface survey were also discussed as well as the potential of sub-surface material being present in any of these areas.

7.2 Constraints on the surveys

The ground surface in some of the development locations in the study areas was partially to completely obscured (varying from 0%-100% cover) by vegetation cover. It is possible that some

archaeological material may have been present in the study area but may have been obscured from view because of the vegetation cover in the area at the time of the survey.

6.0 Survey Results

There were a number of places that were identified during the Work Area Clearance Program that contained archaeological material and were places of significance to the Aboriginal representatives on the site inspections found in the study area location. These areas were all located away from the negotiated development and access areas and were associated with the sand dunes and sand ridges at the edges of the claypan that is to be used for dam construction.

The archaeological material found consisted predominantly of flaked and ground stone artefacts with some areas containing charcoal staining from Aboriginal campfires, as well as nodules of rock that appeared to have been used as heat retainers in Aboriginal ovens.

The Yandruwandha/Yawarrawarrka Native Title Claimant Group has recommended that the developments can proceed in all of the development areas that were inspected during the clearance as long as all activities and impacts are restricted to those areas nominated in Appendix 1: Recommended access routes and other restrictions.

9.0 Assessment of significance

There were a number of places discovered during this survey that can be assessed in terms of cultural or scientific significance. It is therefore useful to include a brief summary of the terminology and the process for reference for all of the stakeholder parties.

It is possible that other previously unknown Aboriginal sites or cultural material may be discovered during the development process and if this occurs the following set of criteria will also need to be applied.

9.1 Criteria for significance assessment

The South Australian *Aboriginal Heritage Act (1988)* defines a site as being an area of land:

"a) that is of significance according to Aboriginal tradition;

or

b) that is of significance to Aboriginal archaeology, anthropology or history"

The *Act* defines 'Aboriginal tradition' as

"...traditions, observances, customs or beliefs of the people who inhabited Australia before European colonisation and includes traditions, observances, customs and beliefs that have evolved or developed from that tradition since European colonisation."

There are a number of different considerations that affect the assessment of the significance of cultural heritage:

Aboriginal significance - how the site/area is viewed in terms of significance by the local Aboriginal community, in this case the Yandruwandha/Yawarrawarrka Native Title Claimant Group

Research/scientific potential of a site or an area, this is based on a number of considerations including the site's contents, structure and integrity

Heritage value - the value that a site has to benefit the general public aesthetically or educationally

9.2 Effects of proposed Geodynamics Limited development sites on Cultural Heritage

There will be no impacts by this project on known areas or sites, if the strategy of site avoidance is fully implemented. There is a slight possibility that previously undiscovered Aboriginal sites or cultural material may be affected during the construction of these proposed Geodynamics Limited developments.

If an archaeological site or cultural material is encountered during the construction of this development it will then be necessary for the developer to stop all works in that area and to inform the Yandruwandha and the Yawarrawarrka Native Title Claimant Groups and it may be necessary for the developer to apply to the Minister of Aboriginal Affairs for a determination under Section 12 of the South Australian *Aboriginal Heritage Act (1988)* (as amended). If the site is determined to be an Aboriginal Site and subsequently registered it is still possible to continue development activities if an authorisation by the Minister under Section 23 of the *Act* is issued in order to continue activities that may damage or destroy that site.

10.0 Recommendations

The Yandruwandha/Yawarrawarrka Native Title Claimant Group has recommended that the proposed developments should go ahead subject to Geodynamics Limited and their contractors' full compliance with the restrictions recommended in *Appendix 1: Recommended access routes and other restrictions*, which forms a part of this report. The Aboriginal representatives conducting the Work Area Clearance state that the Geodynamics Limited developments will cause no impacts on any areas or objects that are known to be of cultural importance if a strategy of site avoidance, based on these recommendations and the results of the Work Area Clearance survey, is implemented. Some cultural material and Aboriginal archaeological sites were discovered during the heritage assessment and work area clearance, these were located away from the negotiated development areas on rocky outcrops, in deflations at the edges of claypans, sand dunes and sand ridges. It is recommended that all activities and access are restricted to those areas given clearance and that all personnel should not disturb any Aboriginal cultural sites or cultural material. It is recommended that all personnel should access all development areas from seismic lines or established roads, tracks or fence lines, or recommended access routes. Access routes to the proposed drilling sites have been nominated in order to restrict possible impacts to cultural sites. It is recommended that the all rocky outcrops, eroded areas, the edges of claypans, sand dunes and sand ridges be avoided, as much as possible, during all development activities and any future activities.

As the South Australian *Aboriginal Heritage Act (1988)* (as amended) provides possible protection for any previously unknown sites or archaeological material that may be discovered during the development process, it is advisable that any earthworks or excavations be conducted with the exercise of due care by the machine operators doing the work.

In the event of Aboriginal cultural material being exposed it is advised that all development work that could impact on any material of cultural or scientific significance should cease immediately. In South Australia an assessment must then be made by staff of the Heritage Team of the Department of State Aboriginal Affairs (DoSAA) and the relevant Aboriginal Heritage organisation, in this instance the Yandruwandha/Yawarrawarrka Native Title Claimant Group. At that time a determination under Section 12 of the South Australian *Aboriginal Heritage Act (1988)* (as amended) can be made, in order to determine what appropriate action should be taken.

Telephone Contacts:

Yandruwandha and Yawarrawarrka Native Title	(08) 8414 3382
Claimants Legal Representative	Contact Person: Michael Steelc
State Aboriginal Heritage Committee	(08) 8226 8900
	Contact Person: Leonie Casey (Chairperson)

Appendix 1:

Recommended access routes and other restrictions

Well/area name	Easting WGS84	Northing WGS84	Recommendation
Habanero 1	475823	6923172	Keep area of impact as small as possible
Dam	476320	6922770	All activities to take place in the centre of the depression, all excavations should be closely monitored by machine operators
Access to dam			Along existing track to McLeod 1
Access to dam	476379	6922893	Shortest distance to this point from McLeod 1
Access to dam	476314	6922781	Restriction to low lying area between sand ridges; sand dunes and ridges and the edges of claypans to be completely avoided
Access to GDMW 1	476303	6924410	From closest point on the Dillon Highway to this location on existing gas pipeline
GDMW 1	475840	6925006	Shortest route to this point from above location, avoiding all rocky outcrops
Access to GDMW 2	475001	6921525	Access from the Dillon Highway at this point
GDMW 2	474575	6921560	From above point on the Dillon Highway; sand dunes and ridges and the eroding edges of dunes and ridges to be completely avoided
Access to GDMW 3	476872	6923807	Access to seismic line 83-NCS at this point
GDMW 3	477193	6921713	Sand dunes and ridges and the eroding edges of dunes and ridges to be completely avoided

Appendix 2:

Relevant Communications

ATTENTION: Doone Wyborn

Executive Director

**Geodynamics Ltd
PO BOX 2046 Milton QLD 4064**

**Level 2, 349 Coronation Drive, Milton
Queensland 4064 Australia.**

TELEPHONE NUMBER: +61 7 3876 8955
FACSIMILE NUMBER: +61 7 3876 8966

RE:

***Budget for performing Yandruwandha/Yawarrawarrka -
Geodynamics Work Area Clearance***

FROM:

Sean Freeman

Cultural Heritage Consultant (ABN 70 005 206 036)

PO Box 850
Mt. Barker SA 5251

Telephones:

(08) 8537 5130 (office/home)
(0428) 848 043 (mobile)

Email

seanfreeman@iprimus.com.au

DATE: 9/10/2002

The following budget is based on four representatives of the Yandruwandha/Yawarrawarrka Native Title Claimant Group and one specialist to travel from their respective home bases (Adelaide, Bundaberg, Melbourne and Rockhampton) to the Cooper Basin via Adelaide or Brisbane and return. The specialist will depart from Adelaide to Moomba on Friday 11/10/02, due to flight availability. A hire four wheel drive vehicle will be picked up in Moomba and then travel to Innamincka to conduct the work area clearance. It is intended that the members of the work area clearance team will mobilise on Saturday 12/10/02 to travel from their homes direct to Innamincka via a chartered aircraft from Brisbane. The Geodynamics work area clearance is to be conducted on Saturday/Sunday with the Queensland based team members returning to Brisbane on the charter flight on Monday 14/10/02. The specialist will depart from Innamincka to travel from Moomba to Adelaide on Monday 14/10/02, again due to flight availability.

