Olsen Consulting Group Pty Ltd

Appendices III - VIII

ENVIRONMENTAL ASSESSMENT

Illawarra Coal Seam Gas Exploration Drilling
&
Gas Monitoring Program

APEX Energy NL

March 2009

APPENDIX III

(No. of pages excluding this page = 68)

Illawarra Coal Seam Gas Exploration Drilling Programme: Aboriginal and Historical Cultural Heritage Assessment, January 2009

Biosis Research Pty Limited

BIOSIS
RESEARCH

Illawarra Coal-Seam Gas Exploration Drilling Programme: Aboriginal and Historic Cultural Heritage Assessment

Report for Olsen Environmental Consulting on behalf of Apex Energy NL

January 2009

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- Sharralyn Robinson, Johnny Pagett, Steven Henry (Illawarra LALC)
- Maria Maher (Kullila Welfare & Housing Aboriginal Corporation)
- Robert Evitt (Registered Aboriginal interest)
- Karen Gough (Registered Aboriginal interest)
- Maurice Stewart (Office of the Registrar/Department of Aboriginal Affairs)
- Dave Gordon, Kate Hopkins, Fran Scully (DECC)
- Dave Olsen (Olsen Environmental Consulting)
- Chris Rogers (Apex Energy NL)

ABBREVIATIONS

AHC	Australian Heritage Council
AHIMS	Aboriginal Heritage Information Management System
AIATSIS	Australian Institute of Aboriginal and Torres Strait Island Studies
ATSIC	Aboriginal and Torres Strait Islander Commission
BP	before present
CCL	Consolidated Coal Lease
CHL	Commonwealth Heritage List
DECC	Department of Environment and Climate Change
DEWHA	Department of Environment, Water, Heritage and the Arts
EA	Environmental Assessment
EP&A	Environmental Planning and Assessment
EPBC	Environment Protection and Biodiversity Conservation
GPS	Global Positioning System
GSV	Ground surface visibility
ICOMOS	International Council on Monuments and Sites
KWAHC	Kullila Welfare and Aboriginal Housing Corporation
LALC	Local Aboriginal Land Council
LEP	Local Environmental Plan
LGA	Local Government Area
MGA	Map Grid of Australia – unless otherwise specified all coordinates are in MGA
NHL	National Heritage List
NNTT	National Native Title Tribunal
NPWS	National Parks and Wildlife Service (now part of DECC)
PAD	Potential Archaeological Deposit

PEL	Petroleum Exploration Licence
REP	Regional Environment Plan
RNE	Register of the National Estate
SHI	State Heritage Inventory
SHR	State Heritage Register

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EXECUTIVE SUMMARY

Biosis Research was engaged by Olsen Environmental Consulting Pty Limited on behalf of Apex Energy NL to identify and assess Aboriginal and historic cultural heritage values of 18 proposed borehole well sites within the Wollongong Local Government Area, extending from Helensburgh in the north to Wollongong in the south. The borehole sites have been selected to determine the gas potential of the coal seams in the Illawarra Coal Measures within the areas of Petroleum Exploration Licences 442 and 444 and Consolidated Coal Lease Number 703. The exploration programme will determine the gas potential in all the coal seams of the Illawarra Coal Measures as well as the commercial potential of "goaf gas" which has collected in areas of abandoned coal-seam workings, being predominantly in the Bulli Seam.

The project meets the definition of a Major Project under the *State Environmental Planning Policy (Major Project) 2005*. Consequently, the exploration proposal has to be approved in accordance with Part 3A of the *Environmental Planning and Assessment Act 1979* (*EP&A Act*), Project Application No: 07_0103. Major Projects have a centralised approvals process, with the Minister for Planning issuing project approval for the overall proposal. Reporting and Aboriginal community consultation have been carried out in accordance with guidelines prepared for projects being assessed and approved under Part 3A of the *EP&A Act*.

As a result of the Aboriginal Community consultation process four registered stakeholders were identified:

- Illawarra Local Aboriginal Land Council
- Kullila Welfare and Housing Aboriginal Corporation
- Mr Robert Evitt
- Ms Karen Gough

Searches were carried out of all relevant heritage registers and databases. There are no previously identified Aboriginal or historic heritage items within the Apex Energy NL Illawarra coal-seam gas exploration drilling programme areas. Three of the proposed borehole locations are within 200 m of registered Aboriginal sites.

The environmental context of the study area, and regional patterning, suggest that the study area is likely to have been visited by Aboriginal people, and that this visitation has left observable marks. Predictive site modelling suggests that there is potential for grinding grooves, Aboriginal places, Aboriginal resource and gathering sites, and open campsites, artefact scatters or isolated finds to be identified within the study area. The latter site types are likely to have low integrity given the levels of disturbance predicted to have occurred within the specific borehole locations. There is little potential for historical archaeological sites to be present at the specific borehole locations given that the boreholes are located in areas which have been subject to limited historic development.

A field inspection of the borehole locations was carried out over three days, between 2 – 4 September 2008. The survey team included representatives from Biosis Research, the

Illawarra Local Aboriginal Land Council and the Kullila Welfare and Housing Aboriginal Corporation. All eighteen boreholes for which approval is being sought (Boreholes AI01-AI18) were inspected. Two additional boreholes were also inspected (AM1 and AM2). These boreholes have subsequently been withdrawn from the project. These sites were assessed but they are no longer part of the project and approval for them is no longer being sought.

The survey identified that most of the borehole locations are situated in environments where the potential for Aboriginal archaeological sites is very low. Borehole AI04A was identified during the survey as having Aboriginal constraints. Borehole AI04B, although identified as an archaeological site by the Aboriginal stakeholders participating in the survey, does not, in the opinion of the archaeologist, represent PAD based on the environmental conditions of the area.

The two proposed areas for the location of Borehole AI04 were discussed in-field with the survey participants. The communities indicated that they preferred the works to proceed at Borehole AI04A (the disturbed area with the isolated find) rather than AI04B as this location has low evident disturbance and would require the clearing of good condition native vegetation. Subsequent to the field survey further detail was obtained regarding the coal workings below this area. The borehole must pass through a remnant coal pillar of the Bulli Seam. Borehole AI04A is not above the coal pillar and, as such, is not suitable as a drilling location. Borehole AI04B is above the coal pillar and is the only possible site of the two inspected that is suitable for drilling.

The historic land use patterns of the study area suggest that there is low potential for historic archaeological sites. No historic heritage constraints were identified from background research or during the survey.

The two registered stakeholders who did not participate in the survey were invited to meetings to discuss the survey results and cultural values and significance of the study area.

- Ms Gough identified several themes of importance to her and her family, these are described more fully in Section 8.2.3. There are many aspects of cultural significance which can be understood to exist in the study area. Cultural values are represented not only in physical places, but in the way places are used. Spiritual importance, educational value, cultural continuity and identity are connected with the physical world, and are re-affirmed through community interaction with, and responses to, the physical place. In this context, parts of the study area can be easily understood as places culturally significant to the Aboriginal community. In particular, the Dharawal Nature Reserve was identified as a place where cultural traditions are passed on to the next generation.

- Mr Evitt could not provide comment on cultural significance of the study area as he is not from Country. His particular concern is related to land ownership and management obligations.

Boreholes AI03, AI04B, AI10, AI12, AI14, AI15 and AI18 support good condition, intact native vegetation communities. The educational value of these particular borehole areas is limited as current access constraints deny public visitation. While vegetation communities are a signifier of cultural identity and Country, current access conditions restrict practicing connection to Country at these locations. Regardless of access issues, there is cultural importance attached to the vegetation of the Woronora Plateau and this should be respected.

The two publicly accessible boreholes are located in highly disturbed contexts within broader landscapes of good condition native vegetation. Boreholes AI01 and AI05 are considered to be located in areas of immediate disturbance, and wider cultural significance.

The proposal is not predicted to significantly impact archaeological or cultural heritage values within the proposed borehole locations. While there will be limited impacts at some of the borehole locations, these are manageable impacts.

Impacts which have been identified can be ameliorated through adoption of the following recommendations:

Recommendation 1 – Borehole AI04B

Borehole AI04B is the only of the AI04 boreholes that is suitable for drilling given the underlying structure of the Bulli Seam. While Borehole AI04A was the location preferred by the communities this location is physically unable to meet selection criteria. As such, Borehole AI04B is the only location suitable for drilling.

The Aboriginal community have requested that if this site be selected, that monitors be engaged during the site clearance process. Monitoring is not an archaeological process and is not endorsed by DECC. Should the client wish to, they may directly engage Aboriginal monitors to supervise the site clearance process. Monitoring will be undertaken for cultural reasons, not archaeological and no archaeologist is required to be on site for this work. Monitoring will not require consultation with DECC.

Recommendation 2 – Cultural values at publicly accessible locations

Boreholes AI01 and AI05 are the only two boreholes that might be reasonably considered publicly accessible. The project may impact on cultural values by diminishing Aboriginal enjoyment of the area as a place of connection to Country and a place to conduct inter-generational cultural education; this is particularly relevant at Borehole AI05 which is located in the Dharawal State Conservation Area. Impacts associated with the proposed boreholes are limited and may be ameliorated in the following manners:

- Noise attenuation of all diesel motors to minimise noise impacts during construction. Testing operation will be largely inaudible and will not require mitigation.

- Screening of the site compounds to mask visual intrusion into the landscape. This may include measures such as fixing green shade cloth to the compound site fence to merge the bulk of the fence into surrounding vegetation or planting of local native plant species as a screen around the fence where sufficient depth of soil exists.

Recommendation 3 – Areas of good condition native vegetation

Boreholes AI03, AI04B, AI10, AI12, AI14, AI15 and AI18 have good condition native vegetation which will be impacted by the proposal. While none of these boreholes are situated in areas that are publicly accessible, native vegetation is important to the Aboriginal community. It is recommended that seed banks be established for each of these boreholes, and that at the conclusion of the testing program the areas be 'made good' by the proponent.

Recommendation 4 – Aboriginal objects stop work provision

No Aboriginal archaeological constraints have been identified within the project study area. Should unanticipated Aboriginal objects be identified during project works, all works should cease in the vicinity of the find and an archaeologist should be called in to assess the find. Section 75U Part 3A of the *Environmental Planning and Assessment Act* does not switch off section 86 of the *National Parks and Wildlife Act 1974*. Notification of discovery of Aboriginal objects and places is still required under the *National Parks and Wildlife Act 1974.*

Recommendation 5 – Historic relics stop work provision

No historic heritage constraints have been identified within the project study area. Should unanticipated historic relics be identified during project works, all works should cease in the vicinity of the find and an archaeologist should be called in to assess the find. Section 75U Part 3A of the *Environmental Planning and Assessment Act* does not switch off section 146 of the *Heritage Act 1977*. Notification of discovery of historic relics is still required under the *Heritage Act 1977*.

Heritage and archaeological reports and the management recommendations contained therein may be independently reviewed by Aboriginal heritage staff of the Environment Protection and Regulation Division of the NSW Department of Environment and Climate

Change (DECC), the relevant Aboriginal community and the Heritage Branch, NSW Department of Planning.

Although the findings of a consultant's report will be taken into consideration, recommendations in relation to managing heritage places should not be taken to imply automatic approval of those actions by the DECC, the Aboriginal community or the Heritage Branch, NSW Department of Planning.

1.0 INTRODUCTION

Cultural heritage legislation protecting Aboriginal and historic heritage places applies in New South Wales. These places are an important part of our heritage. They are evidence of more than 40,000 years of occupation of New South Wales by Aboriginal people, and of the more recent period of post-contact settlement.

Heritage places can provide us with important information about past lifestyles and cultural change. Preserving and enhancing these important and non-renewable resources is encouraged.

When a project or new development is proposed, it must be established if any cultural heritage places are in the area and how they might be affected by the project. Often it is possible to minimise the impact of development or find an alternative to damaging or destroying a heritage place. Therefore, preliminary research and survey to identify heritage places is a fundamental part of the background study for most developments.

The first stage of a study usually incorporates background research to collect information about the land relevant to the proposed development project (the study area). A second stage often involves a field inspection of this area.

Possibly the most important part of the study involves assessing the cultural heritage significance of heritage places in the study area. Understanding the significance of a heritage place is essential for formulating management recommendations and making decisions.

1.1 Project background

Biosis Research was engaged by Olsen Environmental Consulting Pty Limited on behalf of Apex Energy NL to identify and assess Aboriginal and historic cultural heritage values of 20 proposed borehole well sites within the Wollongong Local Government Area (LGA). Two of the proposed boreholes have subsequently been dropped from the proposal and this report assesses the 18 remaining borehole locations. Results of this investigation will be used to identify predicted impacts to heritage items and places associated with the proposed borehole areas. Recommendations designed to minimise impacts to cultural heritage places and values have been formulated according to legislative constraints and ‘best practice’ heritage management.

1.2 Study area

The study area comprises 18 discrete borehole well sites within the Wollongong LGA, extending from Helensburgh in the north to Wollongong in the south (refer to Figure 1). The borehole sites have been selected to determine the gas potential of the coal seams in the

Illawarra Coal Measures within the areas of Petroleum Exploration Licences (PEL) 442 and 444 and Consolidated Coal Lease (CCL) Number 703.

1.3 Proposal

Apex Energy NL proposes to undertake an exploration programme consisting of the drilling of 18 exploratory boreholes at various locations throughout PEL 442, PEL 444 and CCL 703. The boreholes would be drilled to variable depths *below* the base of the Illawarra Coal Measures. The exploration programme will determine the gas potential in all the coal seams of the Illawarra Coal Measures as well as the commercial potential of "goaf gas" which has collected in areas of abandoned coal-seam workings, being predominantly in the Bulli Seam. The proposal will also provide more information regarding regional geology.

The exploration programme will define potential gas quality, volumes and flow rates within the area. Definition of the gas reserves will enable future planning of developments capable of utilising the gas resource.

The proposed program at each borehole involves:

— initial data gathering (core drilling) and

— gas reserve testing (exploration drilling).

The proposed boreholes can be divided into four categories, each of which will require different equipment and duration on site:

— Cored holes drilled over areas with no underlying abandoned goafs (old mine workings) for stratigraphic data, desorption testing of gas content and seam permeability testing. Cored hole diameter is 100mm.

— Cored holes drilled over areas underlain by abandoned goafs. Drilling through and sealing off abandoned goafs requires additional equipment and procedures. This includes a larger diameter hole from the surface to allow placement of additional bore casing. This will require a larger rig and additional time on site.

— Goaf gas exploration wells (ie gas held in abandoned coal mine workings) for exploring gas quality and quantity from such goafs.

— Unmined coal seam exploration wells for extended testing of gas flow rates.

Some planned holes will be combinations of the above.

The drilling programme will require ground clearance at each drill site and has the potential to disturb soil profiles and, consequently, archaeological heritage items and places located at each borehole. This report assesses the likely cultural heritage impacts associated with the drilling programme.

1.4 Planning approvals

1.4.1 Part 3A, *Environmental Planning and Assessment Act 1979*

The project meets the definition of a Major Project under the *State Environmental Planning Policy (Major Project) 2005*. Consequently, the exploration proposal has to be approved in accordance with Part 3A of the *Environmental Planning and Assessment Act 1979* (*EP&A Act*), Project Application No: 07_0103. Major Projects have a centralised approvals process, with the Minister for Planning issuing project approval for the overall proposal.

Part 3A, Section 75U of the *EP&A Act* specifies approvals and legislation not applicable to Major Projects.

75U (1) The following authorisations are not required for an approved project (and accordingly the provisions of any Act that prohibit an activity without such an authority do not apply):

(c) an approval under Part 4, or an excavation permit under section 139, of the *Heritage Act 1977*

(d) a permit under section 87 or a consent under section 90 of the *National Parks and Wildlife Act 1974*

1.4.2 Director-General's Requirements

The Director-General's Requirements for the project identify Aboriginal Heritage as a key issue to be considered in the Environmental Assessment (EA).

Specifically, the Director-General's Requirements state:

> The EA should address and document the information requirements set out in the draft "Guidelines for Aboriginal Cultural heritage Impact Assessment and Community Consultation" involving surveys and consultation with the Aboriginal community.
>
> Identify the nature and extent of impacts on Aboriginal cultural heritage values across the project
>
> Describe the actions that will be taken to avoid or mitigate impacts or compensate to prevent unavoidable impacts of the project on Aboriginal cultural heritage values. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.
>
> The EA needs to clearly demonstrate that effective community consultation with Aboriginal communities has been undertaken in determining and assessing impacts, developing options and making final recommendations.

Historic cultural heritage has not been identified as a key issue within the Director-General's requirements.

1.5 Aims

The following is a summary of the major tasks of this assessment

— Undertake an Aboriginal consultation program based on the guidelines endorsed by the DECC for project approvals under Part 3A of the *EP&A Act* 1979.

— Conduct detailed background investigations into previous studies in the region and particularly the study area.

— Identify all known and potential Aboriginal and historical archaeological and built heritage sites within the study area, including heritage register searches of the Aboriginal Heritage Information Management System (AHIMS), the National Heritage List, Commonwealth Heritage List, Register of the National Estate, State Heritage Register, Local Environmental Plan and National Trust heritage lists.

— Produce a predictive model for site locations, densities, types and chronologies that might be expected to occur within the study area.

— Carry out a suitable field survey to locate all recorded and potential Aboriginal and historical sites within each borehole area and consider appropriate mitigation measures to ensure site avoidance where possible.

— Produce a statement identifying the Aboriginal and historical significance of the study area.

— Identify impacts to all identified Aboriginal and historic cultural heritage sites and places based on potential changes as a result of the proposed development.

— Make realistic recommendations and safeguards that will ensure compliance with statutory and non-statutory obligations and the protection of significant components of the archaeological resource.

— Prepare a report to meet the Department of Environment and Climate Change and Heritage Branch guidelines for archaeological survey and cultural heritage reporting.

1.6 Consultation

1.6.1 Statutory

During the course of this project consultation with the DECC has been ongoing. No consultation has been undertaken with the Heritage Branch, NSW Department of Planning.

1.6.2 Aboriginal

A cultural heritage consultation program was undertaken as part of the Apex Energy NL Illawarra Coal-Seam Gas Exploration Drilling Programme Project as per the DECC guidelines presented in *Part 6 Approvals – Interim Community Consultation Requirements for Applicants.*

Public notifications following the DECC guidelines were made in August 2007. Respondents were forwarded copies of survey methodology for comment.

In accordance with the DECC *Part 6 Approvals – Interim Community Consultation Requirements for Applicants*, Biosis Research notified the following bodies of the Apex Energy NL Illawarra Coal-Seam Gas Exploration Drilling Programme Project on 16 August 2007:

- Illawarra Local Aboriginal Land Council;
- The Registrar of Aboriginal Owners;
- Native Title Services;
- The Wollongong Shire Council; and
- The NSW Department of Environment and Climate Change.

In addition to the written notifications, an advertisement was placed in the *Illawarra Mercury* on 17 August 2007. A register for interested parties was opened on 17 August 2007 and registrations were received by Biosis Research until 31 August 2007.

The following respondents registered an interest in the project:

- Ms Karen Gough (Interested individual registered on behalf of her children);
- Mr Robert Evitt (Interested individual);
- Illawarra Local Aboriginal Land Council (Ms Sharralyn Robinson); and
- Kullila Welfare and Housing Aboriginal Corporation (Ms Maria Maher)

Collectively they are referred to as ‘registered stakeholders’.

1.7 Structure of this report

The study area comprises 18 discrete borehole locations situated in the Wollongong / Illawarra region of NSW. In the interests of keeping all relevant information for each of these sites together, the report has been structured to present general methodologies and regional background material in the earlier chapters, while Appendix 1 presents specific information for each of the 18 borehole sites.

2.0 ABORIGINAL CULTURAL HERITAGE ASSESSMENT METHODOLOGY – PART 3A APPROVALS

2.1 Philosophy

The New South Wales Department of Environment and Climate Change (formerly the Department of Environment and Conservation) defines Aboriginal cultural heritage as consisting of places and items that are of significance to Aboriginal people because of their traditions, observances, customs, beliefs and history (2005). This cultural heritage is evidence of the lives of Aboriginal people right up to the present. Aboriginal cultural heritage is dynamic – it is not static. It may comprise physical (tangible) or non-physical (intangible) elements. As such, it includes things made and used in earlier times, such as stone tools, art sites and ceremonial or burial grounds, as well as more recent evidence such as old mission buildings, massacre sites and cemeteries.

Aboriginal people have shared a relationship with the landscape that is now called NSW for a very long time. Archaeologists agree that this time is at least 45,000 years. Unlike the culture of all the other people in multi-cultural Australia, Aboriginal culture makes no reference to any other place or time to define itself – it is, in every sense, indigenous culture. The evidence and important cultural meanings relating to Aboriginal culture are present throughout the landscape, as well as in documents and in the memories, stories and associations of Aboriginal people. Therefore, activities that impact the landscape may affect Aboriginal cultural heritage.

In most communities one of the most valuable and important aspects of life that is handed on from one generation to the next is cultural knowledge. For Aboriginal people, this knowledge is intimately and inseparably entwined with the natural environment.

2.2 Guiding Principles

This methodology has been designed to conform to the requirements of the relevant advisory documents and guidelines. These guidelines and documents are:

— DECC endorsed *National Parks and Wildlife Act 1974: Part 6 Approvals – Interim Community Consultation Requirements for Applicants* (2004) [hereafter referred to as 'DECC Part 6 Guidelines']

— DECC endorsed *Draft Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation* (July 2005), for assessing potential impacts on Aboriginal cultural heritage for development applications assessed under Part 3A of the *Environmental Planning and Assessment Act 1979* [hereafter referred to as 'DECC Part 3A Guidelines']

— The *Australia ICOMOS Burra Charter* [hereafter referred to as 'the Burra Charter']

— DECC endorsed *Aboriginal Cultural Heritage Standards and Guidelines Kit* [hereafter referred to as 'DECC Standards and Guidelines Kit']

— DECC endorsed *Guidelines for Aboriginal Heritage Impact Assessment* (DRAFT) [hereafter referred to as 'DECC Draft Impact Guidelines']

In line with these documents, our consultation protocol acknowledges the following principles:

— Input from those Aboriginal people with a cultural association with the land is an essential part of assessing the significance of Aboriginal heritage objects and values that could be impacted by an activity;

— Aboriginal heritage can have both cultural and scientific/archaeological significance and both should be the subject of assessment;

— Aboriginal people are the primary determinants of the significance of their heritage;

— Aboriginal community involvement needs to take place early in the assessment process to ensure that their values and concerns are fully taken into account, and that their own decision-making structures are able to function; and

— Consideration should be given to any measures that could be implemented to avoid, mitigate or offset likely impacts.

The DECC Part 6 Guidelines note that the community consultation process ensures that Aboriginal communities have the opportunity to positively influence assessment outcomes by:

— Influencing the design of the assessment of cultural and scientific significance;

— Providing relevant information in relation to cultural significance values; and

— Contributing to the development of cultural heritage management recommendations.

2.3 Aims

The aims of the Aboriginal community consultation to be undertaken by Biosis Research, and outlined in this methodology, are to:

— Gain the Aboriginal community's view on the methodology for cultural and archaeological assessment, and refine the methodology to incorporate these views as required;

— Gain the Aboriginal community's views and determinations of value for the study area and any cultural heritage sites therein;

— Gain the Aboriginal community's views about potential impacts on the cultural heritage values of the study area and the wider landscape;

— Discuss with the Aboriginal community mitigation and management strategies for sites that may potentially be impacted (including the requirement for statutory approvals);

— Discuss with the Aboriginal community mitigation and management strategies for potential impacts to the cultural landscape;

— Discuss with the Aboriginal community their views regarding employment opportunities within the ambit of future mitigation and management works (if required) relating to cultural heritage impacts;

— Provide comprehensive and realistic management recommendations to Apex Energy NL. These recommendations will integrate Aboriginal community views and current cultural heritage management best practice.

2.4 Agreed Methodology – Apex Energy NL Illawarra Coal-Seam Gas Exploration Drilling Programme

2.4.1 Cultural Consultation Process

The objectives of the consultation process are to ensure that an opportunity is given to a broad range of Aboriginal stakeholders to express their cultural heritage values of the study area, including spiritual connections, recorded archaeological sites, and the natural environment and landscape values.

The cultural consultation process will involve the following:

— Distribution of a project information pack that outlines:

1. The proposed works within the study area;
2. Proposed methods of archaeological assessment of the study area;
3. Findings of previous archaeological assessments within the study area, including detailed mapping of previously recorded sites and areas of Aboriginal archaeological potential; and
4. An outline of key themes relating to cultural values that will be discussed during organised consultation meetings (meeting program outlined below).

— Face to face meetings. The key themes to be discussed during community consultation meetings will include:

1. Affiliation to country - being traditional and/or contemporary;
2. Places, sites, traditional resources and landscape values that are identified as significant;
3. Identified connection to place, sites or landscape - physical or spiritual; and
4. Related stories - historical or contemporary that reinforce the significance of place.

— Management issues and recommendations relating to cultural values within the study area will include:

1. Identification of places and sites that are significant to stakeholders and discussion of options for avoidance by the proposed works;

2. Identification and acknowledgment of community management strategies for physical and spiritual sites and places; and
3. Discussion of requirements or restrictions within the study area which may occur if Aboriginal objects or places are identified within the impact area of the proposal.

Following the completion of the field assessment within the study area, further consultation will occur with key stakeholders to discuss any issues that may have become apparent during the survey. This will also involve requests for comments on the draft report and the formulation of management recommendations. If required, further face to face consultation to discuss this can be completed.

2.4.2 Archaeological Methodology

The archaeological assessment will involve the following tasks:

— A search of the DECC's Aboriginal Heritage Information Management System (AHIMS);

— Literature review of all relevant cultural heritage and archaeological reports and publications for the local area and region;

— A search of the NSW Heritage Branch State Heritage Inventory and State Heritage Register; and

— Consultation of historical source material (including historical maps and aerial photography) to determine land-use history.

A search was requested of the DECC AHIMS and the results mapped and forwarded to registered stakeholders.

An archaeological survey of the proposed 18 drill sites will be conducted, as described below.

Pedestrian Survey of the 18 proposed drill sites

Block pedestrian survey of the 18 proposed drill sites will be conducted. Each drill site will include a compound and drill area of approximately 50 m x 70 m. Survey will involve a team comprising a Biosis Research archaeologist and Aboriginal community members walking parallel survey transects with close spacing between survey team members. The aim of the block survey is for the survey transects to cover as far as practical the entire drill site area (except any areas considered dangerous subject to Occupational Health and Safe considerations). In summary **all of the area within each of the drill site compounds will be surveyed**.

Identification and Recording of Traditional Resources

During the archaeological surveys the identification and recording of any traditional resources within the study area will be conducted. This will involve recording the type of resource, location of occurrence, and the traditional uses of the resource.

2.4.3 Assessment of Significance

In New South Wales the Department of Environment and Climate Change affirms that the 'Aboriginal community are the primary determinants of the significance of their heritage' (NSW DEC 2005). Biosis Research recognises that our role in the cultural heritage assessment process is to provide specialist skills, particularly in regard to archaeological and heritage management expertise. These specialist skills can be articulated and enhanced through consultation with the Aboriginal community, with the aim of providing a holistic assessment of cultural heritage significance.

Archaeologists study the material cultural heritage—artefacts, sites and structures—of past peoples and societies. However, not all places and sites of cultural heritage value and significance have material evidence. Places, sites and things have heritage value because of what they mean to people, and because of the values they represent for people. Places, sites and things will have different heritage values for different people. These different values may require negotiation among various stakeholders and can shape what decisions are made about conservation. Cultural heritage management is the process of investigation, consultation and making decisions about the conservation of heritage places through the assessment of heritage values.

Heritage management is based on the principle that the heritage significance of a place will guide all future decisions that affect the place. The determination of cultural heritage significance relies on a comprehensive approach to heritage assessments and to the values that are attached to heritage places. Cultural heritage significance can be considered to be the importance of a place, site or object arising from the combination of values attributed to it. These values determine the 'what' and 'how' of conservation and direct management decisions. The categorisation and significance of a place or site will also determine the statutory protection that may be afforded to it.

This approach is laid out in the Australia ICOMOS Burra Charter (1999), which has been adopted by cultural heritage managers and government agencies as the set of guidelines for best practice heritage management in Australia. The Burra Charter identifies the following categories of values: aesthetic, historic, scientific and social. Most assessment approaches also include a ranking of significance – high, moderate or low for example. For each value associated with a place, an attempt is made to assess the degree or level of significance in terms such as *unique, important, representative, rare* and so on – which relies on a comparison of that value in relation to other places. One of the more common applications of the significance assessment process is to mitigate or control landscape modifying activities to protect or conserve identified heritage values.

Both professional and community understandings can come into play when determining heritage and its significance, and 'expert' interpretation will often need to be integrated with other understandings and assessments of heritage. This is particularly relevant in a discussion of Aboriginal cultural heritage, where there can be differences in the way places are valued and in understandings of how knowledge can be used. As a consequence, outcomes should rely on processes and practices that promote integration and an effective incorporation of different values in decision making.

For example, an 'archaeological' site can be of broader interest to groups other than archaeologists. There are additional scientific interests in archaeological sites to those that arise through archaeology alone. Many types of scientific research or 'informational' interests can use data from archaeological sites, and these can all contribute to the 'scientific value' of a place or site. Also, the wider interests of the general community can be complementary to archaeological values. In terms of Aboriginal communities, heritage places – including those that are otherwise defined as 'archaeological sites' – will possess differing values. These may include custodianship obligations, education, family or ancestral links, identity, and symbolic representation.

History and traditions are important: it is our obligation to future generations to retain certain things as they are currently seen and understood. This also means we should retain alternative understandings in addition to those that come through scientific assessments. Heritage places are often more complex than is identified through the scientific determination of value. Cultural and social values can be complex and rich - the past is a vital component of cultural identity. Feelings of belonging and identity are reinforced by knowledge of the existence of a past, and this is further reinforced and maintained in the protection of cultural heritage.

Assessment of Cultural Heritage Significance

As well as the Australia ICOMOS Burra Charter, the NSW DECC has endorsed the *Guidelines for Aboriginal Cultural Heritage Impact Assessment*. The relevant sections of the *Guidelines* are presented and discussed below.

The *Guidelines* state that an area may contain evidence and associations which demonstrate one or any combination of the following Aboriginal heritage values. The values described by the *Guidelines* are drawn from the Burra Charter, and are reproduced below:

Social value (sometimes termed Aboriginal value) refers to the spiritual, traditional, historical or contemporary associations and attachment that the place or area has for the present-day Aboriginal community. Places of social significance have associations with contemporary community identity. These places can have associations with tragic or warmly remembered experiences, periods or events. Communities can experience a sense of loss should a place of social significance be damaged or destroyed. These aspects of heritage significance can only be determined through consultative processes with one or more Aboriginal communities.

Historic value refers to the associations of a place with a person, event, phase or activity of importance to the history of an Aboriginal community. Historic places may or may not have

physical evidence of their historical importance (such as structures, planted vegetation or landscape modifications). Gaining a sufficient understanding of this aspect of significance will often require the collection of oral histories and archival or documentary research, as well as field documentation. These places may have 'shared' historic values with other (non-Aboriginal) communities. Places of post-contact Aboriginal history have generally been poorly recognised in investigations of Aboriginal heritage, and the Aboriginal involvement and contribution to important regional historical themes is often missing from accepted historical narratives.

Scientific value refers to the importance of a landscape, area, place or object because of its archaeological and/or other technical aspects. Assessment of scientific value is often based on the likely research potential of the area, place or object and will consider the importance of the data involved, its rarity, quality or representativeness, and the degree to which it may contribute further substantial information.

Aesthetic value refers to the sensory, scenic, architectural and creative aspects of the place. It is often closely linked with social values and may include consideration of form, scale, colour, texture, and material of the fabric or landscape, and the smell and sounds associated with the place and its use.

All Aboriginal sites and places, including those that are considered to be 'archaeological' – for example, middens or artefact scatters – may have a particular value and meaning to Aboriginal people.

Cultural Landscapes

In addition to these four definitions of value, the *Guidelines* also specify the importance of considering cultural landscapes when determining and assessing Aboriginal heritage values. The principle behind a cultural landscape is that 'the significance of individual features is derived from their inter-relatedness within the cultural landscape'. This means that sites or places cannot be 'assessed in isolation' but must be considered as parts of the wider cultural landscape. Hence the site or place will possibly have values derived from its association with other sites and places. By investigating the associations between sites, places, and (for example) natural resources in the cultural landscape the stories behind the features can be told. The context of the cultural landscape can unlock 'better understanding of the cultural meaning and importance' of sites and places.

Determination of Cultural Heritage Significance

The Burra Charter suggests that heritage practitioners 'should prepare a succinct statement of cultural significance, supported by, or cross referenced to, sufficient graphic material to help identify the fabric of cultural significance'. The statement must be clear and concise, and must not simply restate the physical or documentary evidence presented as part of the assessment.

We will present our assessments of cultural heritage significance as *statements of significance* that preface a concise discussion of the contributing factors to the cultural heritage significance.

When determining cultural significance for sites and places we will be referring to each of the categories defined above, and nominating the level of value—high, moderate, low or not applicable—for each relevant category. Our consideration of the thresholds for each level of value for the categories will be guided by the contributing factors defined above for each category. The categories are:

— Social value

— Historic value

— Scientific value

— Aesthetic value

— Cultural landscape value

The determination of cultural landscape value will be applied to individual and collective sites and places (to explore inherent values and associative values).

3.0 HERITAGE STATUS AND PLANNING DOCUMENTS

3.1 Commonwealth Registers

3.1.1 National Heritage Registers

The Commonwealth *Australian Heritage Commission Act* was recently repealed and in its place amendments were made to the *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act*).

Under the *EPBC Act* Amendments (No 88, 2003) two mechanisms have been created for protection of heritage places of National or Commonwealth significance. The National Heritage List provides protection to places of cultural significance to the nation of Australia. The Commonwealth Heritage List comprises natural, Aboriginal and historical heritage places owned and controlled by the Commonwealth and therefore mostly include places associated with defence, communications, customs and other government activities.

Nominations to these two lists are assessed by the Australian Heritage Council (AHC), who also compile the Register of the National Estate, a list of places identified as having national estate values. There are no management constraints associated with listing on the RNE unless the listed place is owned by a commonwealth agency.

APPLICATION TO THE STUDY AREA – NATIONAL HERITAGE REGISTERS

No items within the study area are listed on the National Heritage List, the Commonwealth Heritage List or the Register of the National Estate.

3.1.2 National Native Title Register

The Commonwealth *Native Title Act 1993* establishes the principles and mechanisms for the recognition, determination of Native Title for Aboriginal people.

The purpose of searching the register is to identify any Traditional Owner groups with current registered claims close to the study area that may identify themselves as relevant stakeholders with traditional knowledge or experience.

APPLICATION TO THE STUDY AREA – NATIONAL NATIVE TITLE REGISTER LISTINGS

A search of the National Native Title Register, the Register of Native Title Claims and the Register of Indigenous Land Use Agreements was completed on 3 September 2007. There are no lands determined to have native title, and no registered native title claims or indigenous land use agreements within the study area or its immediate vicinity.

3.2 State Registers

3.2.1 National Parks and Wildlife Act Registers

The Department of Environment and Climate Change (DECC) maintains a register of Aboriginal sites in NSW. Under the NSW *National Parks and Wildlife Act 1974* Aboriginal sites in NSW are required to be registered on the Aboriginal Heritage Information Management System (AHIMS) database. The database contains a list of registered Aboriginal objects, Aboriginal places and other Aboriginal heritage values in NSW.

A search of the AHIMS register was undertaken at the commencement of the project. The area searched on the AHIMS database was larger than the study area, as Aboriginal sites recorded within the wider area will provide a regional perspective on the types of sites that maybe expected to be found within the study area.

APPLICATION TO THE STUDY AREA – AHIMS DATABASE

A search of the AHIMS Database completed on 7 August 2007 and 29 August 2007 and identified 284 previously recorded Aboriginal sites within a large, regional search area encompassing all 18 borehole sites, (see Section 5.2.1 and Borehole Data Sheets in Appendix 1). Three of these sites are within 200 m of a proposed borehole location.

3.2.2 Heritage Act Registers

The Heritage Branch, NSW Department of Planning, maintains registers of heritage and archaeological items that are of State or local significance to New South Wales.

The State Heritage Register (SHR) contains items that have been assessed as being of State Significance to New South Wales. The State Heritage Inventory (SHI) contains items that are listed on Local Environmental Plans and/or on a State Government Agency's Section 170 registers and may include items of State significance not included on the SHR and items of local level significance.

If an item or place does not appear on either the SHR or SHI this may not mean that the item or place does not have heritage or archaeological significance; many items have not been assessed to determine their heritage significance. An assessment is required for items that are 50 years or older. Items that appear on either the SHR or SHI have a defined level of statutory protection.

APPLICATION TO THE STUDY AREA – NSW STATE HERITAGE REGISTER LISTINGS

No items in the study area are listed on the State Heritage Register.

APPLICATION TO THE STUDY AREA – NSW STATE HERITAGE INVENTORY LISTINGS

No items in the study area are listed on the State Heritage Inventory.

S.170 provisions: In addition, Section 170 of the NSW *Heritage Act 1977* requires that culturally significant items or places managed or owned by Government agencies be listed on departmental Conservation and Heritage Registers. Information in these Registers has been prepared according to NSW Heritage Branch guidelines and should correspond with information in the State Heritage Inventory.

APPLICATION TO THE STUDY AREA – SYDNEY CATCHMENT AUTHORITY S.170 REGISTER

No items within the study area are included on the

- Sydney Catchment Authority S170 Heritage and Conservation Register
- Roads and Traffic Authority S170 Heritage and Conservation Register

Relics Provisions: Generally, approval must be obtained from the Heritage Council of NSW when making changes to a heritage place listed on the State Heritage Register (Section 60 Permit), or when excavating any land in NSW where there is a possibility that archaeological relics may be disturbed (Section 140 Permit).

While the *Heritage Act 1977* currently affords automatic statutory protection to 'relics' that form part of archaeological deposits (Sections 139–145 of the Act), the relics provisions are not applicable to Major Projects being assessed under Part 3A of the *EP&A Act 1979*.

APPLICATION TO THE STUDY AREA – NSW HERITAGE ACT 1977 RELICS PROVISIONS

Approvals specified by the relics provisions of the *Heritage Act* do not apply to Major Projects being assessed under Part 3A of the *EP&A Act 1979.*

3.2.3 Environmental Planning and Assessment Act Registers

The *Environmental Planning and Assessment Act 1979* includes provisions for local government authorities to consider environmental impacts in land-use planning and decision making. Such impacts are generally considered in relation to the planning provisions contained in the Local Environment Plan (LEP) or regional Environment Plan (REP).

Local Environmental Plans: Each Local Government Area (LGA) is required to create and maintain a LEP that includes Aboriginal and historic heritage items. Local Councils identify items that are of significance within their LGA, and these items are listed on heritage

schedules in the local LEP and are protected under the *EP&A Act 1979* and *Heritage Act 1977*.

APPLICATION TO THE STUDY AREA – WOLLONGONG LEP 1990 SCHEDULE 1

No items within the study area are listed in the heritage schedule of the *Wollongong LEP 1990*.

Regional Environmental Plans: Under the *EP&A Act 1979*, broad scale regional plans have also been developed that address cultural heritage resources that may extend beyond the geographic limit of one LGA. The *Illawarra Regional Environmental Plan 1986 No 1* applies to the Wollongong, Shellharbour, Kiama, Shoalhaven and Wingecarribee local government areas and provides a planning and decision making framework for how to best use land resources, improve quality of life and protect regional interests and investment. The REP identifies the Illawarra region as possessing unique characteristics worth preserving and distinguishes items of cultural heritage.

APPLICATION TO THE STUDY AREA – ILLAWARRA REP 1986 NO 1

No items within the study area are listed in the heritage schedule of the *Illawarra REP 1986 No. 1*.

3.3 Non-Statutory Registers

3.3.1 The National Trust of Australia (NSW)

The National Trust of Australia (NSW) is a community-based conservation organisation. The Trust maintains a Register of heritage items and places. Although the Register has no legal foundation or statutory power, it is recognised as an authoritative statement on the significance to the community of particular items, and is held in high esteem by the public. The National Trust lists items or places that have heritage or cultural value to the community and, as such, the Trust encourages and promotes the public appreciation, knowledge, and enjoyment of heritage items for future and present generations.

APPLICATION TO THE STUDY AREA – NATIONAL TRUST OF AUSTRALIA (NSW)

No heritage items classified (listed) by the National Trust of Australia are located within the study area associated with this proposal.

3.4 Management Documents

3.4.1 Aboriginal Cultural Heritage

Aboriginal Heritage Planning Study *Dallas & Sullivan (1995)*

Mary Dallas (1995) prepared an Aboriginal heritage planning study of the Wollongong LGA. This document describes the landforms of the Wollongong LGA and specifies the site type likely to be encountered in each landform unit. Recommendations were made regarding the specific planning policies that Wollongong City Council should adopt to protect Aboriginal cultural heritage within the LGA.

3.4.2 Historic Cultural Heritage

City of Wollongong Heritage Study *McPhee et al. (1991)*

McPhee et al. prepared a thematic history of the Wollongong LGA, identifying significant activities within the district at certain times. Their understanding of the historic context of the area was used to identify historic built elements that reflected significant historic processes and periods. This document is concerned primarily with built heritage and is not specifically aimed at providing a predictive framework in which archaeological sites may be identified and managed. However, an understanding of the larger historic processes at work within the area will suggest the site types likely to be present within the Wollongong LGA.

Wollongong Technical Policy No. 97/2 *Historic Heritage DCP*

Wollongong City Council has prepared a historic heritage Development Control Plan (Technical Policy 97/2) which explains Council's policies and objectives in relation to buildings and landscapes which are listed as heritage items or which are within heritage conservation areas. As the study area does not include listed heritage items and is not within a conservation area listed in *Wollongong LEP* 1990 this document is not applicable to the current proposal.

3.5 Summary of heritage listings in the study area

There are no previously identified Aboriginal or historic heritage items within the Apex Energy NL Illawarra coal-seam gas exploration drilling programme areas. Three of the proposed borehole locations are within 200m m of registered Aboriginal sites. These boreholes are discussed more fully in Appendix 1 of this report.

4.0 ENVIRONMENTAL CONTEXT

A description of the environmental background to the study area is provided in order to give context to the archaeological assessment. The environmental aspects of an area will influence the type of archaeological remains that are likely to be present.

Firstly, the environmental conditions of the study area may have influenced the land use by people in the past, and secondly, they will affect the processes by which sites are preserved. Environmental values of an area can also contribute to the cultural significance and attachments people have to a place.

The following background is a brief summary of information relevant to the current assessment of archaeological values of the study area.

4.1 Geomorphology

4.1.1 Geology

The study area is located on Hawkesbury Sandstone, with occasional occurrences of the Mittagong Formation when the Lucas Heights Soil landscape is encountered. The Hawkesbury Sandstone contains medium to coarse-grained quartz sandstone and also occasional shale and laminite lenses (Hazelton & Tille 1990:31). Sandstone outcrops in the area generally have a blocky appearance due to a combination of bedding planes and widely spaced joints (Hazelton & Tille 1990:45). The Mittagong Formation consists of interbedded shale, laminite and fine to medium grained sandstone. Stratigraphically it is situated between Ashfield Shale and Hawkesbury Sandstone, and is relatively shallow. This formation lacks rock outcrops (Hazelton & Tille 1990:23).

4.1.2 Soils

Two major soil landscapes have been defined within the study area, with minor occurrences of a third soil landscape (Hazelton and Tille 1990). Soil landscape have distinct morphological and topological characteristics, resulting in each landscape having different archaeological potential. Because they are defined by a combination of soils, topography, vegetation and weathering conditions, soil landscapes are essentially terrain units that provide a useful way to summarise archaeological potential and exposure. There is one colluvial landscape (Hawkesbury) and two residual landscapes (Lucas Heights and Bundeena) in the study area (Hazelton and Tille 1990: 23-6, 31-33, 45-9). Residual soil landscapes are characterised by areas where soils are derived from the long-term, in situ weathering of parent materials. Examples of these types of soil landscapes are flats, plains and plateaus with poorly defined drainage lines. Colluvial soil landscapes are dominated by areas where mass movement is the principal agent of accumulation. Cliffs, scarps, and steep slopes are examples of colluvial soil landscapes.

The Hawkesbury soil landscape is characterised by rugged sandstone escarpment and ridges, with moderate to steep slopes and narrow, deeply incised valleys of the Woronora Plateau (Hazelton & Tille 1990). Sandstone rock outcrops are very common, and occur as boulders, benches and large blocks, often forming scarps up to 10 metres high. The landscape is confined to the margins of the major rivers including the Nepean and Avon, and larger tributaries. The soils in this landscape are shallow, discontinuous and generally sandy. The Hawkesbury landscape is the most archaeologically sensitive landscape in the study area, as the blocks and weathered scarps provide overhangs with a suitable environment for rock art and in some cases the accumulation of cultural deposits; however deposits with the potential for deep, stratified archaeological sites are very limited. Previous archaeological work in the region has demonstrated an abundance of rock art associated with this landscape, and the steep gorges and gullies are where most archaeological survey has been focused.

The Bundeena soil landscape comprises exposed plateaux and coastal headlands within the Woronora Plateau (Hazelton & Tille 1990:31). The soils consist mostly of siliceous and earthy sands, along with yellow earths and gleyed podsolic soils on the mid to lower slopes. Limitations include low soil fertility, stoniness and low available water-holding capacity. swamps are a commonly noted feature of this landscape. As rock outcrops constitute approximately 30-50% of the land surface (Hazelton & Tille 1990:31), archaeological site types most likely to be found in this area consist of axe grinding grooves, engraving sites and isolated stone artefact occurrences.

The Lucas Heights soil landscape consists of soils which are generally yellowed to lateritic podsolic; however, this landscape is known for outcrops and limited deep soil bases (Hazelton & Tille 1990:23). Limitations include stoniness, hard-setting surfaces and low soil fertility. Within the study area this soil type is confined to the ridge tops and gentle slopes. Although this soil landscape consists of generally shallower soils, it is still considered to be of some Aboriginal archaeological potential. These site types are more likely to comprise isolated stone artefact occurrences situated on travel routes rather than campsites.

4.1.3 Topography

The survey area is located mainly on Hawkesbury and Bundeena soil landscapes, with occasional occurrences of the Lucas Heights landscape. The Hawkesbury soil landscape is described by Hazelton and Tille (1990:45) as consisting of ‘steep, rugged sandstone slopes and ridges’, with local relief between 100-200 m and slope grades between 20% and 70%. Rock outcrops and surface rocks are abundant, occurring as sandstone benches, broken scarps and boulders, with the scarps being up to 10 m high.

The topography of the Bundeena soil landscape is described by Hazelton and Tille (1990:31) as comprising gently inclined slopes with a gradient of between 5% and 20%, occasional narrow benches and broad ridges and crests, while the Lucas Heights landscape can be described as having gently undulating crests, ridges and plateau surfaces, with local relief between 10 to 50 metres and slopes of less than ten per cent (Hazelton & Tille 1990:23).