TOTAL NUMBER OF PAGES INCLUDING COVER SHEET: 2

IF ALL OF THE ABOVE PAGES ARE NOT RECEIVED PHONE:
(0428) 848 043 (mobile)
(08) 8537 5130 (office/home)

MinterEllison

LAWYERS

Work area clearance agreement

Geodynamics Limited (**Geodynamics**)

The Yandruwandha Yawarrawarrka Native Title Claimants
(**Claimants**)

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AUCKLAND WELLINGTON CHRISTCHURCH HONG KONG SHANGHAI JAKARTA
BANGKOK NEW YORK LONDON

Details

Date **October 2002**

Parties

Name **Geodynamics Limited**
ABN **55 095 006 090**
Short form name **Geodynamics**
Notice details **Level 2, 349 Coronation Drive, Milton Queensland 4064**
Facsimile: (07) 3876 8966
Attention: Dr Bertus de Graaf

Name **The Yandruwandha/Yawarrawarrka People**
Short form name **Claimants**
Notice details **c/o Hunt & Hunt Solicitors, 12th Floor, 26 Flinders Street, Adelaide SA 5000**
Facsimile (08) 8211 7362
Attention: Mr Michael Steele

Background

- A Members of the Claimants claim native title in all of the Claimed Land and have filed a Native Title Application under section 13(1) of the Native Title Act 1993 (Commonwealth) (as amended) with the Federal Court of Australia in proceeding Number SG/ 6024/98 for a determination of native title in respect of the Claimed Land.
- B Geodynamics by itself and its subsidiaries has been granted GEL 97 and GEL 98 by the South Australian Minister for Minerals and Energy under the provisions of the Petroleum Act which interests are located within the boundary of the Claimed Land.
- C The grant of the Licences to Geodynamics was not subject to the right to negotiate provisions of the Native Title Act.
- D Geodynamics has a proposal as set out in **Schedule 2**.
- E Geodynamics and Claimants acknowledge that there may be Areas of Significance affected by Geodynamics proposal and this Agreement is intended to:
- (i) assist Geodynamics to avoid damage, disturbance or inference to Areas of Significance by identifying and recording the areas on the Land which are cleared or not cleared by Survey Team in accordance with **clause 5(d)(iii)**;
 - (ii) set out the procedures which must be followed by Geodynamics to obtain Clearance from the Claimants; and
 - (iii) ensure that Geodynamics meets its obligations under laws relating to Aboriginal Heritage including the *Aboriginal Heritage Act* and the *Aboriginal and Torres Strait Islander Heritage Protection Act (1984) Cth*.

Signing Page

EXECUTED as an agreement.

Signed for and on behalf of Geodynamics Limited by its duly authorised officer
Dr Doone Wyborn in the presence of:



Signature of witness

G. A. MATTHEWS

Name of witness (print)



Signed for and on behalf of Claimants

by PATRICK FERGUSON
in the presence of:



Signature of witness

SEAN FREEMAN

Name of witness (print)



Signed for and on behalf of Claimants

by Aaron Paterson
in the presence of:



Signature of witness

SEAN FREEMAN

Name of witness (print)



Sean Freeman

From: "Darren_Hincks" <Darren_Hincks@dosaa.sa.gov.au>
To: "Sean Freeman" <seanfreeman@iprimus.com.au>
Sent: Tuesday, 15 October 2002 4:49 PM
Attach: innamincka 2.jpg
Subject: RE: Geodynamics Ltd proposed drilling and dam
Sean

Please find attached a jpeg image showing Innamincka and the two sites we discussed.

Darren

-----Original Message-----

From: Sean Freeman [mailto:seanfreeman@iprimus.com.au]
Sent: Tuesday, 15 October 2002 1:10 PM
To: Darren_Hincks
Subject: Geodynamics Ltd proposed drilling and dam locations

Darren,

Please find attached a word document containing a regional map and aerial photograph of the proposed drilling and dam locations.

Cheers,

Sean

Sean Freeman
Archaeologist & Cultural Heritage Consultant
PO Box 850
Mount Barker SA 5251
Australia

Telephones:
08 8537 5130 (SA office/home)
0428 848 043 (mobile)
03 9419 4236 (Victorian office)

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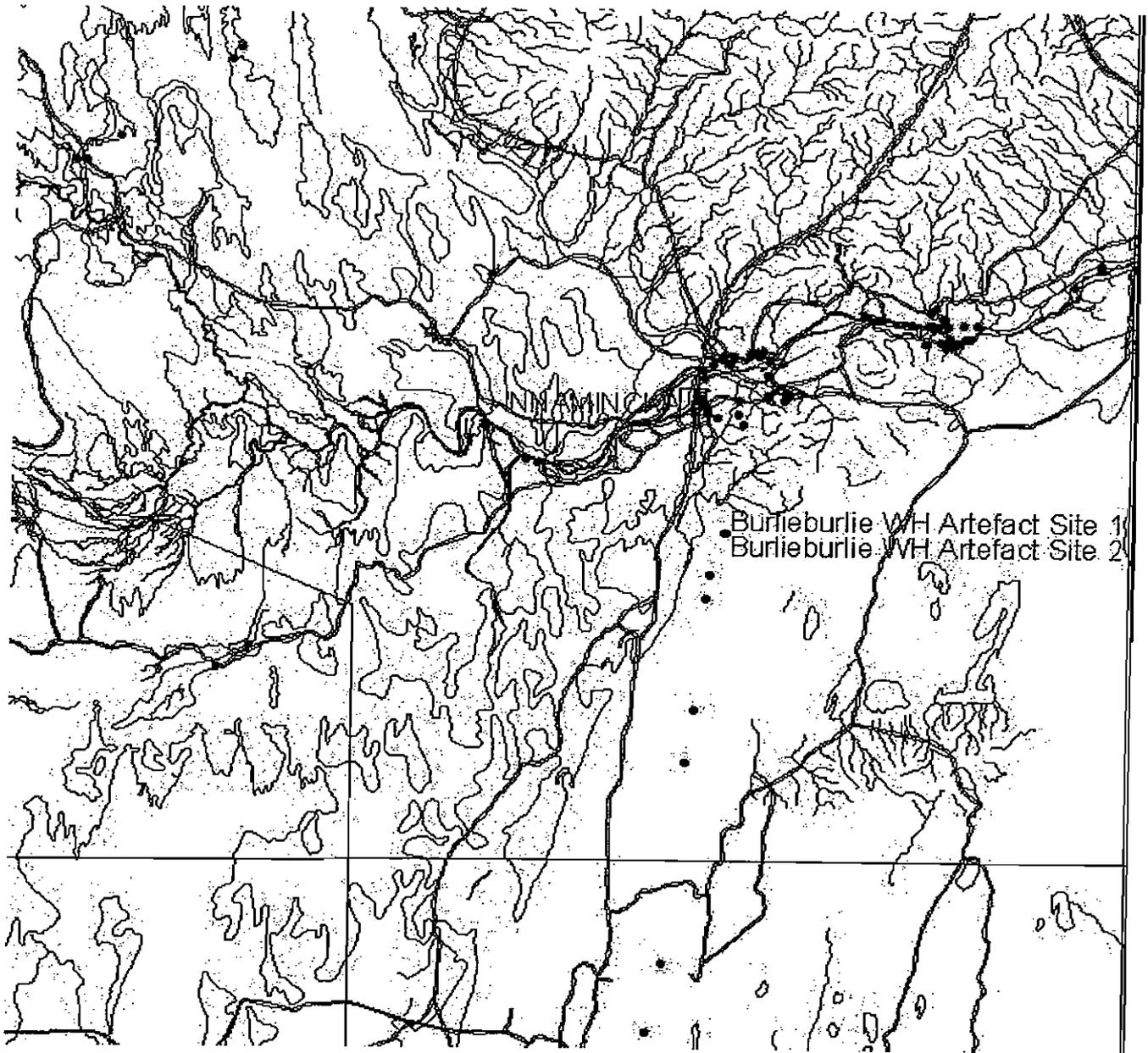
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17/10/02