In general, the topography surrounding the borehole locations includes discrete areas of rugged sandstone escarpment and ridges, with moderate to steep slopes and narrow, deeply incised valleys. These areas are most likely to contain significant sandstone overhangs that may have been used as shelter sites. Those sections of the study area that are located away from major water courses will comprise gently undulating crests, ridges and plateau surfaces. On open plateau, adjacent to swamps where open sandstone platforms occur, axe grinding groove sites are the most likely Aboriginal site type to occur.

4.2 Climate

In general, the climate within the study area is warm to temperate. There are, however, significant variations within the various landscape types. Average maximum daytime temperatures in the Wollongong region range from 26 degrees Celsius in summer to 17 degrees Celsius in winter. Autumn is the wettest time of the year and winter the driest, with average annual rainfall at over 1,000 millimetres (Bureau of Meteorology 2005). The plateau region is cooler and drier than the coast. Conditions in the study area would have been relatively mild during human habitation of the region and would not have posed any major restriction to a hunter-gatherer lifestyle.

The climate of the study area would have allowed a hunter-gather lifestyle year-round in the Holocene period, that is, the last 10,000 years. The prior glacial period would have been cooler and drier and the coast would have been a considerable distance to the east of its present position. Sea levels were lower as most of the water was trapped in glacial ice. Mainland Australia had few glaciers, which were located in alpine areas. A cooler climate would have affected a hunter-gatherer lifestyle as, for example, flora and fauna resources would be different than those found in today's warmer climates.

4.3 Flora and Fauna

For the purposes of discussing the significance of plant species in relation to Aboriginal and historic use, the details of each community will not be discussed here in detail. The details of individual plant communities can be found in Biosis Research (2008b). Instead, a general summary of four broad vegetation types that are relevant to traditional usages will be summarised below.

4.3.1 Flora

Upland Swamps

The Upland Swamps of the Illawarra Escarpment and Woronora Plateau are low heaths and sedgelands ranging in height from 0.5 metres to 3 metres. Species composition is variable but typical shrub species may include *Acacia rubida* (Wattle), *Banksia paludosa* (Swamp Banksia), *Banksia robur* (Large-leaved Banksia), *Banksia ericifolia* (Heath Banksia), *Hakea teretifolia* (Dagger Hakea) and *Leptospermum* spp. (Tea trees, Tantoon). The ground layer is

dominated by a variety of herbs, sedges and grasses including *Dodonaea triquetra* (Common Hop Bush), *Lomandra longifolia* (Spiny headed Mat Rush), *Baumea teretifolia* (Wrinkle-nut Twig-rush), *Gahnia sieberi* (Red-fruited Saw Sedge), *Lepidosperma limicola, Leptocarpus tenax* (Twine-rush), *Entolasia stricta,* and *Gleichenia dicarpa* (Pouched Coral Fern).

Ridge-top Woodland

The ridges and plateaus of the study area support eucalypt woodland and open forest to a maximum height of 15 metres. The unit is relatively homogeneous throughout the broader sandstone ridges and plateaus and has well-defined tree, small tree, shrub and ground layers. Characteristic tree species include *Corymbia gummifera* (Red Bloodwood), *Eucalyptus racemosa* (Scribbly Gum) and *Eucalyptus sieberi* (Silvertop Ash). A variety of stringybark species are also usually present in smaller numbers. *Banksia serrata* (Old Man Banksia) and *Leptospermum trinervium* (Paperbark Tea-tree) dominate the small tree layer while *Banksia spinulosa* (Hair Pin Banksia), *Dillwynia retorta*, *Platysace linearifolia*, *Petrophile sessilis*, *Eriostemon australasius, Isopogon anemonifolius*, *Phyllanthus hirtellus*, *Lambertia formosa*, *Hakea sericea* and *Persoonia levis* are common shrub species amongst many others. The composition of the ground layer is largely determined by localised drainage patterns but may include *Cyathochaeta diandra*, *Gahnia sieberiana*, *Lomandra* spp., *Dampiera stricta*, *Lepyrodia scariosa* and *Lepidosperma laterale*.

Gully Forest

Gully Forest occupies the slopes and gullies of the Woronora Plateau. It is a dry forest to a height of 25 metres dominated by *Eucalyptus piperita* (Sydney Peppermint) and *Corymbia gummifera* (Red Bloodwood). A diverse shrub layer that includes *Banksia spinulosa* (Hair-pin Banksia), *Persoonia* spp. (Geebungs), *Acacia longifolia*, *A. myrtifolia*, *A. ulicifolia*, *A. binervata*, *Pultenaea* spp. (Bush Peas) and *Leucopogon lanceolatus* (Lance Beard-heath) is present. *Telopea speciosissima* (Waratah) are also common and are conspicuous when in flower. *Banksia serrata* (Old Man Banksia) is common as a small tree. The ground cover is similarly diverse with combinations of *Entolasia stricta*, *Lomandra* spp. (Mat Rushes), *Dendrobium speciosum* (Rock Orchid), Patersonia *glabrata* (Leafy Purple Flag), *Dianella caerulea* (Blue Flax-lily), *Billardiera scandens* (Apple Berry), *Gonocarpus teucrioides* (Raspwort), *Lomatia silaifolia* (Crinkle Bush) and *Phyllanthus hirtellus* (Thyme Spurge) found consistently within sites. Variation occurs within this vegetation type in response to the degree of shelter and rainfall.

Warm Temperate Rainforest

Warm Temperate Rainforest occurs in gully lines and south and east-facing slopes. This vegetation type is composed of a closed canopy of *Ceratopetalum apetalum* (Coachwood) and *Doryphora sassafras* (Sassafras) that can reach heights up to 30 metres. *Acmena smithii* (Lilly Pilly), *Cryptocarya glaucescens* (Jackwood), *Acacia melanoxylon* (Blackwood), *A. binervata* (Two-veined Hickory) and *Backhousia* myrtifolia (Grey Myrtle) are common in the small tree layer. Limited sunlight penetrates the canopy and as a consequence only a sparse understorey of shade tolerant species are present including *Lastreopsis decomposita* (Trim

Shield Fern), *Microsorum scandens* (Fragrant Fern), *Arthropteris tenella*, *Morinda jasminoides* (Sweet Morinda), *Polyosma cunninghamii* (Featherwood), *Tasmannia insipida* (Brush Pepperbush) and *Livistona australis* (Cabbage-tree Palm). Greater elevation on the Woronora Plateau favours the growth of rainforest species associated with cool temperate environments, such as *Quintinia sieberi* (Possumwood) and *Eucryphia moorei* (Pinkwood).

4.3.2 Fauna

The vegetation across the plateau would have contained a diverse range of fauna (NSW NPWS 2002), including koalas, quolls, rock wallabies, bandicoots as well as birds such as cockatoos, falcons and owls. Along the waterways there would have been frogs, platypus and within the waters there would have been numerous fish species, such as perch, eels and galaxias. The plateau was an abundant resource for Aboriginal people. Aboriginal people hunted animals for food and materials. For example, the bones of animals could be fashioned into fishhooks and other everyday implements.

Species present within the study area would have provided a range of resources for Aboriginal people. Food, tools, shelter and ceremonial items were derived from floral resources, with the locations of many campsites predicated on the seasonal availability of resources.

4.4 Resource Statement

Based on the background information provided from various source material, it is possible to speculate what resources would have been available for both Aboriginal and European exploitation.

Quartz is the main stone raw-material type suitable for Aboriginal tool manufacture that would be likely to occur in the vicinity of the study area in any abundance. This would be in the form of pebbles derived from the Hawkesbury sandstone. Elsewhere on the Woronora Plateau and Cumberland Lowlands the potential raw materials for stone artefact making include silcrete, chert, tuff, mudstone, quartz, quartzite and basalt (Smith 1989). Deposits of clays and ochres suitable for art, particularly stencil art, are locally available in the vicinity of the study area and its adjacent land systems.

The Woronora River is a permanent watercourse, and the river and its tributaries would have provided an accessible, year-round water supply for Aboriginal people, early settlers and fauna within the region.

The Woronora Plateau would have provided a wide diversity of resources for the Aboriginal hunter-gatherer population. This diversity is even greater when it is considered how close the coastal resource areas are to the rugged plateau.

Many of the plants found within the area were important to both Aboriginal people and early Europeans inhabiting the area, and could be used for numerous purposes. Based on the known

species that occur within the study area, the following table summarises how these would have been utilised by the Aboriginal people inhabiting the area. These include using the wood to make implements; berries, leaves and tubers for food and medicines; as well as bark for shelters (Table 1 below).

Table 1: Traditional Aboriginal plant resources and use within the study area (from Robinson 1991; Stuart and Percival 1997).

SPECIES	*TRADITIONAL USE*
Upland Swamps	
Acacia rubida (Red-stemmed Wattle)	Seeds were ground for flour
Banksia paludosa (Swamp Banksia)	The nectar of the flowers was sucked or soaked to make a sweet beverage. The cones were used for retaining fire as they will remain alight for a considerable period
Banksia robur (Large-leaved Banksia)	The nectar of the flowers was sucked or soaked to make a sweet beverage. The cones were used for retaining fire as they will remain alight for a considerable period
Banksia ericifolia (Heath Banksia)	The flowers were sourced for their sweet nectar and either sucked or soaked
Dodonaea triquetra (Common Hop Bush)	The leaves were chewed for toothache and used as a poultice for stonefish and stingray wounds. The liquid made from soaking the roots was used for open cuts and sores
Lomandra longifolia (Spiny headed Mat Rush)	The seeds were ground for flour. The flowers and the base of the leaves are edible. The tough leaves were also used to make baskets
Pteridium esculentum (Common Bracken Fern)	The rhizome of this plant was a staple food source – roasted first to destroy the toxins before being chewed/eaten
Gahnia sieberiana (Saw sedge)	The seeds were pounded to produce flour and the bases of the leaves are edible
Ridge Top Woodland	
Banksia serrata (Old Man Banskia) *Banksia spinulosa* (Hair-pin Banksia)	The nectar of the flowers was sucked or soaked to make a sweet beverage. The cones were used for retaining fire as they will remain alight for a considerable period
Corymbia gummifera (Red Bloodwood)	The nectar from flowers was sucked. The resinous sap was used to stop fibre fishing lines from fraying. The red resinous sap was also used to attract Cryptococcus insects which form sweet tasting galls. The exudate was also used internally and applied externally in powdered form to treat sores
Eucalyptus agglomerate (Blue-leaved Stringybark)	The bark from these trees was made for making canoes. Also used the bark for making twine by rolling the fibres of soaked bark against their thighs
Eucalyptus sieberi (Silver Top Ash)	A fine grained hard wood used for tool handles, such as axes and oars
Leptiospermum trinervium (Paperbark Tea-tree)	The leaves are pungent and crushed for medicinal purposes
Gahnia sieberiana (Saw sedge)	The seeds were pounded to produce flour and the bases of the leaves are edible
Persoonia levis (Broad Leaf Geebung)	The fruits were eaten, although difficult to collect ripe as birds eat the unripened fruit. The bark of the Geebung was used to make a solution in which fishing lines were soaked for strength
Lomandra cylindricabn (Mat Rush)	Both the flowers and the bases of the leaves (pea like flavour) were edible
Xanthorrhoea media (Forest Grass Tree)	The flower stems produce significant nectar which can be eaten or placed in water to sweeten drinks. The stalks were used for spear shafts and the resin as glue for tools and weapons. The resin was collected as a powder by beating the leaf bases. The resin could also be collected in the trunks of old, dead, burnt stumps

Gully Forest	
Acianthus spp. (Orchids)	The tubers of this plant were eaten and were an important source of nourishment
Corymbia gummifera (Red Bloodwood)	The nectar from flowers was sucked. The resinous sap was used to stop fibre fishing lines from fraying. The red resinous sap was also used to attract Cryptococcus insects which form sweet tasting galls. The exudate was also used internally and applied externally in powdered form to treat sores
Eucalyptus piperita (Sydney Peppermint)	First plant to be used medicinally by Europeans – the oil from the leaves was distilled
Eucalyptus agglomerate (Blue-leaved Stringybark)	The bark from these trees was made for making canoes
Dendrobium speciosum (Rock Orchid)	The starchy stems are roasted and eaten, and also chewed and rubbed into sores, burns and wounds
Dianella species (Blue Flax Lilies)	The fruits were eaten raw. The roots were also eaten after pounding and roasting. The strong leaf fibres were made into string.
Persoonia levis (Borad Leaf Geebung), *Persoonia pinifolia* (Pine-leaf Geebung)	The fruits were eaten, although difficult to collect ripe as birds eat the unripened fruit. The bark of the Geebung was used to make a solution in which fishing lines were soaked for strength
Warm Temperate Rainforest	
Acacia melanoxylan (Blackwood)	The seeds were collected and eaten
Amema smithii (Lilypilly)	The fruit was edible
Livistona australis (Cabbage Tree Palm)	The tip of this palm is edible. The leaves were used as roof thatch and for weaving baskets. The bark was used for making fishing lines
Lomandra longifolia (Spiny headed Mat Rush)	The seeds were ground for flour. The flowers and the base of the leaves are edible. The tough leaves were also used to make baskets

The various fauna species present within the study area would have provided a range of resources for the Aboriginal peoples. Terrestrial and avian resources were not only used for food, but also provided a significant contribution to the social and ceremonial aspects of Aboriginal life. Mammals such as kangaroos and wallabies and arboreal mammals such as possums can be used as a food source and also for tool making. For example, tail sinews are known to have been used as a fastening cord, whilst 'bone points' which would have functioned as awls or piercers are an often abundant part of the archaeological record. Ethnographic observations of early European settlers coming in contact with Aboriginal people noted the use of a variety of animal parts; claws, talons, bone, skin, teeth, shell, fur and feathers were all used for a variety of tools and non-utilitarian functions. Aquatic species such as freshwater crayfish would have been easily accessible in larger waterways. Aquatic vertebrates such as fish and eels would also have been present in the larger creeks and waterways.

Previous archaeological investigation within the study area has identified sources of ochre on the Woronora Plateau (Sefton 1998:33). Cavernous weathering results in the disintegration of a sandstone surface, exposing coloured (yellow: goethite-rich or red: hematite-rich) sandstone. Often, the case-hardened surfaces present around these disintegrating areas are undercut (Sefton 1998:36).

5.0 ABORIGINAL CONTEXT

5.1 Ethnohistory

It is generally accepted that people have inhabited the Australian landmass for at least 50,000 years (Allen and O'Connell 2003). Dates of the earliest occupation of the continent by Aboriginal people are subject to continued revision as more research is undertaken. The timing of the human occupation of the Sydney Basin is still uncertain. Whilst there is some possible evidence for occupation of the region around 40,000 years ago, the earliest undisputed radiocarbon date from the region comes from a rock shelter site north of Penrith on the Nepean River, known as Shaws Creek K2, which has been dated to 14,700 +/- 250 BP (Attenbrow 2002: 20). This site is over 50 km north of the study area along the Nepean River. To the south, along the coast just north of Shellharbour, the site of Bass Point has been dated to 17,101 +/- 750 BP (Flood 1999). Closer to the study area, on the Woronora Plateau, the oldest date for Aboriginal occupation so far recorded is 2,200 +/- 70 BP at Mill Creek 11 (Koettig 1985). Such a 'young' date is more likely a reflection of conditions of archaeological site preservation and sporadic archaeological excavation, than of actual evidence of the presence or absence of an Aboriginal population prior to this time.

Our knowledge of Aboriginal people and their land-use patterns and lifestyles prior to European contact is mainly reliant on documents written by non-Aboriginal people. The inherent bias of the class and cultures of these authors necessarily affect such documents. They were also often describing a culture that they did not fully understand – a culture that was in a heightened state of disruption given the arrival of settlers and disease. Early written records can, however, be used in conjunction with archaeological information and surviving oral histories from members of the Aboriginal community in order to gain a picture of Aboriginal life in the region.

The study area is described as being within the traditional lands of the Wodi Wodi tribal group. The traditional Wodi Wodi lands have been described as extending from around Stanwell Park to the Shoalhaven River, and as far inland as Picton, Moss Vale and Marulan. The Wodi Wodi spoke the Dharawal language, however Dharawal (Tharwal) was not a word they had heard of or used themselves (Tindale 1974, Navin Officer 2000:20). Many of the town and place names of the Illawarra are believed to be derived from the Dharawal language.

Traditional Aboriginal social organisation consisted of clans and bands. It was through clans that associations with lands and sites were dictated. Marriage was between clans, and groups that included individuals who had married into the group are referred to as bands. In day to day life bands ranged over economic areas that included lands of more than a single clan. Attenbrow (2002) sums up the situation succinctly by saying "whilst the relationship of clan to country was principally religious in character, that of band to range was economic."

Interactions between different types of social groupings would have varied with seasons and resource availability. It has been noted that interactions between the groups inhabiting the many resource zones of the Sydney Basin (coastal and inland) would have varied but were

continuous. This is reflected in the relatively homogenous observable cultural features such as art motifs, technology and resource use (McDonald 1992).

The arrival of European colonists in early 1788 wrought swift and catastrophic change to the Aboriginal people of the Illawarra region. Europeans began appearing in the area before the end of the eighteenth century, and by the first couple of decades of the nineteenth century forestry had begun in the region, and the land was broken up for pastoral and dairy enterprises throughout that century. Conflict, disease and dispossession took a terrible toll on the Wodi Wodi and Dharawal (Tharawal) peoples. In 1820 approximately 3,000 Aboriginal people were living in the Illawarra, but by 1899 their numbers had declined to only 33 people of non-mixed descent. Today many Wodi Wodi and Dharawal people continue to live in the Illawarra.

5.2 The Archaeological Record

5.2.1 AHIMS Database

Searches of the NSW DECC AHIMS[1] database were conducted on 7/8/2007 and 29/8/2007, with 284 previously recorded sites (and 54 duplicate entries) located within a search area encompassing the 18 borehole sites comprising the study area (refer to Figures 2a – 2c).

The dominant site types in the search area are shelter sites (53%), followed by axe grinding grooves (27%). Artefact scatters (9%), open camp sites (5%), middens (3%), burials (1%) and rock engravings (1%) are also recorded within the search area. Of the shelter sites, 44% were shelters with art, 22% were shelters with art and deposit, 20% were shelters with deposit, 6% were shelters with art, deposit and grinding grooves, and 6% were shelters with middens.

Of the 284 Aboriginal sites recorded within the search area, none are at the precise location of a borehole. Three of the borehole sites have registered Aboriginal sites located with 200 m of the proposed borehole location.

[1] It should be noted that the AHIMS database reflects Aboriginal sites that have been officially recorded and included on the list. Large areas of NSW have not been subject to systematic, archaeological survey; hence AHIMS listings may reflect previous survey patterns and should not be considered a complete list of Aboriginal sites within a given area.

Table 2 (following) provides details of the sites located within 200 m of a proposed borehole location. These site frequencies across the Woronora Plateau provide an indication of site types that are likely to occur within the Drilling Programme Area.

Details of specific site location are considered sensitive and have not been included in this report.

Table 2: AHIMS sites registered within 200 m of a proposed borehole location

BOREHOLE	*AHIMS SITE #*	*SITE NAME*	*SITE TYPE*	*LANDFORM*
AI03	52-2-3480	Flat Rock Creek 289	Grinding groove	Site location is inaccurately recorded in AHIMS database – site is actually 250 m south of Borehole AI03. Site comprises 2 axe grinding grooves and well on sandstone exposure at a tributary of Flat Rock Swamp.
	52-5-0082	Darkes Forest; Flat Rock Creek 39	Shelter with art	North west facing shelter situated above a tributary of Waratah Rivulet. Living area approximately 2 m^2. Frieze on lower rear wall includes 5 charcoal profile human figures and two indeterminate charcoal drawings. Site is 180 m south west of Borehole AI03.
AI05	52-2-0690	Darkes Forest; O'Hares Ck 21	Open camp site	Site card contains few details of this site, other than site comprises a surface scatter of artefacts. Site located above a confluence of several major creeklines. Card notes that artefacts have been historically collected at this site. Site is 200 m south west of borehole AI05.
AI08	52-5-0861	Coal Cliff; Site 24	Grinding groove	The site comprises 16 grooves scattered over 5 sandstone platforms in the upland swamp in 1;1;9;4;1 configuration. Site located on Coalcliff Dam Creek approx 180 m north of Borehole AI08.

5.2.2 Archaeological reports

Several archaeological surveys have been completed in the region and provide an understanding of archaeological patterning within the wider landscape.

Byrne, Denis & Hilary du Cros, July 1985. *Survey for Archaeological Sites on Proposed Housing Subdivisions along Old Illawarra Road, Menai/Lucas Heights, NSW.* Report to Land Planning and Sales Pty Ltd.

This study was completed for Land Planning and Sales Pty Ltd to assess archaeological sites within a development area. In those areas where the proposed subdivisions back onto the steep-sided gullies of the Woronora Valley, it was proposed to construct fire trails around the edges of the blocks between the gully edge and the housing allotment. 17 blocks of land were surveyed. A total of seven rockshelter sites were located during the survey, with two of these

containing archaeological material consisting of stone artefacts and shell. Two further shelters contained evidence of European occupancy in conjunction with potential archaeological deposit, while the final three were determined to contain potential archaeological deposit. It was recommended that during construction of the proposed fire trails care should be taken to ensure the safety of the shelters. In the development area, it was recommended that the developer should be aware of the possibility of archaeological materials being present during construction works, and that any discoveries should be reported to the National Parks and Wildlife Service.

Dallas, Mary, August 2002. *Archaeological Test Excavations of NPWS Site #52-2-2189 at the Former Lagoon Restaurant, Stuart Park, North Wollongong, NSW.* Report to Emibarb Pty Ltd.

Emibarb Pty Ltd engaged Mary Dallas to undertake archaeological test excavations of the former Lagoon Restaurant in Stuart Park, Wollongong, prior to proposed redevelopment of the site. Site #52-2-2189 is recorded as a midden site. The excavation was undertaken using a backhoe to excavate 2-3 metre trenches. Following the excavation, it was recommended that no further investigations were required at the site, and that the likelihood of further remains being present in the area was low. It was further recommended that an application be made for a Consent to Destroy permit for site #52-2-2189 prior to the commencement of development at the former restaurant site.

Illawarra Prehistory Group, December 1995. *1994-1995 Archaeological Survey of Kangaroo Creek Royal National Park.* Report to the Australian Institute of Aboriginal and Torres Strait Island Studies.

This study was completed as part of a continuous survey of the Illawarra Region by the Illawarra Prehistory Group and was funded by a grant from Australian Institute of Aboriginal and Torres Strait Island Studies (AIATSIS). The study focussed on Kangaroo Creek which is a major tributary of the Hacking River. The study area was bounded by the Illawarra Railway to the west and north, the ridgeline which separates Kangaroo Creek and the Hacking River to the east and south, as well as Farnell Avenue in the east. Numerous sites were located in the survey and included grinding grooves, rock engravings, engraved groove channels; surface artefact scatters, middens and shelters, including those containing art as well as deposit. Sixty-nine shelters with art and/or archaeological deposit were located during the survey, along with 54 open sites, including ten rock engraving sites. The report concluded that on the Woronora Plateau, there was a trend for a north-easterly increase in the number of rock engravings.

Illawarra Prehistory Group, December 1996. *1995-1996 Archaeological Survey of the North and Western Side of the Hacking River Including Royal National Park and Garrawarra State Recreation Area.* Report to the Australian Institute of Aboriginal and Torres Strait Island Studies.

This study was completed as part of a continuous survey of the Illawarra Region by the Illawarra Prehistory Group and was funded by a grant from Australian Institute of Aboriginal and Torres Strait Island Studies (AIATSIS). The study area was mostly situated within Royal National Park and Garrawarra State Recreation Area. The survey focussed on the Hawkesbury sandstone within the area. Numerous sites were located in the survey and included grinding

grooves; rock engravings; engraved groove channels; surface artefact scatters; middens and shelters, including those containing art as well as deposit. Eighty shelters with art and/or archaeological deposit were located during the survey, as well as 30 open sites (including artefact scatters, grinding grooves and engraving sites).

Illawarra Prehistory Group, August 2002. ***Archaeological Sur of the Eastern Drainage of the Hacking River to Upper Peach Trees.***

This study was completed between 1994 and 1996 by the Illawarra Prehistory Group on a self-funded basis. In 2002 Royal National Parks agreed to fund the production of a report based on the survey findings. The study area included all tributaries of the Hacking River which flow from the eastern catchment, including Boora Gully, Toonum Brook, Bola Creek, Bola Gully, Palona Brook, Tamur Brook and Dumbal Brook. Most of the study area is contained within Royal National Park. The study focussed on the Hawkesbury sandstone region. Numerous sites were located in the survey and included grinding grooves; rock engravings; engraved groove channels; surface artefact scatters; middens and shelters, including those containing art as well as deposit. 115 archaeological sites were located during the survey, including 19 grinding sites and 97 shelters. Of the grinding sites, 2 had rock engravings associated and one had an engraved groove channel. The shelters included those with art, and archaeological deposit (including stone artefacts and shell) and six had grinding grooves associated.

Illawarra Prehistory Group, February 2007. ***Archaeological Survey of the Western Catchment of Southwest Arm to Grahams Point Royal National Park.***

This study was undertaken between January and October 2001 by the Illawarra Prehistory Group on a self-funded basis. In 2007 Royal National Parks agreed to fund the production of a report based on the survey findings. The study area included all of the western catchment of the South West Arm, which flows into the Hacking Estuary. The study area was bounded by Wises Track to the south, the spur which separates the South West Arm from the Hacking River to the west and the South West Arm itself to the east. The study area is located in Royal National Park. Numerous sites were located in the survey and included grinding grooves; rock engravings; engraved groove channels; surface artefact scatters; middens and shelters, including those containing art as well as deposit. Ninety-five archaeological sites were located during the study. This included 66 shelters and 17 open sites. The shelters included those with art, archaeological deposit (including stone artefacts and shell) and midden deposit.

Navin, Kerry, December 1991. ***An Archaeological Survey of Areas in the Lady Crrington Estate, Helensburgh, NSW.*** **Report to Quality Environmental Management for Gutteridge Haskings and Davey Pty Ltd.**

Kerry Navin was commissioned to undertake an archaeological survey of the proposed Lady Carrington Estate prior to the commencement of development. The development area was located on a ridgeline, east of Helensburgh West, NSW. During the survey it was noted that there was a large number of old growth trees present within the development area. An isolated artefact and a shelter site adjacent to the development were also located. A previously

recorded grinding groove site was present within the development area. It was recommended that the sandstone platform on which the grinding grooves are located be incorporated into the development concept and that vehicular access to the site be restricted. It was also recommended that recreational facilities including walking tracks be positioned so as to not encourage visitation to either the identified shelter site or the isolated find. Further recommendations included sub-surface testing of the deposit within the shelter to determine if avoidance of the site was adequate as a management strategy, and archival recording of art within the shelter.

Biosis Research, June 2008a. *Cultural Heritage and Archaeological Assessment for a Proposed Residence, Lot 1, DP 616230, East of Helensburgh.* Report for Mr Robert Hogarth.

Biosis Research was commissioned by Mr Robert Hogarth to provide archaeological advice for a proposed development site east of Helensburgh, NSW. No recorded Aboriginal sites fell within the development area, although 17 archaeological sites were located within a 1km radius of the study area. It was recommended that vehicular works attempt to stay on top of the plateau.

5.3 Discussion

Although the timing of occupation is still uncertain, archaeological evidence suggests that coastal regions were inhabited at least 18,000 years ago, and sites inland along the Nepean were inhabited at least 14,500 years ago. Closer to the immediate study area, dates are much younger, being only 2,200 years ago (Mill Creek 11), although this is more likely related to site preservation (Koettig 1985).

Limited information is available on the Dharawal Aboriginal groups that once inhabited the present study area. Previous archaeological works suggests that the Georges River was a natural boundary between two of the Dharawal clans. Early European settlement resulted in the deaths of many of these traditional peoples, from displacement, disease and massacre.

Prior to European settlement, however, the region would have been a resource-rich area for the inhabitants of the Dharawal. The landscape provided suitable sandstone outcrops and overhangs for shelter. Various water sources were also available, from major rivers to more minor drainage lines and swamps. The evidence of resource use throughout the immediate study area can be identified from the rock art motif types depicted on the walls of shelters and the extensive grinding grooves sites situated along waterlines. A number of flora and fauna species have been identified on the Woronora Plateau that would have been utilised by the Aboriginal people. These resources are indicative of the environment across the Woronora Plateau.

Recorded Aboriginal archaeological sites across the Woronora Plateau can be attributed to the sandstone environment and archaeological survey techniques. The site types that have been recorded include sandstone shelters with art and/or deposit, shelters with PAD, axe grinding grooves, rock engravings and open campsites or isolated artefact occurrences. The frequency

and distribution of these site types is dependant on appropriate environmental requirements or cultural behaviours within an area. Overall, however, the available archaeological data can be used to identify general patterns of occupation, and can aid in determining those site types likely to occur within the present study area.

5.4 Predictive Model

The archaeological predictive model has been formulated based on the results of the location and type of Aboriginal sites that were recorded within the regional area, the results of the AHIIMS database search and information about previous archaeological work. This information has been broken down into patterns that have been compared to the character of the study area to allow for an understanding of Aboriginal archaeological potential.

Most of the sites described in Section 5.2.1 (and Table 2) were identified as a result of surveys undertaken in response to either development proposals or academic research.

Specifically, the environmental context and regional patterning suggest that the study area is likely to have been visited by Aboriginal people, and that this visitation has left observable marks. Aboriginal site types are discussed in the following section, with particular regard to the potential for such sites within the study area.

- *Rock shelters with art and/or deposit*

Rock shelters with art and/or deposit are the most frequently recorded site types within the study area. These sites generally occur within specific geological and topographical landscapes comprising sandstone exposures, shelving and overhangs. Suitable sandstone exposures or overhangs and cavities possessing sufficient sheltered space to contain potential archaeological deposit/art have been documented within the AHIMS search area.

Shelter sites generally occur on, or next to, sloping ground as characterised by the steep cliff lines bordering the escarpment in the west. Such topographical features are found within the wider region, but are unlikely to be present at the borehole sites.

- *Middens*

Middens are among the most common Aboriginal sites identified in the Illawarra coastal plains region, however the study area is situated on the plateau. While some midden material has been recorded in shelters on the Woronora Plateau, as noted above, shelters are unlikely to be encountered at the borehole locations.

- *Open campsites, artefact scatters and isolated finds*

Open campsites have been recorded within the regional area and may be present within the current study area. Open campsites will be generally located on level, well-drained ground within easy distance of a water source, isolated finds may be identified in any environmental context. Such sites may be identified within the current study area. The current project has

sought to locate boreholes in areas of previous disturbance where possible. Given this, it is predicted that any open campsites or isolated finds present in the study area will have been previously impacted and will have low integrity.

- *Grinding grooves*

Grinding grooves are often found on large open and relatively flat areas of sandstone shelving and outcrops in close proximity to water. The wider study area is characterised by creek lines and upland swamps. Several boreholes are located in close proximity to water, and grinding grooves may be identified in areas of suitable outcropping stone.

- *Scarred trees*

Scarred trees can be expected to occur in all landscapes where stands of old growth timbers remain. Such stands are unlikely to be present at the proposed borehole locations, which have generally been previously disturbed. The likelihood of mature trees exhibiting evidence of scarification being present within the study area is consequently considered to be low.

- *Burials*

Aboriginal burial sites are generally situated within deep, soft sediments such as Aeolian (wind deposited) sand or alluvial (river deposited) silts. Burials tend to become visible where there has been some disturbance of sub-surface sediments or where erosion processes have exposed them. Given the soil profiles of the study area, it is considered there is low potential for burials to be present within the study area, however, their presence cannot be conclusively ruled out.

- *Aboriginal ceremony and dreaming sites*

These types of highly significant sites tend to occur at places where the connections and pathways between the spheres of the world are realised. It is considered unlikely that additional, unregistered ceremonial and dreaming places are within the study area.

- *Post-contact sites*

These are sites relating to the shared history of Aboriginal and non-Aboriginal people of an area. Many of these sites can hold special significance for Aboriginal people and may include places such as missions, massacre sites, post-contact camp sites and buildings associated with post-contact Aboriginal use. This site type is usually known from historical records or knowledge preserved within the local community. It is considered unlikely that any additional, unregistered post-contact sites will be present within the study area.

- *Aboriginal places*

Aboriginal *places* may not have any “archaeological” indicators of a site, but are nonetheless significant to Aboriginal people. They may be places of cultural, spiritual or historic significance. Often they are places tied to community history and may include natural features (such as swimming and fishing holes), places where Aboriginal political events commenced or particular buildings. Often these places are significant in the living memory of a

community. The potential that Aboriginal places of spiritual and cultural significance will be found in association with the study area is moderate.

- *Aboriginal resource and gathering sites.*

Aboriginal resource and gathering sites are sites where there is ethnographic, oral, or other, evidence that suggest that natural resources have been collected and utilised by Aboriginal people. These natural resources have a cultural significance and connection for the Aboriginal community, such as ochre outcrops that were used for art or ceremonial purposes. These sites are still considered important places today. There is moderate potential that such sites will be identified within the study area.

6.0 HISTORICAL CONTEXT

6.1 Method

Historical research has been undertaken to identify the historical context of the regional area. This history incorporates an understanding of land-use, building patterns, and areas of disturbance, as well as land owner histories. This research will lead to an understanding of the historical archaeological potential for the study area.

The historic background is based on information held at the following repositories:

- *State Library of NSW – Mitchell Library*

The Mitchell Library contains many primary source maps and plans for NSW, as well as many secondary sources that relate to the history of NSW.

- *Local History Library*

The local studies collection of the Wollongong Library has collated many primary source materials such as early journals, newspapers and other local documents. As well as written sources, local studies collections often also include early photographs and oral histories of the area, adding to the depth of historical background.

- *Other source material*

Historic aerial photographs provide an understanding of more recent historic development with the study area. Where available, these have been consulted to inform the current investigation.

Parish Maps contain information about land ownership as well as occasional notes on the date roads, reserves and other features were proclaimed and/or built.

All of this information has been used to locate known and potential historical archaeological sites.

6.2 Regional historic context

Prior to the construction of overland roads, early settlements in the Colony were generally located in coastal areas or along rivers where access by boat was possible. Water transport was critical to settlement as it allowed for the movement of passengers and goods with minimal investment in capital works. Settlement of south coast New South Wales followed this pattern with the earliest settlements located along the coast or along major rivers.

The City of Wollongong Heritage Study (prepared by McPhee et al. 1991) presents a thematic history of the City of Wollongong and the Municipality of Shellharbour in seven historic phases. These phases form the basis of the historical summary presented in this document. McPhee et al. present the thematic history in discrete temporal blocks arranged according to the predominant development activity. These development activities, although grouped,

should not be considered static, as many were operating concurrently; for instance it is likely that earlier settlers also looked for leisure opportunities in the area, while mining and agriculture are still present as economic activities. The thematic history is summarised below. It should be noted that the thematic history is largely related to the areas of direct settlement and only deals peripherally with the current study area, much of which has been an area of restricted access since the early 20th century.

6.2.1 1770-1820: Gaining a foothold: discovery, exploration and first occupation

The first European recording of the Illawarra coast was by Lt James Cook between 25-28 April 1770. Although he was unable to land due to the heavy surf, a record was made of the principal features observable from the ship. Bass and Flinders were the next recorded white men to visit the area, their boat putting in at a beach on 26 March 1796. Following this they entered Lake Illawarra and made the first recorded contact with the Aboriginal people of the area (p.21).

The following year, survivors of the *Sydney Cove* (wrecked in Bass Strait) travelled through the area on their way to find help. They camped overnight at Coal Cliff, and kept warm with a fire burning coal they discovered in a seam. Rescued the following day, reports of the coal led the Governor to send Bass back to the area to investigate the find. Bass reported on a coal seam 6 feet thick, but it was another 80 years before this spot was exploited (p. 21).

Charles Throsby is credited with the first non-Aboriginal settlement in the area. Aborigines at his Liverpool property informed him of the conditions in the Illawarra and, following an exploratory visit, Throsby brought cattle down the escarpment and established a stockman's hut and cattle yard behind South Beach (now Wollongong City Beach), Wollongong, to take advantage of the lagoon of natural water in this location (p.21).

In 1816, Surveyor-General John Oxley was instructed to survey the district between Appin and Shoalhaven, reserving certain lands to the Crown and allocating land to grantees wishing to take up properties in the area (p. 21). Oxley believed that Kiama (with its large cedar reserves) would become the principal settlement in the area. Consequently, no land was reserved at Wollongong for the establishment of a town (Jeans and Jack 1991:184). Five grants were made in the vicinity of Lake Illawarra. 'The grantees were all absentee landlords whose lands were for many years occupied only by their cattle and a few stockmen' (McPhee et al. 1991:21). Between 1816-1821 an additional 12 grants totalling 16,050 acres were made in the Illawarra, but in evidence to Commissioner Bigge, Oxley noted that no recipients of grants had settled in the area.

Despite this, the area was not unoccupied. Several people occupied the unalienated lands and grazed cattle. There were few fences and the cattle were allowed to roam freely, being mustered as required. These conditions were ripe for exploitation, and cattle thieves soon became such a nuisance that a substantial reward was offered for information leading to a conviction of stock stealing (p.21).

Cedar getting was also an early activity in the area. Although supposedly under government control, whereby a licence ensured that royalties were paid, illicit timber getting was a noted problem in the Illawarra. The problem was acknowledged to be so bad that the 'Governor felt it necessary to issue a Government and General Order to reinforce the regulations already in existence to control the trade, and thereby protect revenue' (McPhee et al. 1991:21).

6.2.2 1821-1850: Winning the land

This 30 year period saw the more intensive settlement of the area and establishment of government control. Widespread settlement at Wollongong did not occur as early as expected given its coastal location. This was partly due to the natural topography of the area - the wide area of sandstone country separating Wollongong from Sydney hindered overland access from the north, and the Illawarra escarpment hindered overland access from the west.

Surmounting the overland isolation was of obvious benefit to the settlers, given the difficulties with Throsby's cattle track at Bulli. The establishment of O'Briens Gap [Mt. Nebo-O'Brien's Rd, Figtree] in 1821 and repairs to the Bulli Pass in 1828, improved access to and from the area. It was the development of Rixon's Pass road in 1848, which was an easier track for travellers on horseback or on foot, which became the preferred route to Sydney. The road was opened to wheeled traffic in 1858 following improvements paid for by public subscription (McPhee et al. 1991:23).

Improvements in water access to the area were also important. In 1837 construction of a basin (100 feet long by 35 feet wide) and a pier at Wollongong Harbour were commenced. Completed by 1844, they provided 'relatively safe accommodation for coasting vessels from five to twenty tons' (McPhee et al. 1991:23). A twice weekly steamer service to Sydney greatly improved the amenity of the area, when commenced in 1841. Prior to this, settlers were reliant on the small sailing ships carrying goods to the Sydney markets.

In 1834 Surveyor-General Major Mitchell arrived to lay out the township of Wollongong on property owned by Charles Throsby Smith. The following year Surveyor Gilbert Elliott drew up a plan for a government township on land adjoining the initial surveyed area. These two surveys laid out the foundation for Wollongong's spatial development for the next 100 years, it not being until the 1950s that the town outgrew the original design (McPhee et al. 1991:23).

With the increase in settlers, social institutions were established. Churches and schools were built at Wollongong and a Civil and Military Commandant of Five Islands (or Illawarra) was appointed. A second nucleus of settlement emerged at Brownsville (now known as Dapto). This was largely the result of the 1834 construction of a windmill on George Brown's Mullet Farm property, and was no doubt further encouraged when he relocated his Ship Inn from Wollongong to there. A school and two churches soon followed, consolidating the area as a subsidiary settlement.

The thick timber of the Illawarra hindered extensive agricultural use of the land by the early settlers. The extensive labour required to clear the land, combined with the early difficulties in transporting produce to Sydney, resulted in most settlers concentrating on pastoral grazing. A clearing lease system was introduced in the Illawarra following the abandonment of the assigned convict system. Under the leases, a tenant leased a block of land for a number of years, endeavouring to clear the land in that time. As the land was cleared the tenant could plant crops or graze livestock and, when the lease expired, the land and all improvements reverted to the owner who usually leased the land back out. This system continued in use until the 1860s and accelerated land clearance in the Illawarra (McPhee et al. 1991:24).

Agriculture become more important with the increase in cleared land, and many small farmers chose to grow wheat. A number of mills opened in the area, including ones at Mt Keira and Para Meadow. In 1841, the windmill at Brownsville was replaced with a steam mill.

The first coal, shipped from Wollongong Harbour in 1849, was from James Shoobert's small coal mine on Mt Keira. This was the herald of another important Illawarra industry. Several other industries had operated in the area during this time (e.g. ship building established at Wollongong Harbour in 1831 and whaling operating from Bulli Point that same year); however, agriculture and mining were to dominate the economic development of the Illawarra for the next 50 years.

6.2.3 1851-1900: Using the land: mining and agriculture

The exploitation of mineral resources in the Illawarra resulted in the development of associated infrastructure such as small towns and transport facilities. Improved transport then encouraged further settlement and development of mines. In addition, with the rich coal resources of the area at hand, industries such as coke manufacture were established. These changes were most noticeable in the northern Illawarra area, as this is where the mines were predominantly located.

In the southern Illawarra, it was the transition from arable agriculture to dairying that prompted the most significant change in land use. This was partly due to the subdivision or leasing of the large land holdings into smaller allotments (McPhee et al. 1991:25).

The shift from grazing cattle to mixed farming ensured that there were several locally grown products available, including wheat, maize and potatoes, and to a lesser extent, meat, bacon, eggs, poultry, and some dairy products, wine and tobacco. By the late 1840s dairying was assuming more importance, and this continued until, by the 1880s, dairying had taken over as the prime agricultural industry (McPhee et al. 1991:25).

The impetus for the shift to dairying was the introduction of clover as a fodder which increased yield. The gold rush of the 1850s created further incentive to switch to dairying, given the high prices that were being offered for butter and cheese. Wheat farmers who had

resisted the change were practically forced into dairying when rust disease and drought badly impacted wheat crops in the 1870s. Indeed, there was so little wheat to grind that by the late 1870s the district's four mills were forced to close (McPhee et al. 1991:25-26). One mill building was then converted to a cheese factory and then a butter factory.

Butter was the main product of the dairy farms as it provided the higher return per gallon of milk compared to cheese (McPhee et al. 1991:26). The farms were small scale enterprises, with on-site butter production. The cream was skimmed in the dairy and churned to butter, then salted, packed into kegs and shipped to market. The remaining skimmed milk was fed to calves and pigs, resulting in diversified operations. This proved useful, as there was no centralised system for the collection and delivery of dairy products, and farmers were at the mercy of Sydney agents. Transportation was particularly problematic in the pre-refrigeration days, and butter often arrived in Sydney in a rancid condition as a result of being carried as deck cargo (in the sun).

Dairy factories were established in the 1880s and achieved a more consistent quality of butter. A butter factory with two mechanised cream separators was operating in Dapto in 1886 and there was another factory in Albion Park. The opening of the Illawarra Railway Line in 1887 further increased market potential, allowing delivery of butter to Sydney in fresh condition and introducing the possibility of supply of whole milk. These changes ensured that dairying was to be a major economic industry of the area for the following 80 years (McPhee et al. 1991:26).

As noted previously, agriculture was of more importance in the southern Illawarra (surrounding the study area), while mining was more important in the north. A brief mention will be made of the economic importance of mining given that coal became significant in the study area with the construction of the coal fired Tallawarra Power Station in the 1950s. Mining itself, however, is not of direct importance to the study area and is only discussed in general terms.

Coal was the main mineral resource of the area and was well documented from the earliest explorations of the district. Prior to 1848, the Australian Agricultural Company had a monopoly on coal mining. With the termination of the monopoly, other parties were able to extract coal and the Illawarra coal measures were exploited, initially by Shoobert at Mt Keira. Much of the early coal was used locally given the transportation difficulties already discussed.

In 1857, following a rise in coal prices, a second and more determined attempt was made to extract coal. This was the first of many mines that opened and fuelled local development and the establishment of secondary processing industries. The coal wave continued with expansion in the industry. The 1880s were boom years, with new mines and expanded workings, however, the 1890s were characterised by the great strike (in 1890), which led into the depression (McPhee et al. 1991:27). A lack of new technological developments in the industry failed to insulate it from the effects of the depression and the Illawarra district felt these effects keenly, with some mines forced into liquidation and others laying-off staff. Some

mines bucked the trend (such as Corrimal and South Bulli) and were actually able to increase outputs and workforce during this period and it is likely that such operations ameliorated the effects of the general economic climate.

Despite the ups and downs of the market, coal mining has remained an important industry in the Illawarra, with several coal mines and collieries continuing in operation. The significance of the industry to the development of the area is not doubted, although the heritage values of coal mining have only recently begun to be appreciated. A current study, commissioned by Wollongong City Council and the NSW Department of Primary Industries Mineral Resources Division, seeks to identify significant mining objects and places in Wollongong and develop strategies for interpreting them (NSW Heritage Office 05/06:12).

6.2.4 1900-1929: New visions: laying the infrastructure for an industrial city

The first three decades of the twentieth century continued in much the same fashion as the preceding half century. Rural and mining industries continued in importance and developments in technology wrought changes in the industries. The greatest impetus for change in this period, was the construction of the new harbour in Port Kembla, a facility which continued to shape the City of Wollongong. Changes in the industries resulted in dramatic population growth, with the population nearly doubling from 17,182 in 1901 to 32,381 in 1921 (McPhee et al. 1991:49).

6.2.5 1929-1949: Depression and war

Population growth continued during the depression and war, however, not all inhabitants were affluent. 'The 1934 census returns revealed that over 2,000 households were living in tents scattered about the district' (McPhee et al. 1991:55). The growth resulted in the 1942 declaration of Wollongong as a City for local government purposes and 5 years later the Municipality of Greater Wollongong was inaugurated, combining the former areas of the City of Wollongong, Municipality of North Illawarra, and the Shires of Central Illawarra and Bulli. At this time the population had increased by 50% over the preceding decade. Industrial development continued, especially related to the Port Kembla steelworks.

6.2.6 1950-1975: Metamorphosis to a city

The steel industry was the principal factor directing development in this period. In addition, increased demand from Japan for the district's hard coking coals revitalised the coal industry, leading to the redevelopment of many collieries. Spurred by these developments, the population of the area continued to grow strongly, becoming the third largest urban area in NSW. From the 1970s, with further technological improvements and mechanisation of these

industries, the labour force was reduced, leading to increased unemployment in the area (McPhee et al. 1991:60).

During this period, infrastructure to service the burgeoning population was required. Land to the west of the current study area was resumed for a sub-station, while land along the foreshore of Lake Illawarra was resumed for the Tallawarra Power Station. The power station was coal fired, sourcing coal from the associated Huntley Colliery (McPhee et al. 1991:63). Coal was supplied to the site via a railway siding.