Appendix 3:

**Sections 12, 20, 21, 22 and 23 of the South
Australian *Aboriginal Heritage Act 1988* (as
amended)**

ABORIGINAL HERITAGE ACT 1988 - SECTION 20

Discovery of sites, objects or remains

20. (1) An owner or occupier of private land, or an employee or agent of such an owner or occupier, who discovers on the land

- (a) an Aboriginal site; or
- (b) an Aboriginal object or remains,

must, as soon as practicable, report the discovery to the Minister giving particulars of the nature and location of the site, object or remains.

Penalty: (a) in the case of a body corporate \$50 000;
(b) in any other case \$10 000 or imprisonment for 6 months.

(2) This section does not apply to the traditional owner of the site or object or to an employee or agent of the traditional owner.

(3) The Minister may direct a person making a report to take such immediate action for the protection or preservation of the remains as the Minister considers appropriate.

(4) A person must not, without reasonable excuse, fail to comply with a direction of the Minister under this section.
Penalty: \$2 000 or imprisonment for 3 months.

ABORIGINAL HERITAGE ACT 1988 - SECTION 21

Excavating sites, objects or remains

21. A person must not, without the authority of the Minister, excavate land for the purpose of uncovering any Aboriginal site, object or remains.

Penalty: (a) in the case of a body corporate \$50 000;
(b) in any other case \$10 000 or imprisonment for 6 months.

ABORIGINAL HERITAGE ACT 1988 - SECTION 22

Access to and excavation of land by authorised persons

22. (1) Where the Minister has reason to believe that any Aboriginal site, object or remains have been or may be found on or under any land (including private land), the Minister may authorise a person

- (a) to enter the land; and
- (b) to search for the site, object or remains; and
- (c) to excavate the land.

(2) Before entering any land pursuant to an authorisation under this section, the authorised person must give reasonable notice in writing to the owner and occupier (if any) of the land identifying the land affected.

(3) Where any Aboriginal object or remains, or any object or remains that may be an Aboriginal object or Aboriginal remains, is or are found on the land, the Minister, if satisfied that it is necessary to do so for the protection or preservation of the object or remains, may take possession of the object or remains.

(4) The Minister must make good any damage done to land by a person acting in pursuance of this section.

(5) A person must not, without reasonable excuse, hinder or obstruct a person acting pursuant to an authorisation under this section.
Penalty: \$2 000 or imprisonment for 3 months.

ABORIGINAL HERITAGE ACT 1988 - DIVISION 2

DIVISION 2 PROTECTION OF ABORIGINAL SITES, OBJECTS AND REMAINS

ABORIGINAL HERITAGE ACT 1988 - SECTION 23

Damage, etc., to sites, objects or remains

23. A person must not, without the authority of the Minister

- (a) damage, disturb or interfere with any Aboriginal site; or
- (b) damage any Aboriginal object; or
- (c) where any Aboriginal object or remains are found
 - (i) disturb or interfere with the object or remains; or
 - (ii) remove the object or remains.

Penalty: (a) in the case of a body corporate \$50 000;
(b) in any other case \$10 000 or imprisonment for 6 months.

Appendix D

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census data

Australian Bureau of Statistics



Australian Bureau of Statistics

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2006 Census QuickStats : Innamincka (State Suburb) Quality

Declaration

Latest ISSUE Released at 11:30 AM (CANBERRA TIME) 25/10/2007 LOCATION CODE: SSC43796 STATE: SA

Summary Details Explanatory Notes Related Information Past & Future Releases

- On this page:
- **Person Characteristics** |
- Age |
- Selected Characteristics |
- Country of Birth |
- Main Language Spoken at Home |
- Religious Affiliation |
- Marital Status |
- Labour Force |
- Occupation |
- Industry of Employment |
- Income |
- **Family Characteristics** |
- **Dwelling Characteristics** |
- Dwellings Characteristics Occupied Private Dwellings |
- Tenure Type |
- Household Composition |
- Landlord Type

PERSON CHARACTERISTICS (Place of usual residence)

PERSON	Selected Region % of total persons	% of total persons
--------	------------------------------------	--------------------

CHARACTERISTICS ⁱ		in Region	Australia ⁱ	in Australia
Total persons (excluding overseas visitors)	131	-	19,855,288	-
Males	97	74.0%	9,799,252	49.4%
Females	34	26.0%	10,056,036	50.6%
Indigenous persons (comprises Aboriginal and Torres Strait Islander)	6	4.6%	455,031	2.3%

In the 2006 Census (held on 8th August 2006), there were 131 persons usually resident in Innamincka (Suburb): 74.0% were males and 26.0% were females. Of the total population in Innamincka (Suburb) 4.6% were Indigenous persons, compared with 2.3% Indigenous persons in Australia.

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AGE ⁱ	Selected Region	% of total persons in Region	Australia	% of total persons in Australia
Age groups:				
0-4 years	6	4.6%	1,260,405	6.3%
5-14 years	7	5.3%	2,676,807	13.5%
15-24 years	20	15.3%	2,704,276	13.6%
25-54 years	80	61.1%	8,376,751	42.2%
55-64 years	14	10.7%	2,192,675	11.0%
65 years and over	3	2.3%	2,644,374	13.3%
Median age of persons	40	-	37	-

In the 2006 Census 9.9% of the population usually resident in Innamincka (Suburb) were children aged between 0-14 years, and 13.0% were persons aged 55 years and over. The median age of persons in Innamincka (Suburb) was 40 years, compared with 37 years for persons in Australia.

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SELECTED CHARACTERISTICS	Selected Region	% of total persons in Region	Australia	% of total persons in Australia
Australian citizenship	110	84.0%	17,095,569	86.1%
Persons born overseas	21	16.0%	4,416,037	22.2%
Overseas visitors (excluded from all other classifications)	27	20.6%	206,358	1.0%

In the 2006 Census, 84.0% of persons usually resident in Innamincka (Suburb) were Australian citizens, 16.0% were born overseas and 20.6% were overseas visitors.