6.2.7 1976-1991: The search for the 'Leisure Coast': structural change and consolidation

A major restructuring of the coal and steel industries in the 1980s further exacerbated unemployment in the Illawarra. 'From June 1981 to June 1983 some 9,000 jobs were lost in the region, with a further 1,000 mining jobs lost between June 1983 and August 1984' (McPhee et al. 1991:63). Wollongong City Council promoted the idea of Wollongong as the 'Leisure Coast' and sought to increase tourism. The subsequent campaign resulted in tourism becoming the third largest industry in the district. McPhee et al. suggest that this was in part due to the reduction in industrial pollution associated with the contraction of the coal and steel industries (1991:64).

Diversification of heavy industry, growth of a services industry, establishment of the University of Wollongong and electrification of the railway line to Sydney (allowing people to commute to work in Sydney) encouraged urban development in the area (McPhee et al. 1991:65). Redevelopment of existing properties and subdivision of rural properties has accommodated this growth and assisted the transition from rural to urban landscape character across much of the city boundaries.

6.3 Land-use history of the study area

The overall historical development of the borehole locations is consistent across the 18 discrete sites. For the most part, these sites have not been developed in any way that would leave a significant historical signature. Rather, the majority of boreholes are located in areas which have been reserved from development (such as the Metropolitan Special Area, or Nature Reserves), but which have been subject to some disturbance such as track construction or isolated mining impacts.

No borehole is located in an area of historic interest and, as such, it is considered that there is little to no potential for historic sites to be identified at the borehole locations.

7.0 SURVEY

7.1 Survey Methods

Survey methods for Aboriginal sites have been designed in consultation with the local Aboriginal community. They have been designed to locate archaeological sites within the study area with reference to the following information:

- Previously recorded sites within the study area;
- Areas of potential as identified by the background research predictive model (regional site patterns as compared to the physical environment of the study area, or items identified in historic plans); and
- The proposed development footprint.

The survey was conducted exclusively within the study area as outlined in Section 1.1. The size and type of development allowed for 100% survey coverage of each proposed borehole location (excepting those where vegetation was impassable). Information recorded during the survey included the geology of the area, exploitable resources, identifiable land-use impacts and any visible archaeological sites present in the study area. This information was also used to assist in the identification of area of archaeological potential.

Factors that influence the effectiveness of the survey include:

- *Ground Surface Visibility:*

Ground Surface Visibility (GSV) is an average amount of the physical ground that could be viewed at the time of survey, and is expressed as a percentage. The primary effect on GSV is vegetation cover, however modern cultural material, such as concrete, rubble, rubbish or land fill can also hamper GSV.

- *Disturbance*

Physical ground disturbance that occurs within the area has been noted and mapped. Ground disturbance includes events such as natural erosion and impacts from historical land-uses such as farming and construction. Ground disturbance can often result in areas of better GSV, therefore making it easier to identify sites, however, such sites tend to have been impacted by the disturbance event.

- *Limitations*

Other limitations to the survey were also noted. Such limitations might generally include restricted access to private lands, or areas that were considered unsafe to survey.

7.2 Survey Participants

Table 3 details participants in the archaeological field inspection of the borehole locations, including staff of Biosis Research and representatives from the Illawarra LALC and the Kullila Welfare and Housing Aboriginal Corporation. Of the two remaining registered stakeholders: Robert Evitt had planned to participate in the survey but was unable to due to other commitments; Karen Gough was not invited to participate in the survey as she has registered on behalf of her children.

Table 3: Survey participants

DATE	*NAME*	*ORGANISATION*
2 September 2008	Sam Moody	Biosis Research
	Renee Regal	Biosis Research
	Johnny Pagett*	Illawarra Local Aboriginal Land Council
	Maria Maher	Kullila Welfare and Housing Aboriginal Corporation
3 September 2008	Sam Moody	Biosis Research
	Renee Regal	Biosis Research
	Johnny Pagett	Illawarra Local Aboriginal Land Council
	Maria Maher	Kullila Welfare and Housing Aboriginal Corporation
4 September 2008	Sam Moody	Biosis Research
	Renee Regal	Biosis Research
	Steven Henry	Illawarra Local Aboriginal Land Council
	Maria Maher	Kullila Welfare and Housing Aboriginal Corporation

* only participate for half the day.

7.3 Survey Results

Specific survey results for each borehole are discussed in the relevant data sheet presented in Appendix 1.

In summary, most of the borehole locations are situated in environments where the potential for Aboriginal archaeological sites is considered very low. Borehole AI04A was identified during the survey as having Aboriginal constraints (an isolated find was identified at this location). Borehole AI04B, although identified as an archaeological site by the Aboriginal stakeholders, does not represent PAD based on an assessment of environmental variables.

- One newly identified isolated find (ISF AI04A) was identified at Borehole AI04A.
- An alternative location - Borehole AI04B - was also surveyed and this area was identified by Aboriginal stakeholders as having good archaeological potential for Aboriginal archaeological material. While disturbance at Borehole A104B is very low, environmental conditions do not support the identification of this area as Aboriginal PAD.

The two proposed areas for the location of Borehole AI04 were discussed in-field with the survey participants. The communities indicated that they preferred the works to proceed at Borehole AI04A (the disturbed area with the isolated find) rather than AI04B as this location

has low evident disturbance and would require the clearing of good condition native vegetation. Subsequent to the field survey further detail was obtained regarding the coal workings below this area. The borehole must pass through a remnant coal pillar of the Bulli Seam. Borehole AI04A is not above the coal pillar and, as such, is not suitable as a drilling location. Borehole AI04B is above the coal pillar and is the only possible site of the two inspected that is suitable for drilling.

The historic land use patterns of the study area suggest that there is low potential for historic archaeological sites. No historic heritage constraints were identified from background research or during the survey.

8.0 CULTURAL VALUES IN THE STUDY AREA

8.1 Consultation Process

Of the four stakeholders who registered an interest in the project, two groups – Illawarra LALC and the KWAHC – participated in the site inspection. Discussions were held about the cultural significance of the study area and borehole locations during the site inspection.

The two registered stakeholders who did not participate in the survey were invited to meetings to discuss the survey results and cultural values and significance of the study area. Information regarding cultural values of the study area is presented in the following sections.

8.2 Results

8.2.1 Survey participant: Johnny Pagett & Steven Henry (Illawarra LALC)

During the survey, both Illawarra LALC representatives identified that Aboriginal archaeological sites are of cultural significance to Aboriginal people, but provided no other details regarding cultural values which might be present within the study area. Mr Pagett noted that areas of good condition native vegetation are of value to the Aboriginal community and should be preserved where possible.

8.2.2 Survey participant: Maria Maher (Kullila Welfare and Aboriginal Housing Corporation)

During the survey, Ms Maher confirmed that Aboriginal archaeological sites are of cultural significance to Aboriginal people. She also indicated that the Woronora Plateau is a significant landscape, but provided no other details regarding specific cultural values which might be present within the study area. Ms Maher noted that areas of good condition native vegetation are important and impacts should be avoided in such areas.

8.2.3 Meeting: Karen Gough – 22 September 2008

During the meeting, Ms Gough identified several themes of importance to her and her family. The meeting was long and informal, and has been presented thematically rather than as minutes of the discussion. Author additions are included in [square brackets].

Aboriginal Dreaming

- *The Illawarra has a long Aboriginal history. Only the Traditional Owners can tell you about Aboriginal Cultural connections to that Country and say what sites are there and what the real names of things are. I can only tell you about contemporary Aboriginal uses and cultural meanings of the area for my kids growing up here, relating to bushwalking we do in that area.*

- *The Wodi Wodi Track comes down from the escarpment to the coast at Coalcliff and up to Mount Mitchell where it continues along the top of the escarpment.*

- *The Wodi Wodi Track is important for my children's cultural education because of what they see and the stories they hear from their family and elders when walking.*

- *The Wodi Wodi track has unique vegetation. Around the Mount Mitchell end of the track you find Angophora trees and Gymea Lily - a Dharawal plant- together. This is an unusual combination and very beautiful.*

- *From Mount Mitchell you can see other sites and landmarks. Kids learn about the immediate area, but also about important coastal camp sites to the south. Looking the other way, the Stanwell Park area is also important.*

- *The Wodi Wodi track was probably a main entry point into the northern Illawarra coast and it connects up to several other tracks on Dharawal [Tharawal] land.*

The natural environment

- *The hydrological function of the area is important. I would be concerned by anything that impacts the hydrological function and the Wombarra township. There are 7 creeks in the Wombarra / Scarborough catchment. They've been diverted into the Wombarra Drainage Tunnel, which was completed after the 1998 Flood. The tunnel system has not yet been tested for stability and function in a major storm event.*

- *Maddens Plains is important. We go swimming at Maddens Creek. The waterfall on Maddens Creek is also significant. There is a huge array of native flowers up there. A few years ago NPWS covered the nice soft track with a horrible grid-iron pathway. Now I have to make the kids wear shoes and the track is so loud you frighten away the birds and lizards before you can get a good look at them.*

Cultural continuity and education

- *My family goes to Dharawal Nature Reserve to get bush tucker, like bush currants.*

- *Other bush tucker we get there includes sarsparella and wombat berries. We also go to Kelly's Falls at Stanwell Tops to get these.*

- *These areas are accessible. They are close to home. We use them frequently.*

- *The bush up there [at Dharawal Nature Reserve] is significant. Bush tucker is important, but also walking with kids. There is educational value. It's a place where we talk about stories and bush tucker. It's about cultural continuity. It's good for kids, especially when they're young, but it's also a good place for elders; it's level, it's an easy walk for elders and kids. They can be there together and the knowledge is passed on orally.*

- *The kids have heard about local Aboriginal history and stories from their father. They learn about their Country. The area is important, it's a teaching and learning place for transferring cultural knowledge.*

- *It's not something that you do once. You might go several times – you learn about seasons, the availability of bush tucker, where and when things can be found, what they look like and taste like.*

Concerns about the project

- *Having mining machinery intrude up there would be a real pity – make it harder to tap into the spiritual space. We go up there to get away from the modern world, not be reminded of it.*

- *Anything that intrudes on Aboriginal kids learning about Country while walking on Country is detrimental to cultural education.*

- *I'm concerned about any impacts to the face of the escarpment, any visual impacts. There are rock formations that look like elders and we relate to them as Ancestors looking out on us from the escarpment. I am especially worried about AI15 and AI17 for this.*

- *I would be concerned by any impacts within the Dharawal Nature Reserve. I think they [boreholes] will be intrusive, especially if it goes to full works with miners and machinery. I think they should forget about those ones, AI10, AI11, AI13 and AI12B.*

- *How loud will they be in operation and how long will they be there for?*

- *How much damage will be caused by clearing the compounds for the tests?*

Meeting notes reviewed, revised and approved by Karen Gough on 10th November 2008.

8.2.4 Meeting: Robert Evitt – 23 September 2008

A meeting with Mr Robert Evitt was held to discuss the survey results and cultural significance of the study area. Mr Evitt was clear that he could not comment on the cultural significance of the study area, however he was keen to talk through the survey results and the reasons for identifying particular borehole locations as being of low archaeological potential. Mr Evitt is particularly interested in land ownership details for each of the borehole locations and the management issues arising from any sites in DECC held land (National Parks, Nature Reserves etc).

8.3 Discussion

The survey and subsequent consultation identified that archaeological sites are of significance to the registered stakeholders. Moving beyond the strictly archaeological character, however, there are many aspects of cultural significance which can be understood to exist in the study

area. Cultural values are represented not only in physical places, but in the way places are used. Spiritual importance, educational value, cultural continuity and identity are connected with the physical world, and are re-affirmed through community interaction with, and responses to, the physical place.

In this context, parts of the study area can be easily understood as places culturally significant to the Aboriginal community. In particular, the Dharawal Nature Reserve was identified as a place where cultural traditions are passed on to the next generation.

9.0 SIGNIFICANCE ASSESSMENT

9.1 Introduction to the Assessment Process

Heritage assessment criteria in NSW fall broadly within the significance values outlined in the Australia ICOMOS Burra Charter (Australia ICOMOS 1999). This approach to heritage has been adopted by cultural heritage managers and government agencies as the set of guidelines for best practice heritage management in Australia. These values include:

- **historical** significance (evolution and association) refers to historic values and encompasses the history of aesthetics, science and society, and therefore to a large extent underlies all of the terms set out in this section. A place may have historic value because it has influenced, or has been influenced by, an historic figure, event, phase or activity. It may also have historic value as the site of an important event. For any given place the significance will be greater where evidence of the association or event survives in situ, or where the settings are substantially intact, than where it has been changed or evidence does not survive. However, some events or associations may be so important that the place retains significance regardless of subsequent treatment.

- **aesthetic** significance (scenic/architectural qualities, creative accomplishment) refers to the sensory, scenic, architectural and creative aspects of the place. It is often closely linked with social values and may include consideration of form, scale, colour, texture, and material of the fabric or landscape, and the smell and sounds associated with the place and its use.

- **social** significance (contemporary community esteem) refers to the spiritual, traditional, historical or contemporary associations and attachment that the place or area has for the present-day community. Places of social significance have associations with contemporary community identity. These places can have associations with tragic or warmly remembered experiences, periods or events. Communities can experience a sense of loss should a place of social significance be damaged or destroyed. These aspects of heritage significance can only be determined through consultative processes with local communities.

- **scientific** significance (archaeological, industrial, educational, research potential and scientific significance values) refers to the importance of a landscape, area, place or object because of its archaeological and/or other technical aspects. Assessment of scientific value is often based on the likely research potential of the area, place or object and will consider the importance of the data involved, its rarity, quality or representativeness, and the degree to which it may contribute further substantial information.

The significance of Aboriginal and historic sites and places will be assessed on the basis of the significance values outlined above. As well as the ICOMOS Burra Charter significance

values guidelines, various government agencies have developed formal criteria and guidelines that have application when assessing the significance of heritage places within NSW. Of primary interest are guidelines prepared by the Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA) and the NSW Department of Environment and Climate Change (DECC) and Heritage Branch, NSW Department of Planning. The relevant sections of these guidelines are presented below.

9.2 Aboriginal Sites – Assessment of Significance

The following Aboriginal significance assessment is based on Part 1 of the *DECC Guidelines for Aboriginal Heritage Impact Assessment* (2006). These guidelines state that an area may contain evidence and associations which demonstrate one or any combination of the ICOMOS Burra Charter significance values outlined above in reference to Aboriginal heritage. Reference to each of the values will be made when evaluating Aboriginal significance for sites and places.

In addition to the previously outlined heritage values, the *DECC Guidelines* also specify the importance of considering cultural landscapes when determining and assessing Aboriginal heritage values. The principle behind a cultural landscape is that 'the significance of individual features is derived from their inter-relatedness within the cultural landscape'. This means that sites or places cannot be 'assessed in isolation' but must be considered as parts of the wider cultural landscape. Hence the site or place will possibly have values derived from its association with other sites and places. By investigating the associations between sites, places, and (for example) natural resources in the cultural landscape the stories behind the features can be told. The context of the cultural landscape can unlock 'better understanding of the cultural meaning and importance' of sites and places.

Although other values may be considered – such as educational or tourism values – the two principal values that are likely to be addressed in a consideration of Aboriginal sites and places are the cultural/social significance to Aboriginal people and their archaeological or scientific significance to archaeologists. The former is discussed in greater depth below, as it is more comprehensively addressed in the *Guidelines for Aboriginal Impact Assessment.* However we note here that it is best practice for archaeologists when undertaking significance assessments to keep in mind that scientific assessments are part of a larger picture.

The determinations of Aboriginal significance for sites and places will then be expressed as *statements of significance* that preface a concise discussion of the contributing factors to Aboriginal cultural heritage significance. Nomination of the level of value—high, moderate, low or not applicable—for each relevant category will also be proposed and presented in a summary table.

9.2.1 Aboriginal community or cultural values

The NSW DECC recognises that 'Aboriginal community are the primary determinants of the significance of their heritage' (NSW DEC 2004). Biosis Research recognises that our role in the cultural heritage assessment process is to provide specialist skills, particularly in regard to archaeological and heritage management expertise. These specialist skills can be articulated and enhanced through consultation with the Aboriginal community, with the aim of providing a comprehensive assessment of cultural heritage significance.

The heritage assessment criteria outlined above that relate to community or cultural values include social, historic and aesthetic value. Social and aesthetic values are often closely related. Social value refers to the spiritual, traditional, historical or contemporary associations and attachment that the place or area has for the present-day Aboriginal community. Aesthetic values related to Aboriginal sites and places that may contain particular sensory, scenic, architectural and creative values and meaning to Aboriginal people. Historic value refers to the associations of a place with a person, event, phase or activity of importance to the history of an Aboriginal community. Gaining a sufficient understanding of this aspect of significance will often require the collection of oral histories and archival or documentary research, as well as field documentation. Places of post-contact Aboriginal history have generally been poorly recognised in investigations of Aboriginal heritage, and the Aboriginal involvement and contribution to important regional historical themes is often missing from accepted historical narratives.

These aspects of heritage significance can only be determined through consultative processes with one or more Aboriginal communities. In terms of Aboriginal communities, heritage places – including those that are otherwise defined as 'archaeological sites' – will always attract differing values. These may include custodianship obligations, education, family or ancestral links, identity, and symbolic representation. History and traditions are important: this generation has an obligation to future generations to retain certain things as they are currently seen and understood. This includes retaining alternative understandings to those that come through scientific assessments. Heritage places are often more complex than is identified through the scientific determination of value. Cultural and social values can be complex and rich - the past is a vital component of cultural identity. Feelings of belonging and identity are reinforced by knowledge of the existence of a past, and this is further reinforced and maintained in the protection of cultural heritage.

Statement of Cultural Significance

All pre-contact (pre-European settlement) sites that are located in the study area are considered to be of cultural significance to the Aboriginal community, and it is important that comment on the area is provided directly by members of the Aboriginal community. The sites are evidence of past Aboriginal occupation and use of the area, and are the main source of information about the Aboriginal past. In addition, any recorded (and unrecorded) pre-contact sites are of cultural significance because they are rare or, at least, uncommon site-types.

Aboriginal community comments - to be included when received…..

9.2.2 Aboriginal archaeological or scientific values

Scientific value refers to the importance of a landscape, area, place or object because of its archaeological and/or other technical aspects. Assessment of scientific value is often based on the likely research potential of the landscape, area, place or object and will consider the importance of the data involved, its rarity, quality or representativeness, and the degree to which it may contribute further substantial information.

In the past, a consideration of scientific (archaeological) value was the focus of most approvals assessment processes for Aboriginal heritage, and this will still be an important component of most assessment processes. The intent of these *DEC Guidelines* (2006) is to ensure that these values are incorporated within a broader consideration of Aboriginal heritage significance.

While various criteria for archaeological assessment have been advanced over the years, most can be considered under the heading of research potential. Significance in this case lies in the potential of sites or places to elucidate past behaviour, rather than the potential to yield artefact collections or the potential to apply a particular analysis. The major issues in the assessment of research potential are considered to be:

- ***Site intactness or integrity***: This includes the state of preservation of particular remains (e.g. animal bones, plant remains, stone artefacts, and ancestral remains) as well as the stratigraphic integrity of the site, the taphonomic processes acting on the site, the impact of past artefact collections made at the site, etc.

- ***Site representativeness***: This refers to the regional distribution of a particular site type. Representativeness is assessed by whether the site is *common*, *occasional*, or *rare* in a given region. Assessments of representativeness are subjectively biased by current knowledge of the distribution and number of archaeological sites in a region. This varies from place to place depending on the extent of archaeological research. Any such site should be subject to re-assessment as more archaeological research is undertaken.

- ***Site antiquity***: This firstly relates to the potential of a site to provide a chronology extending back into the past. If this chronology is dateable its research potential is enhanced. In some environments the mere presence of a stratified deposit, or a vertical series of artefact-bearing soils, may be a sufficiently rare occurrence to put any site into the 'higher research potential' category. It also considers that the connectedness of the site to other sites may be a major factor in its research potential. In other words, the site, taken in conjunction with other sites, may have a research potential it would not have in isolation.

Statement of Archaeological Significance

Newly identified site ISF AI04A

This site confirms Aboriginal visitation in the area and provides limited data regarding Aboriginal occupation. The site is located in a highly disturbed area and is unlikely to be in a primary context. Isolated finds are not rare along the Woronora Plateau, the site is representative of random discard of material within a landscape. As such, there is no further scientific / archaeological information that this site can provide.

The site is assessed as being of *low* scientific significance.

Area of potential at borehole A104B

This area was identified as having potential for archaeological material by Aboriginal stakeholders participating in the survey. While the area has low evidence of disturbance, environmental conditions suggest that there area is not suitable as a campsite (moderate slope, 200 m to water and presence of shelters with deposit in lower valley closer to water) and does not have high potential for archaeological deposit. It is assessed that there is little to no potential for archaeological deposit in this area.

The area is assessed as having *no* scientific significance.

9.2.3 Aboriginal sites – summary of significance assessment

The determination of Aboriginal significance relies on a comprehensive approach to cultural heritage assessments and to the values that are attached to heritage places. Aboriginal heritage significance can be considered to be the importance of a place, site or object arising from the combination of values attributed to it. These values determine the 'what' and 'how' of conservation and direct management decisions.

The following summary of significance (Table 4) has been based on the results of the archaeological survey, an understanding of regional Aboriginal sites patterning, and from comment and input from the relevant Aboriginal groups.

Table 4: Summary of significance for Aboriginal sites potentially impacted by the proposal.

SITE NAME AND NUMBER	*COMMUNITY OR CULTURAL VALUES*	*ARCHAEOLOGICAL OR SCIENTIFIC VALUE*
Newly identified site ISF AI04A	To be advised	Low
Stakeholder identified area of potential AI04B	To be advised	None

9.3 Historic Sites – Assessment of Significance

9.3.1 Heritage Assessment Criteria

The State Heritage Register, which was established by the amendments to the NSW *Heritage Act* in 1999, has a separate set of significance assessment criteria broadly based on those of the Australia ICOMOS Burra Charter (1999).

To be assessed as having State heritage significance an item will need to meet one or more of criteria listed in Table 5. These criteria, when considered at a local level, can also be used to identify items of local heritage significance.

Table 5: Criteria for significance assessment of historic cultural heritage

CRITERION	*DESCRIPTION*
A	An item is important in the course, or pattern, of NSW's cultural or natural history;
B	An item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history;
C	An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW;
D	An item has strong or special association with a particular community or cultural group in NSW for social, cultural or spiritual reasons;
E	An item has the potential to yield information that will contribute to an understanding of NSW's cultural and natural history;
F	An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history;
G	An item is important in demonstrating the principal characteristics of a class of NSW's cultural or natural places; or cultural or natural environments.

Amendments to the *Heritage Act 1977* clarify and strengthen responsibility for the management of heritage items at the local and State level. Consequently, items can be assessed as having **local** or **State** level significance. Complex items and places may be assigned a grading, in order to better explain components of particular significance.

An item cannot be excluded from listing on the State Heritage Register on the basis that items with similar characteristics have already been listed. These criteria can be applied to items of State and local significance.

These assessment criteria are useful in considering a wide range of heritage items, and may be applied to sites with items of standing heritage as well as areas with the potential to contain archaeological deposits.

9.3.2 Historic sites – summary of significance assessment

No historic sites were identified during the survey, therefore no assessment of significance is possible.

10.0 IMPACT ASSESSMENT

10.1 Proposed development

Apex Energy NL is proposing to undertake an 18 hole exploration drilling programme to define coal seam gas and goaf gas reserves in a sector of the Illawarra Coal Measures. The project will determine the potential for future commercial production of goaf gas and unmined coal seam exploration wells. The proposed drill holes are designed to collect data necessary for the establishment of the potential for gas production in the project area.

The proposed boreholes can be divided into four categories, each of which will require different testing equipment and duration on site:

- Cored holes drilled over areas with no underlying abandoned goafs (old mine workings) for stratigraphic data, desorption testing of gas content and seam permeability testing. Cored hole diameter is 100mm.