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COUNTRY OF BIRTH MAIN RESPONSES IN SELECTED REGION	Selected Region	% of total persons in Region	Australia	% of total persons in Australia
Australia	97	74.0%	14,072,944	70.9%
England	4	3.1%	856,939	4.3%
United States of America	4	3.1%	61,720	0.3%

Ukraine	4	3.1%	13,665	0.1%
Poland	4	3.1%	52,254	0.3%

In the 2006 Census, 74.0% of persons usually resident in Innamincka (Suburb) stated they were born in Australia. Other common responses within Innamincka (Suburb) were: (England) (3.1%), (United States of America) (3.1%), (Ukraine) (3.1%) and (Poland) (3.1%)

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LANGUAGE SPOKEN AT

HOME ⁱ

MAIN RESPONSES IN SELECTED REGION

Selected Region % of total persons
in Region

Australia % of total persons
in Australia

English only spoken at home	110	84.0%	15,581,333	78.5%
Polish	3	2.3%	53,387	0.3%
Russian	3	2.3%	36,501	0.2%

In the 2006 Census, English was stated as the only language spoken at home by 84.0% of persons usually resident in Innamincka (Suburb). Polish and Russian were the only two languages other than English spoken at home.

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RELIGIOUS AFFILIATION ⁱ

MAIN RESPONSES IN SELECTED REGION

Selected Region % of total persons
in Region

Australia % of total persons
in Australia

No Religion	37	28.2%	3,706,557	18.7%
Anglican	30	22.9%	3,718,248	18.7%
Catholic	24	18.3%	5,126,882	25.8%
Uniting Church	11	8.4%	1,135,422	5.7%
Christian, nfd	4	3.1%	313,192	1.6%

In the 2006 Census, the most common responses for religious affiliation for persons usually resident in Innamincka (Suburb) were No Religion 28.2%, Anglican 22.9%, Catholic 18.3%, Uniting Church 8.4% and Christian, nfd 3.1%.

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MARITAL STATUS

(Population aged 15 years and over) ⁱ

Selected Region % of persons aged
15 years and over
in Region

Australia % of persons aged
15 years and over
in Australia

Married	54	46.2%	7,900,684	49.6%
Never married	46	39.3%	5,278,600	33.2%
Separated or divorced	12	10.3%	1,801,979	11.3%
Widowed	5	4.3%	936,813	5.9%

In the 2006 Census, 46.2% of persons aged 15 years and over usually resident in Innamincka (Suburb) were married, 39.3% never married, 10.3% separated or divorced and 4.3% widowed.

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LABOUR FORCE (Population aged 15 years and over) ⁱ

Selected Region % of persons in
the labour force in
Region

Australia % of persons in
the labour force in
Australia

Total labour force (includes employed and unemployed persons)	96	-	9,607,987	-
Employed full-time	86	89.6%	5,827,432	60.7%
Employed part-time	4	4.2%	2,685,193	27.9%
Employed away from work	6	6.3%	337,991	3.5%
Employed hours not stated	0	0.0%	253,567	2.6%
Unemployed	0	0.0%	503,804	5.2%
Not in the labour force	10	-	5,271,116	-

During the week prior to the 2006 Census, 96 people aged 15 years and over who were usually resident in Innamincka (Suburb) were in the labour force. Of these, 89.6% were employed full-time, 4.2% were employed part-time, 6.3% were employed but away from work, 0.0% were employed but did not state their hours worked and 0.0% were unemployed. There were 10 usual residents aged 15 years and over not in the labour force

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OCCUPATION (Employed persons aged 15 years and over) ⁱ	Selected Region	% of employed persons aged 15 years and over in Region	Australia	% of employed persons aged 15 years and over in Australia
Technicians and Trades Workers	30	31.3%	1,309,258	14.4%
Managers	18	18.8%	1,202,267	13.2%
Labourers	18	18.8%	952,520	10.5%
Machinery Operators And Drivers	13	13.5%	604,616	6.6%
Clerical and Administrative Workers	6	6.3%	1,365,805	15.0%
Sales Workers	3	3.1%	896,208	9.8%
Professionals	3	3.1%	1,806,010	19.8%
Community and Personal Service Workers	3	3.1%	801,906	8.8%

In the 2006 Census, the most common responses for occupation for employed persons usually resident in Innamincka (Suburb) were Technicians and Trades Workers 31.3%, Managers 18.8%, Labourers 18.8%, Machinery Operators And Drivers 13.5% and Clerical and Administrative Workers 6.3%.

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INDUSTRY OF EMPLOYMENT (Employed persons aged 15 years and over) ⁱ
MAIN RESPONSES IN SELECTED REGION

	Selected Region	% of employed persons aged 15 years and over in Region	Australia	% of employed persons aged 15 years and over in Australia
Sheep, Beef Cattle and Grain Farming	20	20.8%	133,275	1.5%

Oil and Gas Extraction	13	13.5%	8,970	0.1%
Accommodation	8	8.3%	117,705	1.3%
Other Mining Support Services	7	7.3%	11,325	0.1%
Other Livestock Farming	5	5.2%	9,130	0.1%

In the 2006 Census, the most common industries of employment for persons aged 15 years and over usually resident in Innamincka (Suburb) were Sheep, Beef Cattle and Grain Farming 20.8%, Oil and Gas Extraction 13.5%, Accommodation 8.3%, Other Mining Support Services 7.3% and Other Livestock Farming 5.2%.

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INCOME (Population aged 15 years and over) ¹ Selected Region

Australia

Median individual income (\$/weekly)	892	-	466	-
Median household income (\$/weekly)	700	-	1,027	-
Median family income (\$/weekly)	1,549	-	1,171	-

In Innamincka (Suburb), the median weekly individual income for persons aged 15 years and over who were usual residents was \$892, compared with \$466 in Australia. The median weekly household income was \$700, compared with \$1,027 in Australia. The median weekly family income was \$1,549, compared with \$1,171 in Australia.

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FAMILY CHARACTERISTICS

FAMILY CHARACTERISTICS ¹ Selected Region % of total families in Region

Australia % of total families in Australia

Total families	17	-	5,219,165	-
Couple families with children	9	52.9%	2,362,582	45.3%
Couple families without children	5	29.4%	1,943,643	37.2%
One parent families	3	17.6%	823,254	15.8%
Other families	0	0.0%	89,686	1.7%

In the 2006 Census, there were 17 families in Innamincka (Suburb): 52.9% were couple families with children, 29.4% were couple families without children, 17.6% were one parent families and 0.0% were other families.

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DWELLING CHARACTERISTICS

DWELLING CHARACTERISTICS - PRIVATE DWELLINGS (Includes Visitor only and other not classifiable households) ¹

Selected Region

% of total occupied private dwellings in Region

Australia

% of total occupied private dwellings in Australia

Total private dwellings (includes unoccupied private dwellings)	150	-	8,426,559	-
Occupied private dwellings:	144	-	7,596,183	-
Separate house	18	12.5%	5,685,387	74.8%
Semi-detached, row or terrace house, townhouse etc	0	0.0%	702,550	9.2%
Flat, unit or apartment	0	0.0%	1,076,315	14.2%
Other dwellings	123	85.4%	127,337	1.7%
Not stated	3	2.1%	4,594	0.1%

In the 2006 Census there were 144 occupied private dwellings counted in Innamincka (Suburb): 12.5% were separate houses, 0.0% were semi-detached, row or terrace houses, townhouses etc, 0.0% were flats, units or apartments and 85.4% were other dwellings.