- Cored holes drilled over areas underlain by abandoned goafs. Drilling through and sealing off abandoned goafs requires additional equipment and procedures. This includes a larger diameter hole from the surface to allow placement of additional bore casing. This would require a larger rig and additional time on site.

- Goaf gas exploration wells (i.e. gas held in abandoned coal mine workings) for exploring gas quality and quantity from such goafs.

- Unmined coal seam exploration wells for extended testing of flow rates.

The location of the holes was selected to give a representative coverage of the area under exploration. Other factors taken into consideration in selecting the proposed locations included the level of pre-existing disturbance, ease of access, land ownership and topography.

10.2 Equipment and processes

10.2.1 Construction of exploration sites

Three significantly different types of drilling rigs will be used in the exploration programme:

- Coring rig;
- Open-hole drilling rig; and,
- Workover rig.

Coring rigs are small truck-mounted or jack-up rigs with a gross vehicle weight of less than 20 t. In-ground pits or above ground tanks are required to enable recirculation of drilling fluid. Exploration rigs for coal seam methane drilling are usually truck-mounted, but are larger and heavier than coring rigs and are around 35t gross weight. Drilling of an exploration hole requires a larger operations area than a coring rig site and better access for delivery of casing,

which is 12m long. A workover rig is smaller than a coring rig and will be used to undertake zero radius lateral drilling.

Other equipment on site will include a drillpipe truck (or racked pipe), air compressor (may be an on-board rig or on a separate truck/trailer), pumps, equipment storage container, water tank, drillers' hut and geologists' hut/testing hut.

Temporary access will be required for delivery of drillpipe, casing and other drilling supplies. This could be by semi-trailer. Other vehicle access would be required for a water supply tanker, cement trucks, pump-out tanker and a 4WD geophysical logging vehicle.

Personnel on site will usually comprise a driller and one or two assistants, and a geologist and assistant. Other personnel visiting the site will include drilling and company supervisors, specialist technicians and delivery drivers. Daily access for on-site personnel will be by 4WD or conventional vehicle as appropriate.

The site layout options are shown in Plate 1.

Drilling sites are nominally 50m x 50m but will be varied to suit each particular site. After drilling is completed and the bore established, the drill site will support two fenced enclosures. One will be approximately 10m x 10m and will contain the pipe arrangements to undertake gas monitoring. The other fenced enclosure will be approximately 8m x 8m and will contain a sump that will capture any water extracted from the gas during testing operations. The 10m x 10m fenced enclosure will have a gravel surface and the remainder of the drill site will have vegetation slashed to provide fire protection (D. Olsen pers. comm. 27/10/08). The site compound will be surrounded by a fence approximately 1.8 m high. All equipment will be lower than the fence excepting the solar panel and telemetry mast which may extend up to 3m (D. Olsen pers. comm. 28/10/08).

It will take between 4-6 weeks to construct an exploration site (operating 24 hours a day, 7 days a week). Noise during construction drilling would be predominantly generated by a diesel motor on the drill rig. The motor will be noise attenuated and not audible over 500m (maximum) from the drill rig (D. Olsen pers. comm. 28/10/08). During construction there will probably be up to 6 people on a site at any one time. When testing is underway, there are likely to be 2 to 3 people at site for short durations, otherwise gas monitoring will be undertaken using remote data collection. Site inspections will be required for safety and maintenance matters.

When exploration testing commences the sites will be almost inaudible as gas is being extracted during testing (D. Olsen pers. comm. 27/10/08).

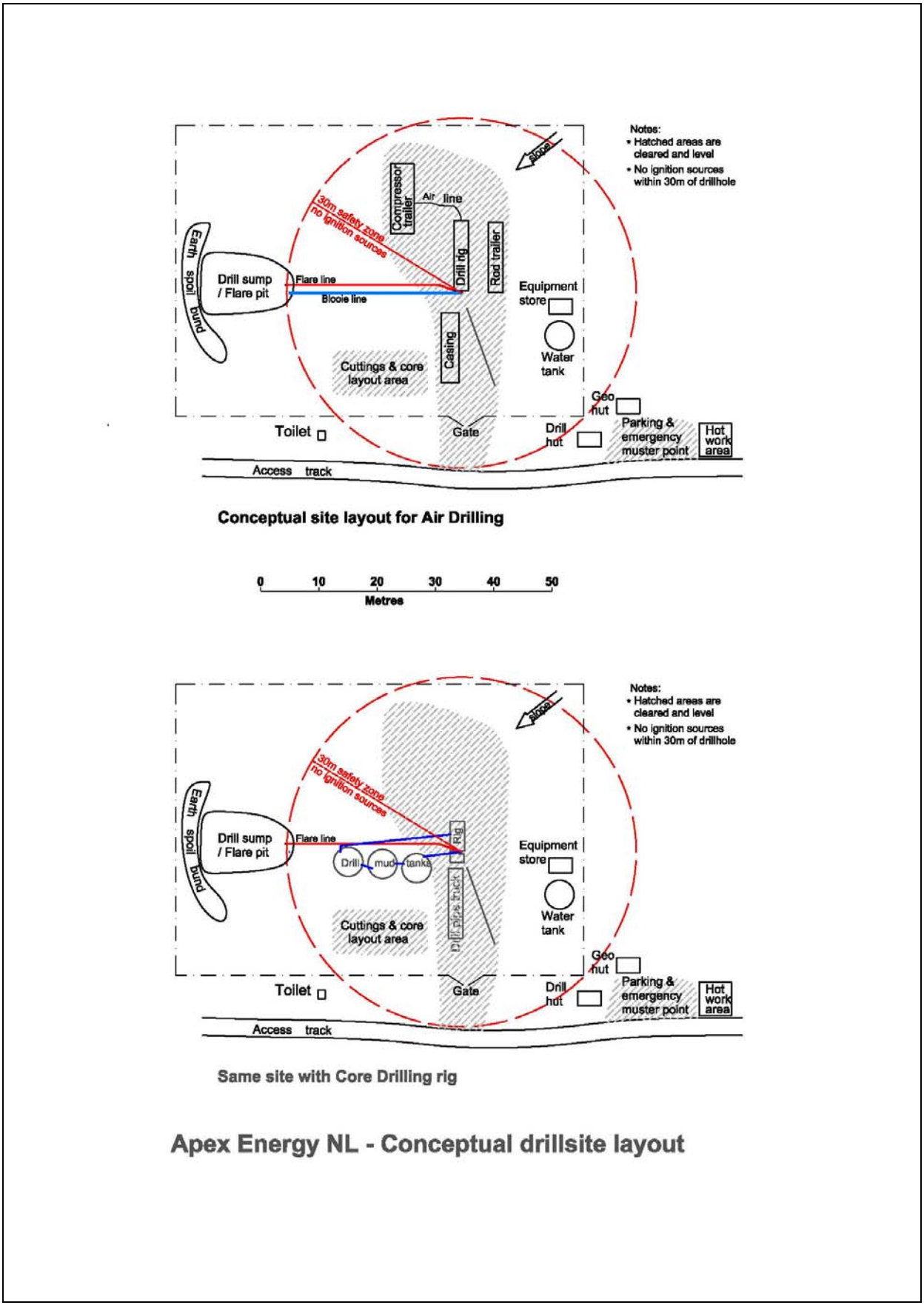


Plate 1: Proposed site layouts (source: Apex Energy NL)

10.2.2 Longevity of exploration sites

Economic considerations require the test sites to be in place for as short a time as possible. Cored holes will be capped at the completion of coring. They may be used for production subject to additional approval. Goaf holes will be tested relatively quickly and their capability determined soon after completion. Both these types of holes would be tested rapidly and typically would be test holes for 3 to 6 months maximum. Combined cored and zero radius drilled holes would be in place for longer to ensure testing was completed. These could be test holes for a maximum of 24 months (D. Olsen pers. comm. 28/10/08).

It is anticipated that testing involving access to the site will only be undertaken over a total of about three weeks after drilling is completed. This testing will occur some time after the hole has been drilled and may occur as two or three individual testing events.

This report is specifically to assist with the approval of an exploration program; it is beyond the scope of this report to identify and assess impacts associated with commercial production at any of these sites. Commercial production would be subject to the results of the exploration testing. It should be noted that even in commercial production, bore sites would not be permanent and would remain in place only while extraction was economically viable; as a guide, a figure of approximately 5 years was suggested subject to a range of variables (D. Olsen pers. comm. 28/10/08).

10.3 Construction & operation impacts on archaeological values

Construction may impact archaeological sites identified, however this is yet to be confirmed.

10.3.1 Borehole AI04A

This potential borehole location is not suitable for drilling given the underlying configuration of the remnant Bulli Seam workings. This location cannot be drilled, and as such, there will be no construction impacts associated with this location.

10.3.2 Borehole AI04B

Construction impacts in this area will include clearance of an intact vegetation community. Disturbance of soil profiles through excavation of a sump area, drilling and installation of associated infrastructure (telemetry mast, fences etc). As discussed previously, although this area was identified as likely to have potential for Aboriginal archaeological material by the Aboriginal participants in the survey, review of environmental factors suggests that this is unlikely. As such, construction and operation activities at this test site are not predicted to impact on any archaeological materials at this location.

10.4 Construction & operation impacts on cultural values

Cultural values within the study area as raised by survey participants and Karen Gough and independent of the cultural significance of archaeological sites can be broadly associated with the dreaming world, the natural environment and people's connection to *place* for reasons of cultural continuity and education. Karen identified several concerns about the project which are addressed in section 10.4.4.

10.4.1 The dreaming world

Parts of the Woronora Plateau are associated with dreaming stories and provide a visual connection to other dreaming places further along the coast. The current proposal does not impact any of the dreaming places identified by Karen Gough, nor do the Borehole locations hinder visual links between the plateau and coastal dreaming sites or the face of the escarpment.

The proposal is not predicted to impact cultural values associated with the dreaming world.

10.4.2 The natural environment

Limited areas of the natural environment will be impacted by the proposal. This is largely contained to vegetation clearance (an area of 50 m x 50 m approximately) within those drill sites where reasonably intact vegetation communities are present.

The proposal is predicted to impact relatively intact vegetation at Boreholes AI03, AI04B, AI10, AI12, AI14, AI15, AI18. None of these boreholes are in publically accessible areas; however the cultural significance of vegetation may not be limited to areas of accessibility, i.e. even though access may not be possible, areas of good condition vegetation are culturally significant.

The drill sites are not predicted to impact on the hydrological function of their catchments (or broader hydrological systems).

There is no identified impact to Maddens Creek or the Wombarra / Scarborough catchment.

10.4.3 Cultural continuity and education

Karen identified several ways her family use the area to ensure cultural continuity and education, primarily associated with visitation, collection of bush tucker and transfer of cultural information. While the Dharawal Nature Reserve was specifically identified as an important area, Karen and her family visit many different areas of the Plateau and it is likely that boreholes located in publicly accessible areas contribute to cultural education within her family.

The only boreholes located in publicly accessible areas are Boreholes AI01 (adjacent to a playing field / model aeroplane field) and Borehole AI05 (adjacent to a track in Dharawal

State Conservation Area). These two sites are heavily disturbed and are unlikely to be specific areas suitable for cultural education, although they do fall within a larger environmental area of educational significance.

10.4.4 Concerns about the project

Having mining machinery intrude up there would be a real pity – make it harder to tap into the spiritual space. We go up there to get away from the modern world, not be reminded of it.

Mining machinery will be limited to the compound area at each specific borehole location.

Anything that intrudes on Aboriginal kids learning about Country while walking on Country is detrimental to cultural education.

The only two publicly accessible boreholes are AI01 and AI05. Both these boreholes are located in disturbed environments, although the wider environment is culturally significant as a place of cultural continuity and education.

I'm concerned about any impacts to the face of the escarpment, any visual impacts. There are rock formations that look like elders and we relate to them as Ancestors looking out on us from the escarpment. I am especially worried about AI15 and AI17 for this.

As discussed previously, the project will not impact the face of the escarpment. The site compounds will be surrounded by a fence 1.8 m high, the bulk of the plant will be screened by the fence, excepting the telemetry mast/ solar panel which may be up to 3 m tall. Boreholes AI15 and AI17 will not be visible from the coastal zone and will not detract from the escarpment.

I would be concerned by any impacts within the Dharawal Nature Reserve. I think they [boreholes] will be intrusive, especially if it goes to full works with miners and machinery. I think they should forget about those ones, AI10, AI11, AI13 and AI12B.

No boreholes are located in Dharawal Nature Reserve. Borehole AI10 is the closest to the Dharawal Nature Reserve, being located within 100 m of the Reserve. Boreholes AI10, AI11, AI12 and AI13 are not within publically accessible lands.

Borehole AI05 is located within the Dharawal State Conservation Area, in a highly disturbed area adjacent to the Maddens Falls walking track. While the specific site of the borehole may not have significant cultural values, it is located in an environment of cultural significance as a place of cultural continuity and inter-generational education.

How loud will they be in operation and how long will they be there for?

Noise will predominantly be limited to the construction phase, when drilling is occurring. Drilling will take between 4-6 weeks at each of the borehole locations, with drill rigs operating 24 hours a day, 7 days a week. During drilling, all diesel motors will have noise

attenuation and will be almost inaudible at 500 m from a drilling location. Once in operation the testing process is essentially inaudible. The test sites may be in place for from 3 months to 2 years depending on the type of area being tested and the test results.

How much damage will be caused by clearing the compounds for the tests?

Site compounds will be approximately 70 x 50 m and an area of approximately 50 x 50 m will be cleared at each area. The level of impact at each of the Borehole locations will vary. Boreholes AI03, AI04B, AI10, AI12B, AI14, AI15, AI18 will require clearance of relatively intact, good-condition vegetation. Detail regarding impacts associated with other environmental aspects (i.e non-archaeological or non-cultural impacts) are beyond the scope of this report.

10.5 Summary and discussion

Boreholes AI03, AI04B, AI10, AI12, AI14, AI15 and AI18 support good condition, intact native vegetation communities. The educational value of these particular borehole areas is limited as current access constraints deny public visitation. While vegetation communities are a signifier of cultural identity and Country, current access conditions restrict practicing connection to Country at these locations. Regardless of access issues, there is cultural importance attached to the vegetation of the Woronora Plateau and this should be respected through impact minimisation wherever possible.

The two publicly accessible boreholes are located in highly disturbed contexts within broader landscapes of good condition native vegetation. Boreholes AI01 and AI05 are considered to be located in areas of immediate disturbance, and wider cultural significance.

The proposal is not predicted to significantly impact archaeological or cultural heritage values within the proposed borehole locations. While there will be vegetation clearance at some of the borehole locations, this is considered to be manageable impact.

11.0 RECOMMENDATIONS

Project approval is being sought under Part 3A of the *Environmental Planning and Assessment Act 1979*. Section 75U of the *EP&A Act* states that:

(1) The following authorisations are not required for an approved project (and accordingly the provisions of any Act that prohibit an activity without such an authority do not apply):

(c) an approval under Part 4, or an excavation permit under section 139, of the Heritage Act 1977

(d) a permit under section 87 or a consent under section 90 of the National Parks and Wildlife Act 1974

(2) Division 8 of Part 6 of the Heritage Act 1977 does not apply to prevent or interfere with the carrying out of an approved project.

Background research, survey results, community consultation and impact assessment identify no significant impacts to cultural or archaeological values at the proposed borehole locations, pending vibration impact assessment results for Borehole AM2.

11.1 Recommendations

Impacts which have been identified can be ameliorated through adoption of the following recommendations:

Recommendation 1 – Borehole AI04B

Borehole AI04B is the only of the AI04 boreholes that is suitable for drilling given the underlying structure of the Bulli Seam. While Borehole AI04A was the location preferred by the communities this location is physically unable to meet selection criteria. As such, Borehole AI04B is the only location suitable for drilling.

The Aboriginal community have requested that if this site be selected, that monitors be engaged during the site clearance process. Monitoring is not an archaeological process and is not endorsed by DECC. Should the client wish to, they may directly engage Aboriginal monitors to supervise the site clearance process. Monitoring will be undertaken for cultural reasons, not archaeological and no archaeologist is required to be on site for this work. Monitoring will not require consultation with DECC.

Recommendation 2 – Cultural values at publicly accessible locations

Boreholes AI01 and AI05 are the only two boreholes that might be reasonably considered publicly accessible. The project may impact on cultural values by diminishing Aboriginal enjoyment of the area as a place of connection to Country and a place to conduct inter-generational cultural education; this is particularly relevant at Borehole AI05 which is located

in the Dharawal State Conservation Area. Impacts associated with the proposed boreholes are limited and may be ameliorated in the following manners:

- Noise attenuation of all diesel motors to minimise noise impacts during construction. Testing operation will be largely inaudible and will not require mitigation.

- Screening of the site compounds to mask visual intrusion into the landscape. This may include measures such as fixing green shade cloth to the compound site fence to merge the bulk of the fence into surrounding vegetation or planting of local native plant species as a screen around the fence where sufficient depth of soil exists.

Recommendation 3 – Areas of good condition native vegetation

Boreholes AI03, AI04B, AI10, AI12, AI14, AI15 and AI18 have good condition native vegetation which will be impacted by the proposal. While none of these boreholes are situated in areas that are publicly accessible, native vegetation is important to the Aboriginal community. It is recommended that seed banks be established for each of these boreholes, and that at the conclusion of the testing program the areas be 'made good' by the proponent.

Recommendation 4 – Aboriginal objects stop work provision

No Aboriginal archaeological constraints have been identified within the project study area. Should unanticipated Aboriginal objects be identified during project works, all works should cease in the vicinity of the find and an archaeologist should be called in to assess the find. Section 75U Part 3A of the *Environmental Planning and Assessment Act* does not switch off section 86 of the *National Parks and Wildlife Act 1974*. Notification of discovery of Aboriginal objects and places is still required under the *National Parks and Wildlife Act 1974.*

Recommendation 5 – Historic relics stop work provision

No historic heritage constraints have been identified within the project study area. Should unanticipated historic relics be identified during project works, all works should cease in the vicinity of the find and an archaeologist should be called in to assess the find. Section 75U Part 3A of the *Environmental Planning and Assessment Act* does not switch off section 146 of the *Heritage Act 1977*. Notification of discovery of historic relics is still required under the *Heritage Act 1977*.

11.2 Report lodgement

This report has been distributed to:

- Olsen Environmental Consulting Pty. Limited
- Apex Energy NL
- Illawarra Local Aboriginal Land Council
- Kullila Welfare and Housing Aboriginal Corporation

- Mr Robert Evitt
- Ms Karen Gough

11.3 Independent review of reports

Heritage and archaeological reports and the management recommendations contained therein may be independently reviewed by the consent authority responsible for determining a project application.

Although the findings of a consultant's report will be taken into consideration, recommendations in relation to managing a heritage place should not be taken to imply automatic approval of those actions by the consent authority.

REFERENCES

Allen, J. and J.F. O'Connell. 2003. The long and the short of it: Archaeological approaches to determining when humans first colonised Australia and New Guinea. *Australian Archaeology*, 57: 5-19

Attenbrow, V. 2002. *Sydney's Aboriginal Past*. UNSW Press, Sydney.

Australia ICOMOS. 1999. *Australia ICOMOS Charter for the Conservation of Places of Cultural Significance (the Burra Charter), revised edition*, Australia ICOMOS, Canberra.

Biosis Research. June 2008a. *Cultural Heritage and Archaeological Assessment for a Proposed Residence, Lot 1, DP 616230, East of Helensburgh.* Report for Mr Robert Hogarth.

Biosis Research. October 2008b. *Flora and Fauna Impact Assessment: Illawarra Coal Seam Gas Exploration Drilling Program.* Report for Apex Energy NL

Byrne, Denis & Hilary du Cros. July 1985. *Survey for Archaeological Sites on Proposed Housing Subdivisions along Old Illawarra Road, Menai/Lucas Heights, NSW.* Report to Land Planning and Sales Pty Ltd.

Dallas, Mary. August 2002. *Archaeological Test Excavations of NPWS Site #52-2-2189 at the Former Lagoon Restaurant, Stuart Park, North Wollongong, NSW.* Report to Emibarb Pty Ltd.

DECC. 1997. *National Parks and Wildlife Service 'Guidelines for Archaeological Survey Reporting (Working Draft)'*, Cultural Heritage Services Division, Sydney.

DECC, NSW. 2004. *National Parks and Wildlife Act 1974: Part 6 Approvals – Interim Community Consultation Requirements for Applicants.* NSW Department of Environment and Climate Change, Sydney NSW.

DECC, NSW. 2005. *Draft Guidelines for Aboriginal Cultural Impact Assessment and Community Consultation.* NSW Department of Environment and Climate Change, Sydney NSW.

DECC, NSW. n.d. *Guidelines for Aboriginal Heritage Impact Assessment (Draft).* Prepared by the NSW National Parks and Wildlife Service with additional text by Krystal Buckley, Context Pty Ltd.

Flood, J. 1999. *Archaeology of the dreamtime: the story of prehistoric Australia and its people* (revised edition), Angus and Robertson, Sydney.

Hazelton, P.A. and Tille, P.J. 1990. *Soil Landscapes of the Wollongong-Port Hacking 1:100 000 Sheet.* Soil Conservation Service of NSW, Sydney.

Illawarra Prehistory Group. December 1995. *1994-1995 Archaeological Survey of Kangaroo Creek Royal National Park.* Report to the Australian Institute of Aboriginal and Torres Strait Island Studies.

Illawarra Prehistory Group. December 1996. *1995-1996 Archaeological Survey of the North and Western Side of the Hacking River Including Royal National Park and Garrawarra State Recreation Area.* Report to the Australian Institute of Aboriginal and Torres Strait Island Studies.

Illawarra Prehistory Group. August 2002. *Archaeological Sur of the Eastern Drainage of the Hacking River to Upper Peach Trees.*

Illawarra Prehistory Group. February 2007. *Archaeological Survey of the Western Catchment of Southwest Arm to Grahams Point Royal National Park.*

Jeans, D. and Jack I. 1996. *Regional histories of New South Wales.* NSW Heritage Office

Koettig, M. 1985. *Archaeological investigations of three sites on Upper Mill Creek near Lucas Heights, Sydney.* Report for Metropolitan Waste Disposal Authority.

McDonald, J. 1992. 'Chapter 2: Aboriginal Usage of the Hawkesbury-Nepean In Prehistory', in Sue Rosen Pty. Ltd. (ed) *Hawkesbury-Nepean Historic Environmental Changes Study. Volume II*, Water Resources Branch - Water Board, Sydney-Illawarra-Blue Mountains.

McPhee, D. Rogers, B. Conacher, A. and D. Fullerton (1991*). City of Wollongong Heritage Study.* Report to Wollongong City Council.

Navin, Kerry. December 1991. *An Archaeological Survey of Areas in the Lady Crrington Estate, Helensburgh, NSW.* Report to Quality Environmental Management for Gutteridge Haskings and Davey Pty Ltd.

Navin Officer. 2000. *Dendrobium Coal Project: Cultural Heritage Assessment*, A Report to Olsen Environmental Consulting Pty Ltd on behalf of BHP Coal Illawarra.

NSW Heritage Office. 1996. *NSW Heritage Manual*, NSW Heritage Office and Department of Urban Affairs & Planning, Sydney.

Pearson, M. & Sullivan, S. 1995. *Looking After Heritage Places*, Melbourne University Press, Melbourne.

Robinson, L. 2003. *Field Guide to the native plants of Sydney, 3rd Edition.* Kangaroo Press, Sydney.

Sefton, C. 1998. *Resurvey of Brennan's Creek Stage II Coal Washery Refuse Emplacement Area.* Report to Collieries Division, BHP Australia Coal.

Smith, L. 1989. *Liverpool Release Areas: archaeological site survey and planning study.* Report to Liverpool City Council.

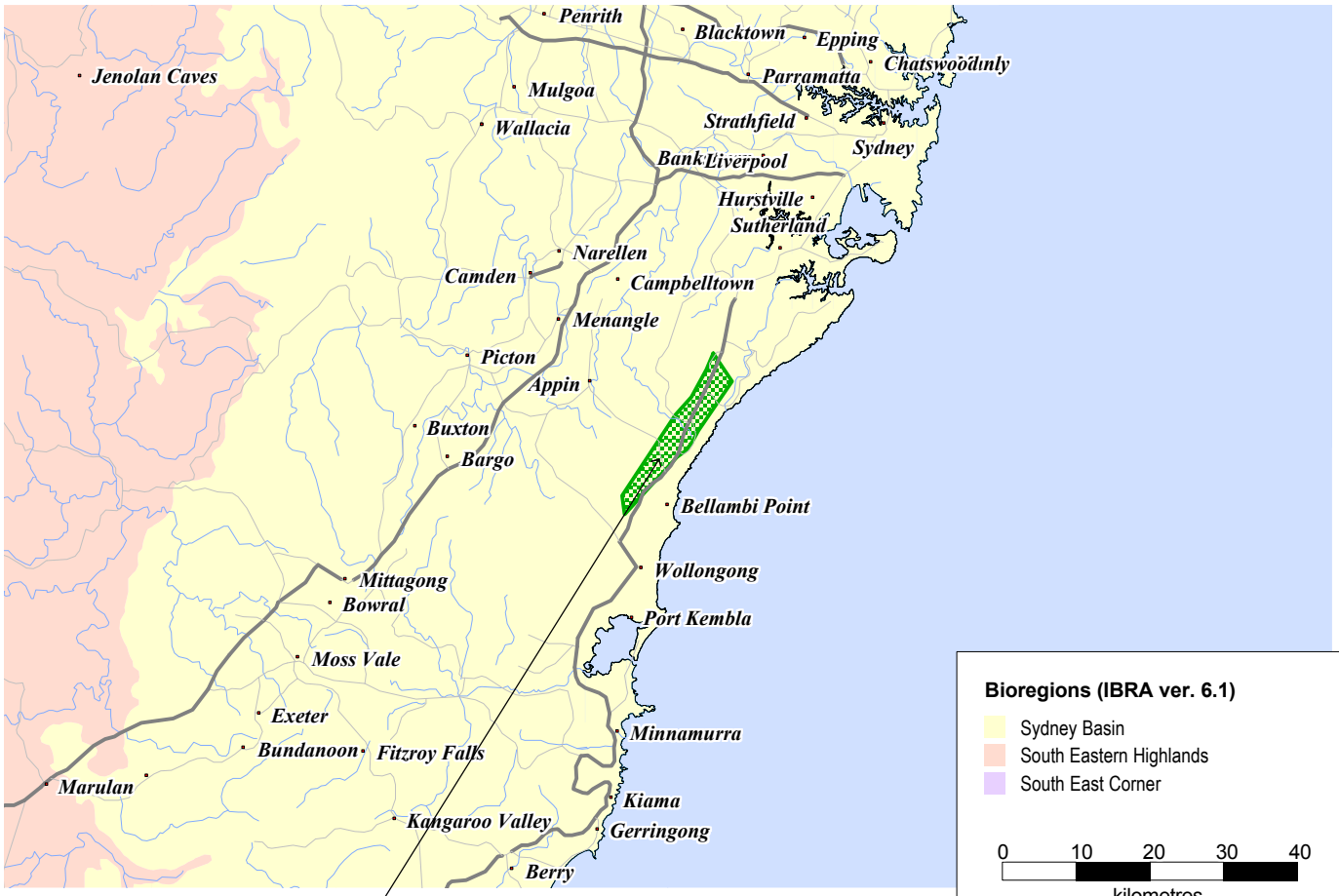
Stewart, K. and B. Percival. 1997. *Bushfoods of New South Wales: a botanic record and an Aboriginal oral history.* Royal Botanic Gardens, Sydney

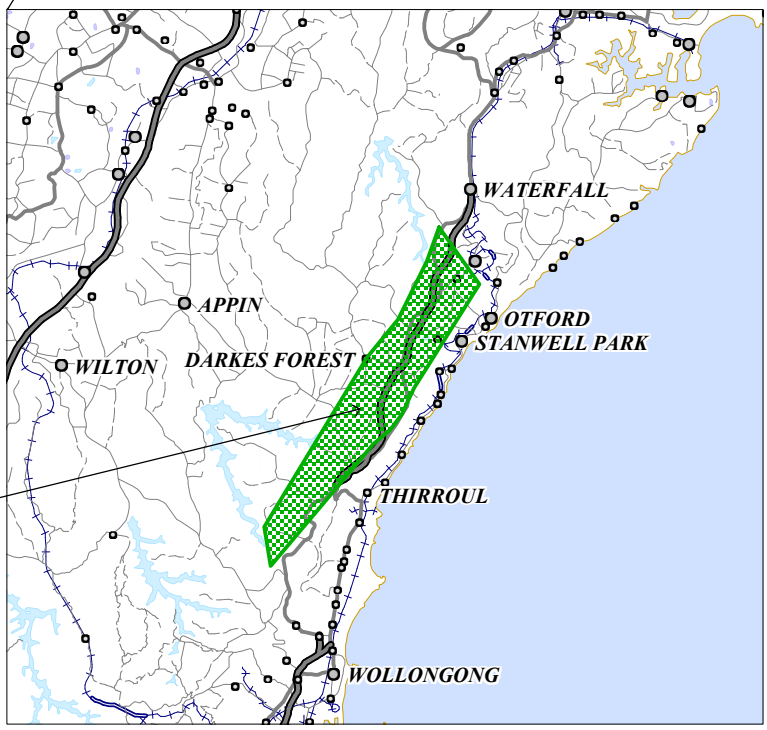
Tindale, N.B. 1974. *Aboriginal Tribes of Australia.* Australian National University Press. Canberra.

Websites:

Bureau of Meteorology website, http://www.bom.gov.au/weather/nsw/

FIGURES





Study area

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NEW SOUTH WALES 2500

Figure 1: Location of the Study Area in a regional context.

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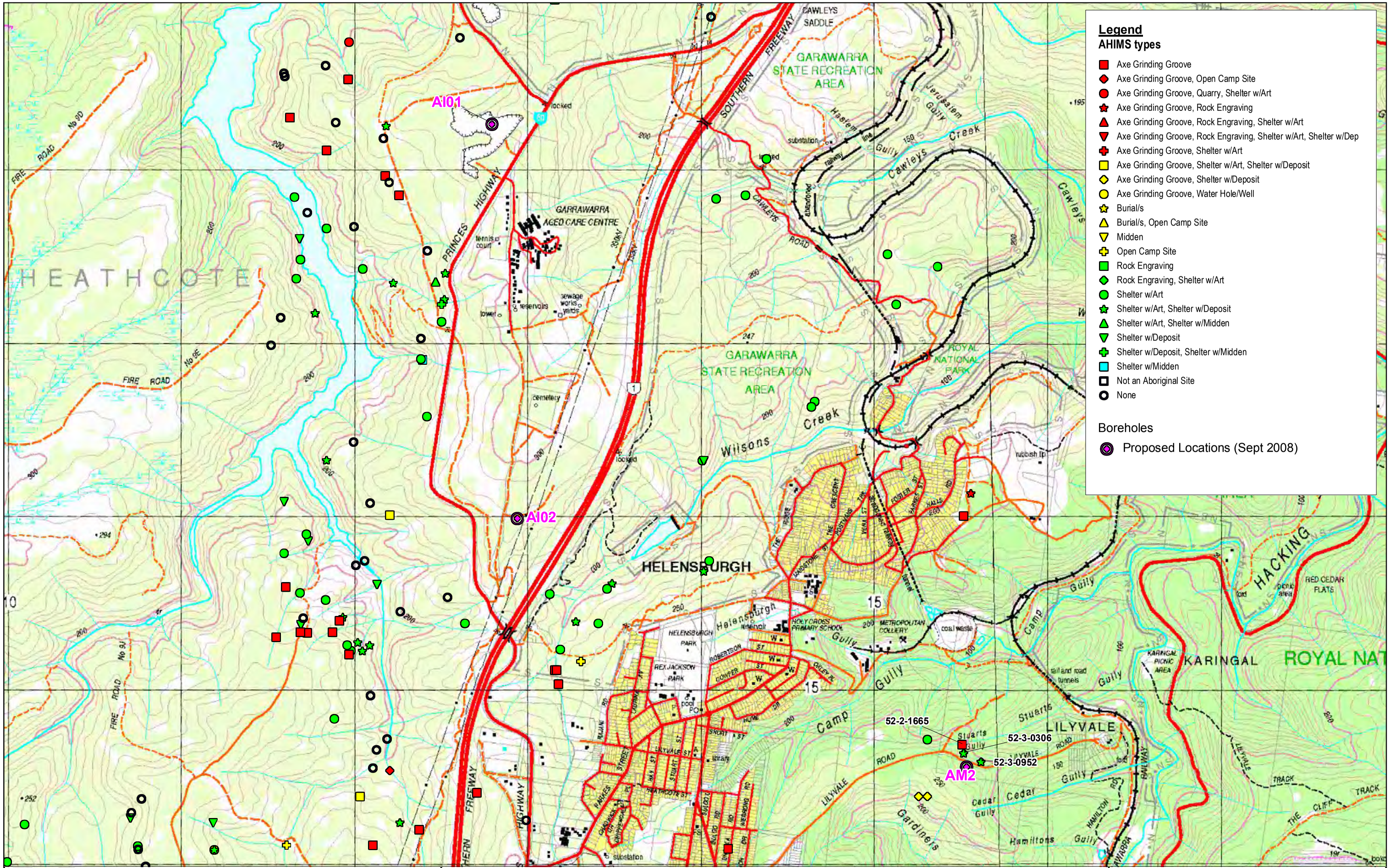

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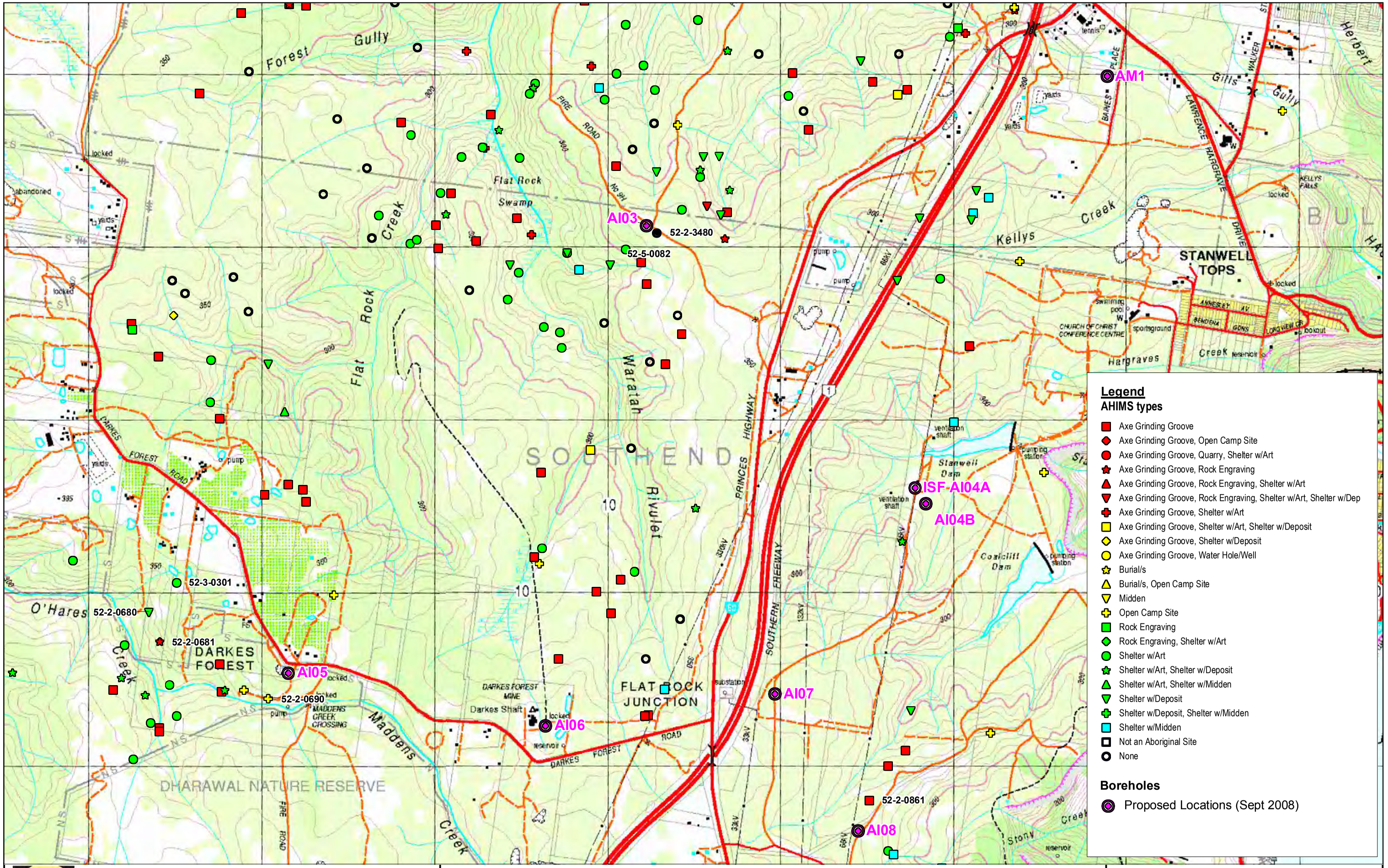

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Figure 2b : AHIMS and boreholes

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Figure 2b : AHIMS and boreholes

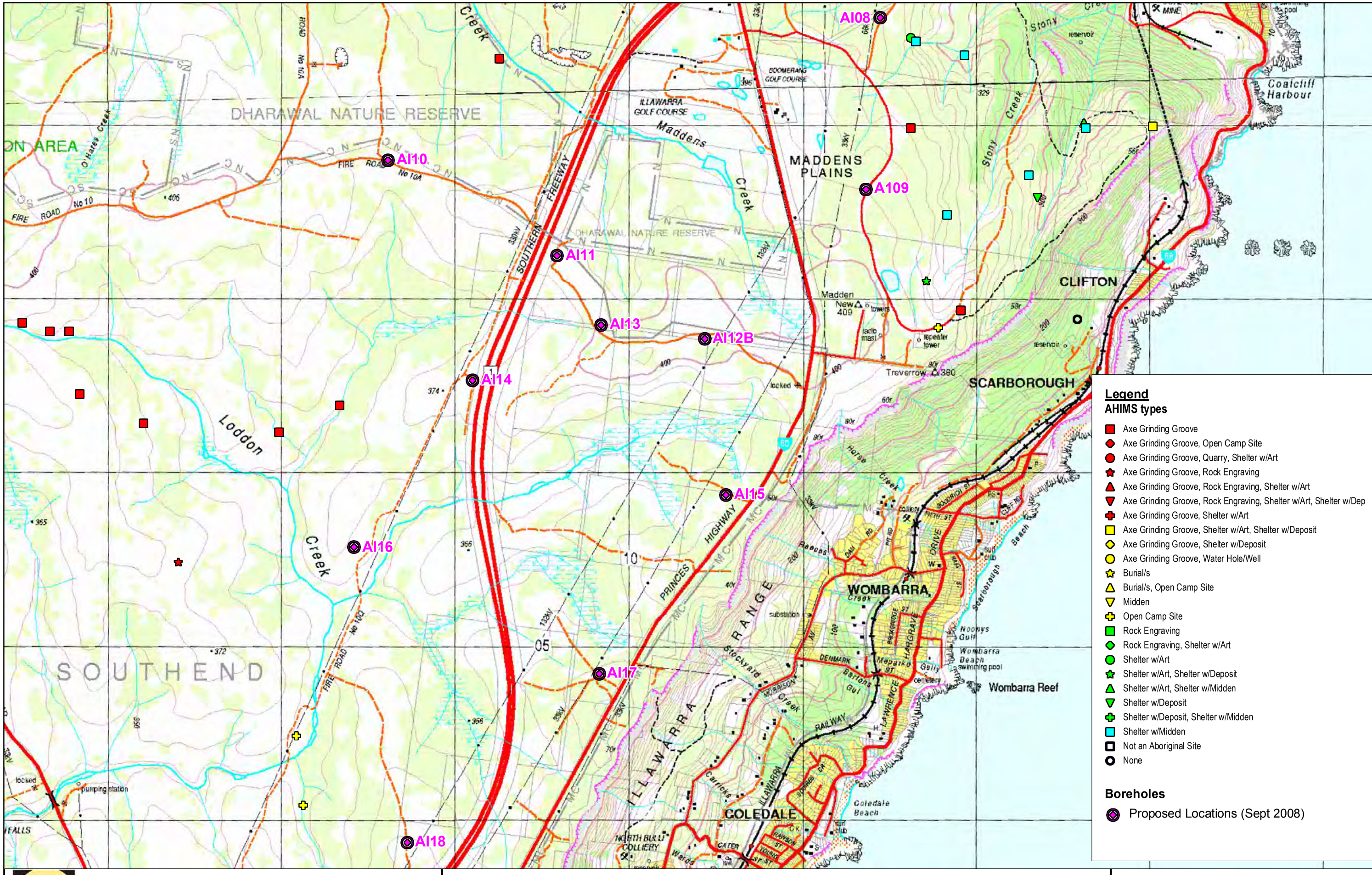

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Figure 2c : AHIMS and boreholes

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Figure 2c : AHIMS and boreholes

APPENDICES

Appendix 1: Borehole data sheets

BOREHOLE AI01			**Cored hole - top of hole drilled with air rig**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Gentle slope Former gravel pit	High	<5%	<5%	None identified

Description

The location of Borehole AI01 is in an area associated with a rehabilitated gravel pit. The site is approximately 600 m from the nearest creek line and, while the surrounding topography slopes gently to the north-east, the proposed borehole area is generally level, with an open aspect.

The area is considered highly disturbed; rehabilitation works include levelling and revegetation. There is no potential for intact soil profiles or ground surfaces in this area. Extensive gravel deposits obscure the ground surface and GSV is very low. There is some small scale revegetation with native species but no mature plantings survive in the this area.

Access will be via the existing road, with limited clearance required to access to the borehole location.

The extensive disturbance and environmental conditions suggest that there is little potential for Aboriginal or historic sites at this location.

Plate 2: General view of Borehole AI01 (view north west).

Plate 3: General view of Borehole AI01 (view south east).

Archaeological Sites at Borehole AI01

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

Borehole AI01 is situated in an area which may be considered publicly accessible, and is therefore in an area where people have the potential to practice connection to Country and inter-generational education. Such practices have high cultural significance.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological values.

The specific location of Borehole AI01 is heavily disturbed and is unlikely to be a place for teaching children about connection to Country. The surrounding area, however, includes much better condition native vegetation where inter-generational education could be practiced. The proposal will indirectly affect people's ability to connect to Country through construction noise and intrusive elements in the landscape. These are temporary impacts which may be ameliorated through adoption of the proposed recommendations.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological sites at Borehole AI01. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.
- Cultural values associated with practicing connection to Country and inter-generational education may be present at this site (which is somewhat publicly accessible). Works may proceed at this location if the following mitigation measures are adopted:
  - Noise attenuation of diesel motors to reduce noise impacts during construction phase (3-6 weeks). Testing operation is essentially inaudible and will not require noise attenuation.
  - Screening of the site compounds to mask visual intrusion into the landscape. This may include measures such as fixing green shade cloth to the compound site fence to merge the bulk of the fence into surrounding vegetation or planting of local native plant species as a screen around the fence where sufficient depth of soil exists.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI01. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI02			**Cored hole - top of hole drilled with air rig**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Gentle slope	Cleared access road	70% on road 0% off road	10% on road 0% off road	None identified

Description

Borehole AI02 is located in an area of thick impenetrable scrub. The borehole location could not be accessed and was not surveyed. Survey focussed on the road where there was some limited GSV.

This area slopes very gently to the south and is approximately 700 m from the nearest creek line. The area has shallow, sandy soils which currently supports a dense growth of shrubs (no tree layer). Surrounding vegetation is larger woodland species, however the study area appears to have been slashed for an adjacent power line resulting in a different vegetation structure. Environmental conditions suggest that there is little potential for Aboriginal or historic sites at this location.

Access will be via the established fire road track.

Plate 4: General view of vegetation at Borehole AI02 (view south west).

Plate 5: View of access track to Borehole AI02 (view north west).

Archaeological Sites at Borehole AI02

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

None identified.

Impacts

The proposal will not impact any identified Aboriginal or historic archaeological or cultural heritage values.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological or cultural heritage sites at Borehole AI02. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI02. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI03			**Cored hole - top of hole drilled with air rig**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Open level area	Minimal, some for road verge	40%	80%	None identified

Description

Borehole AI03 is located within Sydney Catchment Authority Metropolitan Special Area (restricted access for drinking water supply). Access is via an existing Fire Road (9H). Topography is level with an open aspect. Vegetation is Coastal Sandstone Ridgetop Woodland and the proposed location is approximately 200 m from the nearest water source. GSV was reasonable within the slashed road verge, but poor within the established vegetation areas beyond the road verge. Soils appear to be shallow and sandy, there were no areas of exposed sandstone within the study area.

The borehole is proposed to be situated in the cleared road verge immediately adjacent to the intersection of Fire Roads 9H and 9G. An Aboriginal site (52-2-3480) is registered at this location in the AHIMS database, however the site card description of the site states that the grinding grooves are located 250 m south of the intersection of Fire Roads 9H and 9G. Although this site is incorrectly registered in the immediate area of the borehole location, there is no Aboriginal site at the proposed location.

Environmental conditions suggest that there is little potential for Aboriginal or historic sites at this location.

Plate 6: Borehole AI03 (view south east).

Plate 7: Borehole AI03 (view south west).

Archaeological Sites at Borehole AI03

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

52-2-3480 (Flat Rock Creek 289) Axe grinding groove

Site 52-2-3480 is registered to the immediate location of Borehole AI03, but is actually located 250 m south of the proposed borehole location. This site comprises two shallow grinding grooves on a sandstone exposure with a well at a tributary to Flat Rock Swamp. This site will not be impacted by the proposed works and was not relocated as part of this survey.

52-5-0082 (Darkes Forest, Flat Rock Creek 39) Shelter with Art

Site 52-5-0082 is located approximately 180 m south west of Borehole AI03. The site is a shelter with art, situated above a tributary of the Waratah Rivulet. This site is not within the impact area of the proposal and was not relocated as part of this survey.

Cultural Values

Borehole AI03 is situated in an area of good condition native vegetation, which may be considered of cultural importance to Aboriginal people.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological values.

Proposal will require clearance of a discrete area of native vegetation. This may impact cultural values associated with native vegetation, however this location is not publicly accessible, and as such, impacts to cultural values are considered low.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological sites at Borehole AI03. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.
- Cultural values placed on native vegetation require that the area be made good at the conclusion of works. A seed bank comprising the A0 horizon should be collected at commencement of works and dispersed over the site at the conclusion of the testing programme.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI03. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI04A			**Cored hole - top of hole drilled with air rig**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Modified bench on gentle slope	High: mine shaft site	80%	15%	ISF AI04A

Description

Borehole AI04A is located adjacent to a rehabilitated mine ventilation shaft, access road and transmission line.