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DWELLING CHARACTERISTICS - OCCUPIED PRIVATE DWELLINGS ¹	Selected Region		Australia	
Median rent (\$/weekly)	37	-	190	-
Median housing loan repayment (\$/monthly)	0	-	1,300	-
Average household size	2.0	-	2.6	-
Average number of persons per bedroom	1.1	-	1.1	-

In Innamincka (Suburb), the median weekly rent was \$37, compared to \$190 in Australia. The median monthly housing loan repayment was \$0, compared to \$1,300 in Australia. The average household size was 2.0 and the average number of persons per bedroom was 1.1.

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TENURE TYPE - OCCUPIED PRIVATE DWELLINGS ¹	Selected Region	% of total occupied private dwellings in Region	Australia	% of total occupied private dwellings in Australia
Fully owned	64	44.4%	2,478,264	32.6%
Being purchased (includes being purchased under rent/buy scheme)	6	4.2%	2,448,205	32.2%
Rented (includes rent-free)	22	15.3%	2,063,947	27.2%
Other tenure type	6	4.2%	65,715	0.9%
Not stated	46	31.9%	540,050	7.1%

In Innamincka (Suburb), 44.4% of occupied private dwellings were fully owned, 4.2% were being purchased and 15.3% were rented.

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HOUSEHOLD COMPOSITION - OCCUPIED PRIVATE DWELLINGS ¹	Selected Region	% of total occupied private dwellings in Region	Australia	% of total occupied private dwellings in Australia
Family household	17	11.8%	5,122,760	67.4%
Lone person household	22	15.3%	1,740,481	22.9%
Group household	0	0.0%	280,856	3.7%

In the 2006 Census in Innamincka (Suburb), 11.8% of occupied private dwellings were family households, 15.3% were lone person households and 0.0% were group households.

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LANDLORD TYPE - OCCUPIED PRIVATE DWELLINGS BEING RENTED (including rent free accommodation) ¹	Selected Region	% of total rented dwellings in Region	Australia	% of total rented dwellings in Australia
Real estate agent	0	0.0%	1,043,198	50.5%
State or Territory housing authority	0	0.0%	306,697	14.9%
Other landlord type	21	95.5%	652,012	31.6%
Landlord type not stated	0	0.0%	62,037	3.0%

In Innamincka (Suburb), of the occupied private dwellings being rented, 0.0% were rented from a real estate agent, 0.0% were rented from a State or Territory housing authority and 95.5% were rented from other landlord type. In comparison, in Australia 50.5% were rented from a real estate agent and 14.9% from a state or territory housing authority.

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Data for this QuickStats was collected from the 2006 Census of Population and Housing.

Some values in this QuickStats may have been adjusted to avoid release of confidential data. These adjustments may have a significant impact on the calculated percentages in QuickStats. For further information refer to Introduced Random Error.

For further inquiries contact the ABS National Information and Referral Service on 1300 135 070.

2006 Census Dictionary
 Census Data Quality Statement
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Appendix E

Waste water treatment plant –
technical information, Ozzi Kleen

manufacturers of

OZZI KLEEN

**ACTIVATED SLUDGE CYCLIC EXTENDED AERATION
SEWAGE TREATMENT SYSTEMS
FOR COMMERCIAL APPLICATIONS**

HISTORY

Mr Mal Close Managing Director of Neatport Pty Ltd, established Suncoast Waste Water Management in 1983 and also worked as Manager in charge of Operations and Maintenance of the Sewage Treatment Plants with the Maroochy Shire Council for 22 years.



Throughout those years, Mal was able to gain much needed valuable experience from within the industry. It is this experience and knowledge that Mal has been able to utilize in designing and assisting with wastewater treatment, Australia-wide.

Suncoast Waste Water Management entered the domestic and commercial onsite sewerage treatment industry in 1993 with the Ozzi Kleen system. This system has been designed and manufactured from the expertise Mal gained from working with municipal and aerobic sewage treatment plants for over 33 years.

After many years of producing an industry standard Activated Sludge Sewage Treatment Plant for both domestic and commercial applications, Mal has now raised the standard by introducing to this fully aerobic system, modifications which now produce a treated effluent to an ***advanced quality standard*** - carrying out nutrient removal.

Suncoast Waste Water Management Consults and Designs commercial wastewater treatment systems based on the Ozzi Kleen technology, to treat your waste on site.



TREATMENT PROCESS

Please note: All text written in *italics* relates to the Ozzi Kleen Advanced System.

In this compact system, flow equalisation, biological oxidation, secondary sedimentation, and biological nutrient removal occur in an Aerobic process. The treatment plant is to be serviced at the regular interval of every ninety days, which will require a full service as set out in the Operator's and Owner's Manual.

Additional optional equipment to the normal operation of the treatment plant provides for *Phosphate removal*, and Nitrogen removal through Nitrification / Denitrification. Disinfection of effluent is with the use of Chlorination or UV equipment.

The plants consist of the following:

Aeration tank, Effluent disinfection and Irrigation equipment, *Nutrient removal processes and equipment*, Sludge waste and storage facility, Sand filtration and Electronic controls.

The Treatment Plant effluent quality is designed to be within the required guidelines for Secondary Effluent and *Advanced Secondary Effluent* as follows:

Secondary Effluent Quality:

BOD	< 20 mg/L
NFR	< 30 mg/L
TKN	< 10 mg/L
P	< 15 mg/l
E.Coli	< 100 per 100ml

Advanced Secondary Effluent Quality:

<i>BOD</i>	<i>< 10 mg/l</i>
<i>NFR</i>	<i>< 10 mg/l</i>
<i>TKN</i>	<i>< 5 mg/l</i>
<i>P</i>	<i>< 5 mg/l</i>
<i>E.Coli</i>	<i>< 10 per 100ml</i>

The treatment process:

A1	Primary process	Activated Sludge/Cyclic Extended Aeration
A2	Aerobic and Anoxic Cycles	Nitrification/Denitrification
A3	<i>Precipitation</i>	<i>Phosphate Reduction</i>
B	Secondary process	Effluent Disinfection and pumping
C	Waste Sludge removal	Phosphate storage
D	Tertiary process	Sand Filtration/Effluent Polishing

TREATMENT PROCESS

A1 A fully aerobic primary treatment process for raw sewage using the activated sludge technology through cyclic extended aeration, where digestion and oxidation of the waste occurs through three intermittent cycles:

(1) An aeration cycle, in which the influent/sewage is aerated and oxygenated by diffused air supplied from an air blower. As aeration takes place and continues, an ideal aerobic environment is formed for microorganisms and a humus type activated sludge is formed. With the balance aeration and a good healthy activated sludge, digestion and oxidation of the organic waste occurs. A balance of aeration in relation to the organic/hydraulic load is maintained for a good steady reliable treatment process. BOD oxidation and nitrification also occurs during this phase of operation.

(2) A Settling cycle occurs when the aeration cycle is finished which allows a quiet period where the biomass has time to settle. As the biomass is settling it acts as a filter blanket - trapping all the waste that is in suspension in the mixed liquor of the aerobic biomass and settles it to the floor. This provides for further B.O.D oxidation (anoxically), clarification, and denitrification. A zone of clear water is generated at the surface of the aeration tank, which is now acting as a clarifier.

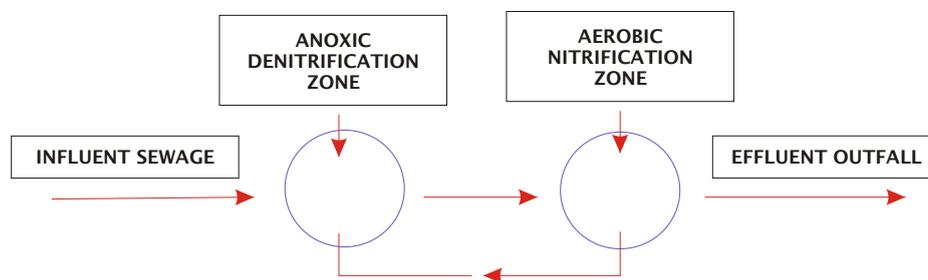
(3) After a predetermined settling period a decanting cycle takes place. The decanting equipment draws off surface water to a predetermined level from an inverted pipe manifold. During the decanting cycle the anoxic treatment process continues BOD oxidation, clarification, and denitrification, and automatically decants highly treated clarified effluent. The decanting cycle continues drawing off effluent until either the liquid level in the aeration tank reaches the standard operation level or the electronic process-timer control puts the system back into the aeration cycle, which air-locks the decanter, stopping the decanting cycle.

At the end of the third cycle, the treatment process is repeated again with the start of the next aeration cycle. Variable duration for each cycle can be chosen for optimum treatment.

A2 Oxidation of Ammonia is the initial process for Nitrification, which takes place in the aeration tank of both systems. For carbon removal and conversion of ammonia to nitrate, aerobic conditions with dissolved oxygen must be maintained. Dissolved Oxygen conditions in the treatment plant must be controlled properly for biological removal of carbonaceous and nitrogenous wastes to occur.

During Nitrification, portion of the biomass is circulated through the anoxic tank where it is mixed with the incoming sewage. The carbon present in the raw sewage associated with endogenous respiration of the microbial sludge is to allow for Denitrification. The extent of Denitrification is determined mainly by the fraction of Mixed Liquor Suspended Solids that is recycled. Conversion of nitrate to nitrogenous gases requires an established anoxic condition.

A simple diagram for the denitrification process is below:



- A3** *Phosphate removal takes place within the mixed liquor of the aeration tank with the addition of flocculating chemicals, which precipitates and binds the element to the activated sludge and is removed from the treatment cycle through the exercise of sludge wasting to the sludge storage compartment.*

Phosphate removal can be set to have a residual at any required level depending on the level of treatment applied to it. The removal of the phosphates from the site would be to a council approved location.

- B** A secondary process of disinfection of effluent is with the use of chlorination equipment treating the final water before discharge. The chlorinator uses tablet chlorine and is self-compensating for variations in flow giving a dose rate residual of between 0.5 to 2.0 mg/Lt. free chlorine.
- C** Sludge wasting is the final part of the treatment process and it is also this part that deals with the phosphate removal as mentioned in part A3.
- D** A rapid sand filter is used for final effluent polishing prior to discharge to the designated transpiration area using a pressure type Rapid Sand Filter. The sand filter has a unique automatic backwash feature, which at the time of each service the filter is backwashed, cleaning the sand to its original condition. The discharge from the backwashing of the filter is recycled back to the sewage inlet of the treatment plant. The sand filter is constructed in polyethylene and is usually inserted as an integral part of the system.

PROJECTS



White Mining 500EP



Australia Zoo 200EP



Kuranda State School 60EP



Coral Cove 1500EP

Kagara Zinc - Surveyor	Mt Garnet, Qld	200EP
Kagara Zinc	Chillagoe, Qld	240EP
Kinchan Dam Education Centre	Mackay, Qld	100EP
Fitzroy Island Resort	Fitzroy Island, Qld	530EP
Team 45 (Fortesque Mining)	Port Headland, WA	165EP
Abbot Point Coal Terminal	Bowen, Qld	100EP
Lockhart River Aerodrome	Lockhart River, Qld	50EP
Cordwell Concrete	Yandina, Qld	35EP
White Mining Ltd	North Goonyella, Qld	500EP
White Mining Ltd	North Goonyella, Qld	250EP
White Mining Ltd	North Goonyella, Qld	35EP
Carmichael's Guest House	North Goonyella, Qld	35EP
Zamaz Guest House	Maleny, Qld	25EP
Mt Isa Mines	Cloncurry, Qld	400EP
Mt Isa Mines	Cloncurry, Qld	35EP
Mt Isa Mines	Cloncurry, Qld	200EP
Heritage Lodge	Daintree, Qld	35EP
Cherbourg Community Council	Cherbourg, Qld	25EP
Elliott Heads Bowls Club	Bundaberg, Qld	25EP
Forcett Lakes Golf Club	Lewisham, Tas	25EP
Valley Retirement Centre	Mirani, Qld	140EP
Mt Isa Mines	Cloncurry, Qld	140EP
Mt Isa Mines	Cloncurry, Qld	250EP
Dodges Ferry Bar & Café	Tasmania	35EP
Kuranda State School	Kurande, Qld	60EP
Redlands Baseball Club	Redland Bay, Qld	35EP
Winery Tamborine	Tamborine, Qld	25EP
Tallai Country Club	Tallai, Qld	35EP
Julatten State School	Julatten, Qld	60EP
Woombye Care Inc	Woombye, Qld	60EP
Bowen Palms Caravan Park	Bowen, Qld	140EP
Australia Zoo	Beerwah, Qld	200EP
Cooktown Caravan Park	Cooktown, Qld	35EP
Oaks Caravan Village	Burnett Heads, Qld	240EP
Malanda Age Care Centre	Malanda, Qld	120EP
Molongle Creek Caravan Park	Molongle Creek, Qld	120EP
Howden Municipality	Howden, Tas	400EP
National Parks & Wildlife (Workshop)	Montague Island, NSW	25EP
Crescent Head Caravan Park	Crescent Head, NSW	50EP
Taylors Beach Caravan Park	Taylors Beach, Qld	50EP
Wrotham Park Station Retreat	Wrotham Park, Qld	50EP
Moore Park State School	Moore Park, Qld	50EP
Lake Sea Lodge	Nowra, NSW	50EP
Overlander Roadhouse	Geraldton, WA	50EP
Fountain Head	Maleny, Qld	70EP
Pajingo Mine	Charters Towers, Qld	70EP
Cape Hillsborough Nature Resort	Cape Hillsborough, Tas	200EP
Coral Cove	Bundaberg, Qld	1500EP

Ozzi Kleen can produce treatment plants for all sorts of applications and sizes up to 2000EP.

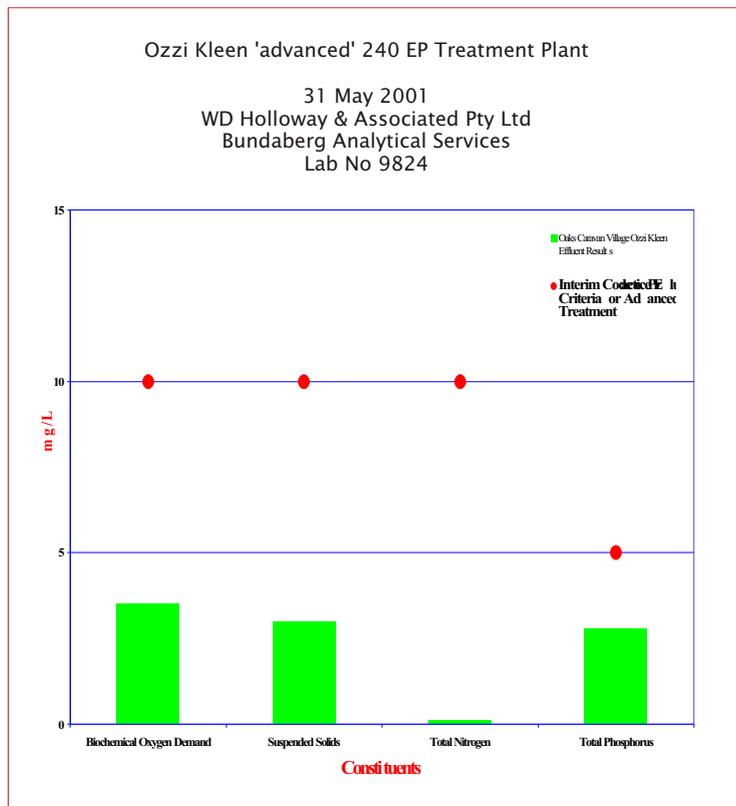
EP = Equivalent Persons.

ADVANCED QUALITY

The **Advanced standard of treatment with nutrient removal** means that there is now a safe, more reliable, user and environmentally friendly sewerage treatment plant that allows the users to safely reuse the treated effluent for watering gardens, lawns and perhaps re-use in certain applications in the home or commercial developments.

The advanced quality level treatment is ideal for environmentally sensitive sites, such as national parks, waterways and off-shore rigs. In areas where water is scarce the treated effluent can be reused through the toilets and urinals or even for road works (water truck).

Results shown below are from an Ozzi Kleen Advanced at the Oaks Caravan Village, Bundaberg (240EP, taken on 31 May 2001 by "WD Holloway & Associates Pty Ltd - Bundaberg Analytical Services, Lab No 9824) - results are well below the required standards.



QUALITY MANUFACTURE

The Ozzi Kleen are fully prefabricated in our factory moved to site and assembled. Site preparations can be carried out before delivery, causing the least amount of disruption to your business.

The Ozzi Kleen sewage treatment plants use the following as standard equipment:



- Manual Rapid Sand Filtration (effluent polishing)
- Turbine type Air Blowers
- Programmable Electronic controls
- Elastox T type air diffusers
- Manual or automatic raw sewage screening
- Chlorinen
- Polyethylene tanks (mist or river gum green)
- Separate Auto disinfection and sludge thickening tanks and equipment
- Final Effluent storage tanks

Optional Equipment:



- Automatic raw sewage screening equipment
- Automatic final effluent micro screening
- U.V. disinfection equipment
- Automatic rapid sand filtration
- Nutrient removal

DURABLE

The majority of treatment plant tanks are a polyethylene construction which is, weight for weight, 100 times stronger than concrete, with an average wall thickness of 16-18mm. The material has a half-life alone of over 500 years. As the Ozzi Kleen tanks are roto-moulded and completely seamless, there is no risk of seepage, leaking or root-intrusion.

The tanks are suitable for full burial in the ground, or partly below ground installation on larger systems setup on a compacted hard stand base.

Polyethylene tanks are not affected by corrosion due to acid fermentation, the way concrete tanks are which can eventually result in leaks or seepage and possible health hazards as well as costly replacement or repair.

Due to the strong but light weight construction materials used in building Ozzi Kleen systems, they travel very well and are easier to install on difficult sites.

We also offer transportable sewerage treatment plants, which can be built on 20-40ft containers or skid frames, therefore can be lifted or dragged from place to place.



EXAMPLES

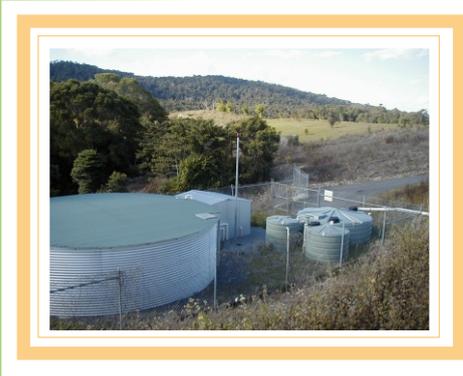
NAME: Kuranda State School

LOCATION: Kuranda, Far Nth Qld

SIZE: 60EP

LOADING: 12,000lt/day

DETAILS: This plant is serving a State High School of over 200 students. It is using **UV disinfection** equipment which is set-up after the tertiary stage treatment of rapid sand filtration. The UV equipment is a pressure vessel design where the treated water is pumped through, it is exposed to ultra violet light prior to the storage tank.



IRRIGATION: The final effluent irrigation pump is controlled by a **time clock**, which will only allow a pumping cycle starting at midnight. The irrigation sprinkler system consists of **pop-up sprinklers** in a sports playing field. This is a very effective method of effluent reuse which gives an even distribution of water over the irrigation area. This system has been operating since 1997.

NAME: Mt Isa Mines - Ernest Henry

LOCATION: Cloncurry, Nth West Qld

SIZE: 200EP

LOADING: 12,000 lt/DAY

DETAILS: This system is treating normal sewage excluding laundry water, which is setup at the ore conservation plant. The high strength sewage is very unstable due to high day time temps up to 45°C in the shade. **High temperatures** and high resident time in the rising main does not affect the performance of the Ozzi Kleen treatment plant.



IRRIGATION: Treated effluent here is irrigated through sprinklers along some drainage levy banks.

EXAMPLES

- NAME:** Redlands Baseball Club
- LOCATION:** Redland Bay, SE Qld
- SIZE:** 35EP
- LOADING:** 7,000 lt/day
- DETAILS:** The loading here is very **erratic** with almost no flows during the week and up to 500 people during weekend sporting events. The premises also has a large reception hall which is hired out for functions.
- IRRIGATION:** The effluent disposal is irrigated with sprinklers into a nature strip between a carpark and sports practice pens.



- NAME:** White Mining
- LOCATION:** Mt Isa, Nth West Qld
- SIZE:** 400EP
- LOADING:** 80,000lt/day
- DETAILS:** This plant is of a **steel construction**, made by other and was refurbished to near new condition. The aeration equipment was updated and the Ozzi Kleen design and some internal changes were made to components and internal plumbing. The plant is currently serving the miners onsite village and construction camp. During the construction of the mine the construction camp housed 750 workmen including canteen staff and caretakers. This plant was almost 190% **overloaded** but was still producing an acceptable effluent. The Activated Sludge Process will operate under extreme loading conditions but requires a higher level of sludge management.
- IRRIGATION:** Effluent was irrigated onto to levy banks in the attempt to combat erosion, due to dry conditions.



EXAMPLES

NAME: Australia Zoo

LOCATION: Beerwah, SE Qld

SIZE: 200EP

LOADING: 41,000 lt/day

DETAILS: The sewage flow is 99% toilet usage from daily visitors to the Zoo. The flows to the plant are very erratic with some days of only several hundred to others during peak holiday periods of several thousands. This plant has provision for **grit and rag removal** through manually operated equipment. It is basically a manually cleaned bar screen, fabricated in polyethylene and aluminium, recommended for all commercial treatment plants where it is not possible to control the inflow or nature of sewage, therefore acting as a screen to remove foreign objects.



IRRIGATION: The treated water from this plant is used for irrigation onto an Avocado Orchard. The **effluent storage** is for up to 4 days as requested by the Environmental Protection Authority (EPA).

NAME: Oaks Caravan Park

LOCATION: Bundaberg, Central Qld

SIZE: 240EP

LOADING: 48,000lt/day

DETAILS: The EPA requirement asks for **nitrogen and phosphorous removal**. Phosphate removal from the effluent disposal, through waste sludge placed onto **drying beds**, drying bed consist of sand gravel bed with under-drain, which once dried is manually removed when ready and used as garden mulch around the park. This sludge is quite inert and stable and has no odours.



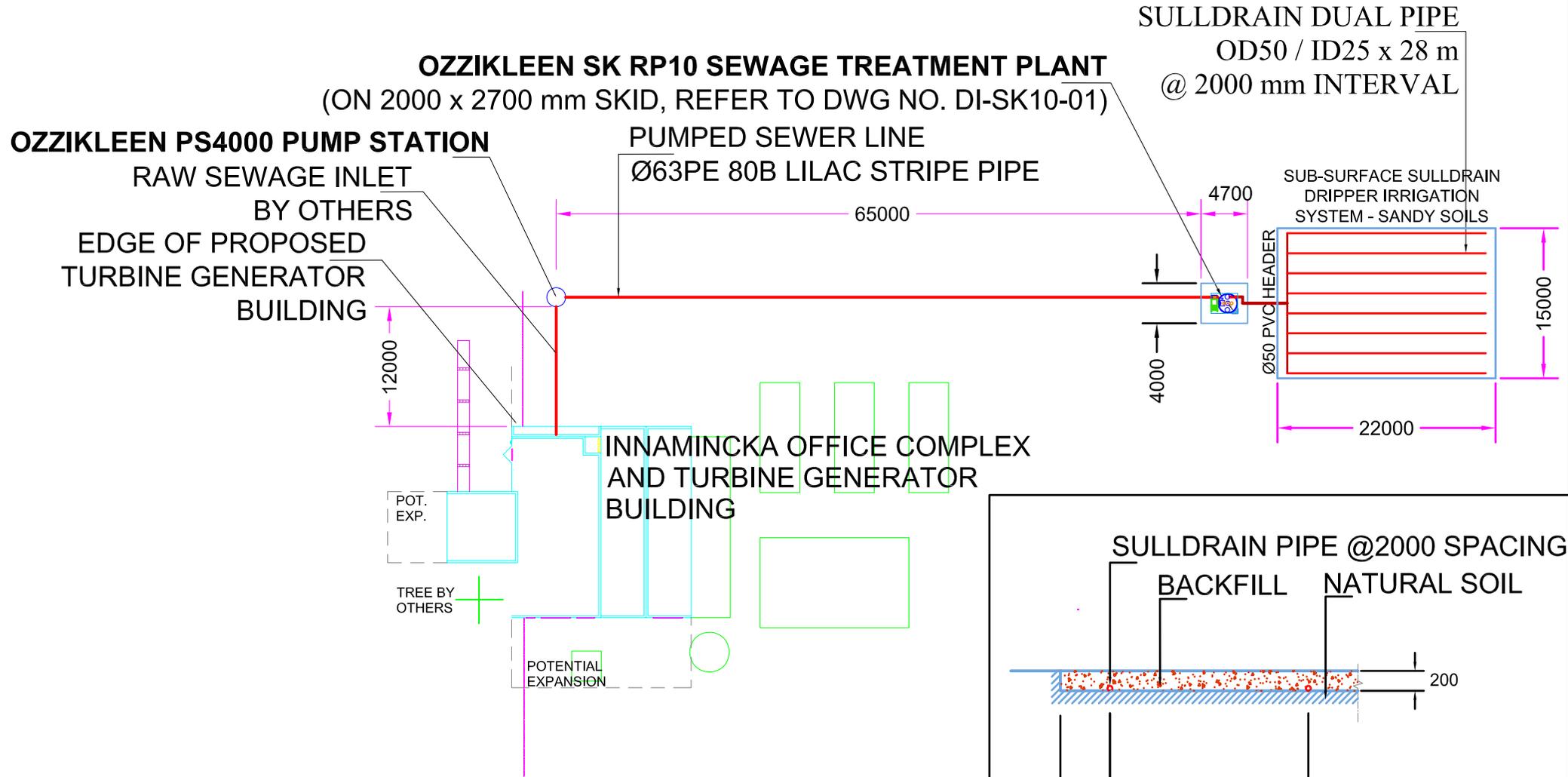
IRRIGATION: This system is discharging to a **Marine National Park Ocean** outfall, and in the drier seasons used to irrigate park gardens.



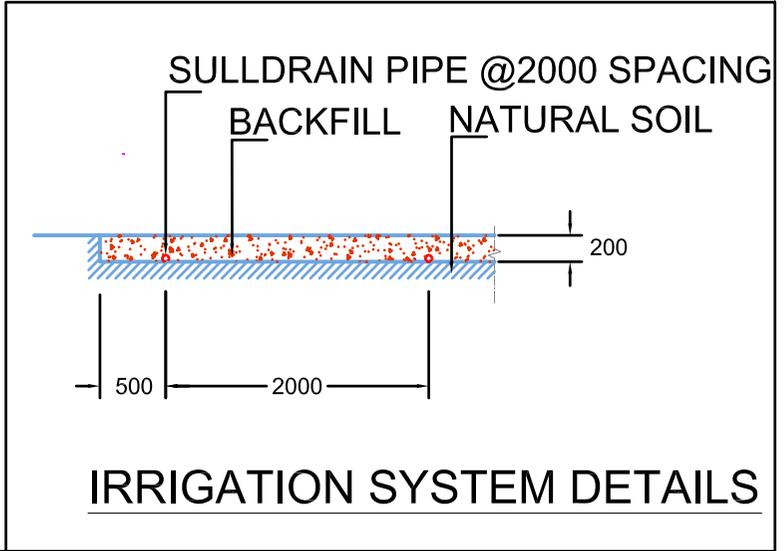
CONTACT US

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Email: info@ozzikleen.com
Website: www.ozzikleen.com



SITE LAYOUT



IRRIGATION SYSTEM DETAILS

30/7/08	IRRIGATION DETAILS ADDED	3	DC	 <p>59 INDUSTRIAL AVE KUNDA PARK QLD 4556 PH +61 7 5459 4900 FAX +61 7 5456 4677 www.ozzikleen.com</p>	CLIENT	DECMIL Australia Pty Ltd	DESIGN	DC			
24/7/08	STP RESIZED, FOR APPROVAL	2	DC		PROJECT	INNAMINKA RP10 STP	DRAWN	DC			
15/07/08	ISSUED FOR CONSTRUCTION	1	DC		TITLE	GENERAL ARRANGEMENT	CHKD	JL			
26/06/08	FOR APPROVAL	A	DC		DATE	30/7/08	SCALE	NTS			
DATE	DESCRIPTION	REV.	BY	Suncoast Waste Water Management		DWG NO.	DI-SK10-03	REV	3	SCALE	NTS

RAW SEWAGE FROM PUMP STATION

BAR SCREEN
(CONTROL BOX BELOW)

Ozzi Kleen RP10 STP

2700

2000

Ø1900

OK 1400 STEPS

ALUMINUM SKID

EFFLUENT TO SUBSURFACE DISPOSAL AREA, Ø50 PVC PIPE

BAR SCREEN

CONTROL BOX

▽ TWL

▽ BWL

EFFLUENT TO DISPOSAL

RAW SEWAGE FROM PUMP STATION

PLAN

ELEVATION

					59 INDUSTRIAL AVE KUNDA PARK QLD 4556 PH +61 7 5459 4900 FAX +61 7 5456 4677 www.ozzikleen.com	CLIENT	DECMIL Australia Pty Ltd			DESIGN	DC
						PROJECT	INNAMINKA RP10 STP			DRAWN	DC
23/07/08	REVISED TO 10EP STP, FOR APPROVAL	B	DC			TITLE	LAYOUT – PLAN			DATE	23/7/08
26/06/08	FOR APPROVAL	A	DC			DWG NO.	DI-SK10-01	REV	B	SCALE	NTS
DATE	DESCRIPTION	REV.	BY	Suncoast Waste Water Management							