The study area is situated on an artificially levelled bench on a slope approximately 80 m above a tributary of Stanwell Dam. The area has a northern aspect. Soils are shallow over sandstone bedrock. Vegetation includes sparse native shrub species colonising the disturbed area.

Disturbance is considered exceptionally high – the proposed borehole is adjacent to a rehabilitated mine ventilation shaft (Coal Cliff Mine), the ventilation shaft has been concrete capped. Prior to decommissioning, the area included a fan house, brick structures and power lines. The ground has been subject to great disturbance and there are extensive areas of introduced gravels - it is possible that the artefact has been introduced to this location with the gravel.

An isolated find (ISF AI04A) was identified at the proposed borehole location and is discussed below.

The high disturbance suggests there is little potential for intact Aboriginal or historic sites at this location.

Plate 8: Borehole AI04A (view west).

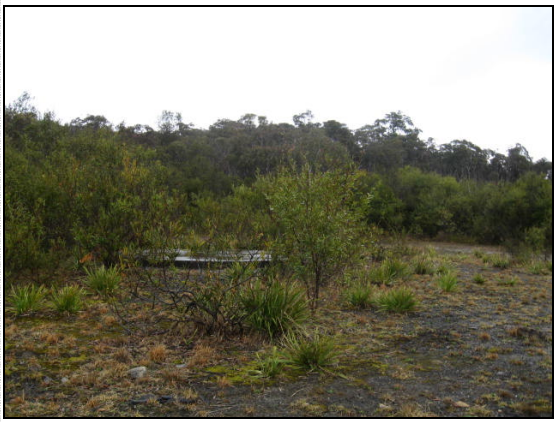

Plate 9: Borehole AI04A with capped ventilation shaft (view south west).

Archaeological Sites at Borehole AI04A

ISF AI04A

ISF AI04A is an isolated find identified in a highly disturbed context associated with a rehabilitated mine ventilation shaft. The artefact is made on a fine grained volcanic and measures 31 x 19 x 13 mm. The artefact is damaged across the platform (vehicle impact?), and has two negative flake scars. There is unlikely to be additional intact archaeological material in this area given the high disturbance and shallow soil profiles. This site is considered to be of low archaeological (or scientific) significance.

The Aboriginal community will provide comment regarding the cultural significance of archaeological potential at this location.

Plate 10: Location of ISF AI04A at borehole AI04A (view south west).

Plate 11: ISF AI04A.

No historic sites were identified at this location, the rehabilitated mine ventilation shaft is not an item of historic heritage significance. There is no identified historic archaeological potential at this location.

Nearby Archaeological Sites

There are no registered Aboriginal or historical sites within 200 m of Borehole AI04A. Two shelters (one with midden, one with art and deposit) are present within the gully, but are more than 200 m away from the proposed borehole location and will not be impacted by the proposed works.

Cultural Values

None identified.

Impacts

Subsequent to the field survey, it has been determined that this location is unable to be drilled. For drilling purposes, the proposed borehole location must be situated above a remnant coal pillar, and the location of Borehole AI04A is not above the coal pillar. As this site cannot be drilled, there will be no impact to newly identified site ISF AI04A.

Recommendations

Aboriginal

Borehole AI04A cannot be selected and there will be no physical impacts to Aboriginal sites at this location.

- Artefact ISF AI04A is to be registered on the AHIMS database.

Historic

Borehole AI04A cannot be selected and there will be no physical impacts to Historical sites at this location.

BOREHOLE AI04B			**Cored hole - top of hole drilled with air rig**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Moderate slope	Low	10%	0%	Limited potential

Description

Borehole AI04B is located in bushland 30 m from the access road and approximately 150 m east of proposed Borehole AI04A.

The study area is situated on a moderate slope approximately 170 m above a tributary to Stanwell Dam. The area has a north eastern aspect. Soils appear to be shallow over sandstone bedrock, there are large areas of exposed sandstone. Vegetation includes Coastal Sandstone Gully Forest with an intact structure. This area appears to have been subject to very low disturbance as mature trees are present within the area.

No Aboriginal or historical archaeological sites were identified at this location, however the Aboriginal community representatives have identified that they consider this area to have reasonable archaeological potential for intact deposits.

While the low disturbance seems to suggest some potential for archaeological deposits in this area, the environmental factors are such that the area cannot be defined as Potential Archaeological Deposit. There is no potential for historic archaeological material at this location.

Plate 12: Borehole AI04B (view north).

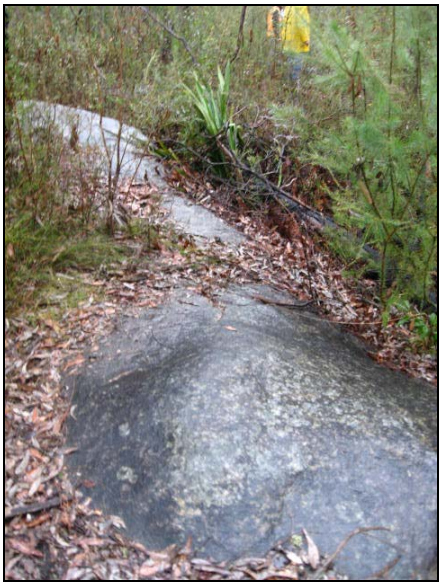

Plate 13: Borehole AI04B with sandstone exposure (view north west).

Archaeological Sites at Borehole AI04B

Aboriginal stakeholders participating in the survey identified that this location is likely to have reasonable potential for Aboriginal archaeological material given the low disturbance and environmental conditions. This borehole is located on a moderate slope, approximately 200 m from a water source. There are two shelters in the surrounding area, indicative of Aboriginal habitation of the gully. The presence of such shelters suggests that any sustained occupation is likely to have occurred at those locations. If this is true, the proposed borehole location is likely to be associated with people moving through the landscape (sporadic discard) rather than a long-term occupation site. The site does not meet the criteria for identification as PAD based on this assessment. As such, the location is assessed as being of no archaeological (or scientific) significance.

The Aboriginal community will provide comment regarding the cultural identification of archaeological potential at this location.

No historic sites or historic archaeological potential was identified at this location.

Nearby Archaeological Sites

There are no registered Aboriginal or historical sites within 200 m of Borehole AI04B. Two shelters (one with midden, one with art and deposit) are present within the gully, but are more than 200 m away from the proposed borehole location and will not be impacted by the proposed works.

Cultural Values

Borehole AI04B is situated in an area of good condition native vegetation, which may be considered of cultural importance to Aboriginal people.

Impacts

The proposed works will impact an area identified by the Aboriginal community as having archaeological potential. Archaeological assessment has identified that this area does not meet the criteria for formal identification as PAD and, as such, the location has no scientific significance. There is unlikely to be any impact to archaeological values at this location.

Proposal will require clearance of a discrete area of native vegetation. This may impact cultural values associated with native vegetation, however this location is not publicly accessible, and as such, impacts to cultural values are considered low.

The proposed works will not impact historic archaeological values.

Recommendations

Aboriginal

Aboriginal stakeholders participating in the survey indicated that they would prefer to see the borehole at location AI04A (rather than AI04B), however since the survey, information has become available which excludes AI04A from selection as the preferred borehole location.

Aboriginal stakeholders also identified that there is likely to be reasonable Aboriginal archaeological potential at Borehole AI04B. This is a cultural assessment of archaeological potential. Material likely to be present in this location is likely to represent background scatter, rather than a sustained occupation site. This site does not meet the requirements for identification and registration as PAD and is assessed as having no scientific significance as a site of PAD.

- The Aboriginal community have requested that if this site be selected, that monitors be engaged during the site clearance process. Monitoring is not an archaeological process and is not endorsed by DECC. Should the client wish to, they may directly engage Aboriginal monitors to supervise the site clearance process. Monitoring will be undertaken for cultural reasons, not archaeological and no archaeologist is required to be on site for this work. Monitoring will not require consultation with DECC.
- Cultural values placed on native vegetation require that the area be made good at the conclusion of works. A seed bank comprising the A0 horizon should be collected at commencement of works and dispersed over the site at the conclusion of the testing programme.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI04B. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI05			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Modified bench on moderate slope	High	90%	80%	None identified

Description

Borehole AI05 is located in the Dharawal State Conservation Area, at an old quarry location accessible from an existing track.

The study area is situated on a modified bench on a moderate to steep slope approximately 350 m above O'Hares Creek. The area has a south western aspect. Soils are exceptionally shallow at this location, with large areas of laterite bedrock exposed. Vegetation within the borehole area is regenerating shrub species. The borehole location has been subject to very high levels of disturbance associated with previous quarrying activity; surrounding areas have low disturbance.

No Aboriginal or historical archaeological sites were identified at this location. The high disturbance and environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 14: Borehole AI05 (view south west).

Plate 15: Borehole AI05 (view north west).

Archaeological Sites at Borehole AI05

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

52-2-0690 (Darkes Forest, O'Hares Creek 21) Open Camp Site

Site card contains few details of this site, other than that site comprises a surface scatter of artefacts. The site is located above a confluence of several major creeklines. Card notes that artefacts have been historically collected at this site.

This site is approximately 200 m south west of the proposed borehole location and was not relocated as part of the current project.

Cultural Values

Borehole AI05 is situated in an area which may be considered publicly accessible, and is therefore in an area where people have the potential to practice connection to Country and inter-generational education. Such practices have high cultural significance.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological values.

The specific location of Borehole AI05 is heavily disturbed and is unlikely to be a place for teaching children about connection to Country. The surrounding area, however, includes much better condition native vegetation where inter-generational education could be practiced. Maddens Falls has been identified as an area where children are brought onto Country and learn about Aboriginal culture. The proposal will indirectly affect people's ability to connect to Country through construction noise and intrusive elements in the landscape. These, however, are temporary impacts which may be ameliorated through

adoption of the proposed recommendations.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological sites at Borehole AI05. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.
- Cultural values associated with practicing connection to Country and inter-generational education may be present at this site (which is publicly accessible). Works may proceed at this location if the following mitigation measures are adopted:
    - Noise attenuation of diesel motors to reduce noise impacts during construction phase (3-6 weeks). Testing operation is essentially inaudible and will not require noise attenuation.
    - Screening of the site compounds to mask visual intrusion into the landscape. This may include measures such as fixing green shade cloth to the compound site fence to merge the bulk of the fence into surrounding vegetation or planting of local native plant species as a screen around the fence where sufficient depth of soil exists.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI05. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI06			**Open hole (rotary drill hole drilled with air rig) OR Cored hole drilled with diamond set drill bit**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Undulating slope	High	Varied, 10-80%	Varied 5-20%	None identified

Description

Borehole AI06 is located adjacent to the Darkes Forest Mine car-park. Darkes Forest Mine no longer operates and is being rehabilitated.

The proposed borehole location is a highly disturbed area associated with a mining lease and mine shaft. The area has previously been cleared (vegetation is re-establishing) and coal wash is present across the area. Sandstone bedrock exposures are present. Soils appear to be shallow, reworked deposits predicted to have little to no integrity. Aspect is open and the borehole location is within 50 m of an ephemeral drainage line to a small swamp. Visibility was very low due to the presence of dense leaf litter and introduced coal wash.

15 m north of the borehole location, 6 angular fragments of purple silcrete were identified in an abandoned vehicle track. These displayed no evidence of working and are likely to have been fractured through vehicle movements in the area.

No Aboriginal or historical archaeological sites were identified at this location. The high disturbance and environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 16: Borehole AI06, exposed sandstone and regenerating shrubs (view south).

Plate 17: Borehole AI06, car park in background (view south west).

Archaeological Sites at Borehole AI06

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

None identified.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological or cultural heritage values.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological or cultural heritage sites at Borehole AI06. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI06. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI07			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Open Plateau	High	0%	0%	None identified

Description

Borehole AI07 is located on an undulating plateau area adjacent to an access track. The proposed borehole location has been cleared of vegetation with approximately 4m depth of coal wash placed on top. Down slope of the borehole beyond the coal wash, an upland swamp vegetation community is present.

The proposed borehole location is a highly disturbed, with no natural ground surface visible.

No Aboriginal or historical archaeological sites were identified at this location. The high disturbance and environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 18: Borehole AI07, with coal wash surface (view north).

Plate 19: Borehole AI07, with coal wash surface (view south east).

Archaeological Sites at Borehole AI07

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

None identified.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological or cultural heritage values.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological or cultural heritage sites at Borehole AI07. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI07. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI08			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Undulating Plateau	High	30%	10%	None identified

Description

Borehole AI08 is located on an undulating plateau area adjacent to an access track. The proposed borehole location has been cleared of vegetation coal wash placed on top. The area slopes to the north and east. There are some areas of "natural" surface with a very thick, sludgy soil structure. Down slope of the borehole beyond the coal wash, an upland swamp vegetation community is present.

The proposed borehole location is a highly disturbed, but there is evidence of heavy earthworks in the area and soil profiles in this area are not considered to be intact. No sandstone exposures were identified.

No Aboriginal or historical archaeological sites were identified at this location. The high disturbance and environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 20: Borehole AI08, with revegetated coal wash surface (view north).

Plate 21: Borehole AI08, with revegetated coal wash surface (view south east).

Archaeological Sites at Borehole AI08

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

52-2-0861 (Coal Cliff Site 24) Axe grinding groove

Site 52-2-0861 is located approximately 190 m north of Borehole AI08. The site comprises 16 grooves scattered over 5 sandstone platforms in the upland swamp. This site is not within the impact area of the proposal and was not relocated as part of the current project.

Cultural Values

None identified.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological or cultural heritage values.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological or cultural heritage sites at Borehole AI08. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI08. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI09			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Undulating Plateau	High	0%	0%	None identified

Description

Borehole AI09 is located on an undulating plateau area adjacent to a sealed access road. The proposed borehole location straddles the road, with the borehole proposed to be west of the road and the sump east of the road. The borehole area has been cleared of vegetation and coal wash placed on top. The road used to be wider (D. Olsen pers. comm. 3/9/08), and it is likely that the deep areas of coal wash on the verge are associated with the wider road formation. Upland swamp flora is present on the western side of the road (borehole area), while thick Banksia scrub has revegetated the eastern side of the road (sump area).

The proposed borehole location is highly disturbed, with no natural ground surface visible.

No Aboriginal or historical archaeological sites were identified at this location. The high disturbance and environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 22: Borehole AI09, borehole area with coal wash surface and swamp vegetation (view west).

Plate 23: Borehole AI09, sump area with Banksia scrub (view south east).

Archaeological Sites at Borehole AI09

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

None identified.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological or cultural heritage values.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological or cultural heritage sites at Borehole AI09. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI09. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI10			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Undulating Plateau	Low	5%	50%	None identified

Description

Borehole AI10 is located adjacent to Fire Road 10Q in an area of undulating plateau. The proposed borehole location is north of the road, between the road and the edge of the Dharawal Nature Reserve. Vegetation is Coastal Upland Swamp, with low, spiky shrubs. Several mature trees ring the proposed borehole location but will not be impacted by the proposal.

This area appears to have been subject to little previous disturbance. The area is swampy (partially waterlogged) with a thin sandy lens of topsoil over a dense silty clay soil.

No Aboriginal or historical archaeological sites were identified at this location. Environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 24: Borehole AI10, borehole area with coal wash surface and swamp veg (view west).

Plate 25: Borehole AI10, sump area with Banksia scrub (view south east).

Archaeological Sites at Borehole AI10

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

Borehole AI10 is situated in an area of good condition native vegetation, which may be considered of cultural importance to Aboriginal people.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological values.

Proposal will require clearance of a discrete area of native vegetation. This may impact cultural values associated with such vegetation, however this site is not publicly accessible, and as such, impacts to cultural values are considered low.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological heritage sites at Borehole AI10. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.
- Cultural values placed on native vegetation require that the area be made good at the conclusion of works. A seed bank comprising the A0 horizon should be collected at commencement of works and dispersed over the site at the conclusion of the testing programme.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI10. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI11			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Open Plateau	High	35%	80%	None identified

Description

Borehole AI11 is located adjacent to an unsealed track in an open plateau area. The proposed borehole location is approximately 400 m south of a tributary of Maddens Creek.

This area is highly disturbed, having been the location of a concrete batching plant during construction of the F6 (which is approximately 80 m to the west). There is no intact ground surface identified; the area has been levelled, sediment ponds constructed and gravel laid. Other infrastructure includes a mobile phone tower, concrete fence line and power line.

Ground surface visibility was very poor as a result of leaf litter and introduced gravels. No Aboriginal or historical archaeological sites were identified at this location. The high disturbance suggest there is little potential for Aboriginal or historic sites at this location.

Plate 26: Borehole AI11, levelled area with introduced gravels (view north).

Plate 27: Borehole AI11, established track with mobile phone tower & power lines (view south).

Archaeological Sites at Borehole AI11

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

None identified.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological or cultural heritage values.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological or cultural heritage sites at Borehole AI11. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI11. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI12			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Open Plateau	Low	2%	5%	None identified

Description

Borehole AI12 is located adjacent to an unsealed track in an open plateau area. The proposed borehole location is approximately 300 m south of a swamp on a tributary of Maddens Creek. Vegetation in this area is transitional between Coastal Upland Swamp and Coastal Sandstone Ridgetop Woodland. Vegetation is in intact condition (Biosis Research 2008) and it appears that the area has been subject to little previous disturbance.

Ground surface visibility was exceptionally low as a result of the thick vegetation growth. No Aboriginal or historical archaeological sites were identified at this location. Environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 28: Borehole AI12 with thick vegetation growth (view south).

Plate 29: Borehole AI12 with thick vegetation growth (view west).

Archaeological Sites at Borehole AI12

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

Borehole AI12 is situated in an area of good condition native vegetation, which may be considered of cultural importance to Aboriginal people.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological values.

Proposal will require clearance of a discrete area of native vegetation. This may impact cultural values associated with native vegetation, however this location is not publicly accessible, and as such, impacts to cultural values are considered low.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological sites at Borehole AI12. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.
- Cultural values placed on native vegetation require that the area be made good at the conclusion of works. A seed bank comprising the A0 horizon should be collected at commencement of works and dispersed over the site at the conclusion of the testing programme.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI12. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI13			**Open hole (rotary drill hole drilled with air rig) OR Cored hole - top of hole drilled with air rig**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Open Plateau	Moderate	15%	5%	None identified

Description

Borehole AI13 is located adjacent to an unsealed track in an open plateau area. The proposed borehole location is approximately 500 m north of a swamp area. Vegetation in this area is regenerating (Biosis Research 2008) with a dense shrub layer and some trees.

The proposed borehole is east of a mobile phone tower compound, but disturbance in the immediate borehole area appears to be limited to previous vegetation clearance.

Ground surface visibility was exceptionally low as a result of the thick vegetation growth. No Aboriginal or historical archaeological sites were identified at this location. Environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 30: Borehole AI13 with thick vegetation growth (view east).

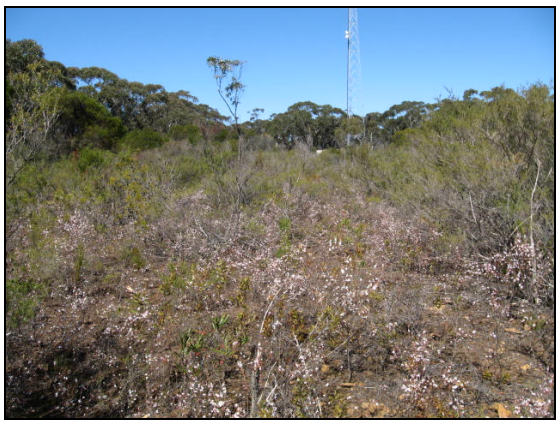

Plate 31: Borehole AI13 with thick vegetation growth, mobile phone tower in background (view south).

Archaeological Sites at Borehole AI13

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

None identified.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological or cultural heritage values.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological or cultural heritage sites at Borehole AI13. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI13. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI14			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Open Plateau	Moderate	0%	0%	None identified

Description

Borehole AI14 is located adjacent to an unsealed track in an open plateau area, approximately 80 west of the F6. The proposed borehole location is approximately 350 m south of a swamp area. Vegetation in this area is intact Coastal Sandstone Ridgetop Woodland (Biosis Research 2008) with a thick understorey layer. Soils include a thin sandy lens of topsoil with a silty, saturated soil.

The surrounding area has been subject to high level of disturbance including construction of the access track, construction of the F6, installation of overhead transmission lines, and clearance of the transmission line easement.

Ground surface visibility was zero as a result of the thick vegetation growth. No Aboriginal or historical archaeological sites were identified at this location. Environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

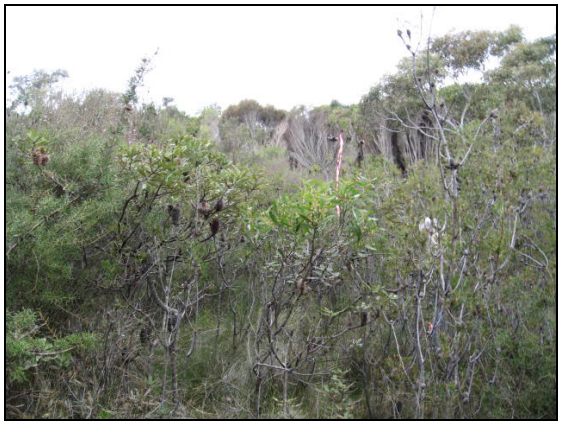

Plate 32: Borehole AI14 with thick vegetation growth (view east).

Plate 33: Borehole AI14 with thick vegetation growth, spot the surveyors! (view west).

Archaeological Sites at Borehole AI14

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

Borehole AI14 is situated in an area of good condition native vegetation, which may be considered of cultural importance to Aboriginal people.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological values.

Proposal will require clearance of a discrete area of native vegetation. This may impact cultural values associated with native vegetation, however this location is not publicly accessible, and as such, impacts to cultural values are considered low.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological sites at Borehole AI14. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.
- Cultural values placed on native vegetation require that the area be made good at the conclusion of works. A seed bank comprising the A0 horizon should be collected at commencement of works and dispersed over the site at the conclusion of the testing programme.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI14. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI15			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Open Plateau	Moderate-Low	0%	0%	None identified

Description

Borehole AI15 is located adjacent to an coal wash road in an open plateau area. Vegetation in this area is transitional Coastal Upland Swamp and Coastal Sandstone Ridgetop Woodland (Biosis Research 2008) with a dense shrub layer and some trees. Soils include a thin sandy lens of topsoil with a silty, saturated soil. Disturbance is limited to the immediate area of the road, once into the vegetated area, ground disturbance appears to be minimal.

Ground surface visibility was exceptionally low as a result of the thick vegetation growth and leaf litter. No Aboriginal or historical archaeological sites were identified at this location. Environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 34: Borehole AI15 with coal wash road and thick vegetation growth (view east).

Plate 35: Borehole AI15 with thick vegetation growth (view south).

Archaeological Sites at Borehole AI15

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

Borehole AI15 is situated in an area of good condition native vegetation, which may be considered of cultural importance to Aboriginal people.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological values.

Proposal will require clearance of a discrete area of native vegetation. This may impact cultural values associated with native vegetation, however this location is not publicly accessible, and as such, impacts to cultural values are considered low.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological sites at Borehole AI15. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.
- Cultural values placed on native vegetation require that the area be made good at the conclusion of works. A seed bank comprising the A0 horizon should be collected at commencement of works and dispersed over the site at the conclusion of the testing programme.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI15. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI16			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Low Localised Knoll	High	85%	30%	None identified

Description

Borehole AI16 is located on a localised knoll of an undulating plateau landform. The borehole is approximately 150 m from an unnamed creek line. Vegetation in this area is likely to have been Coastal Sandstone Ridgetop Woodland, however it has previously been cleared (Biosis Research 2008). The proposed borehole location has almost no soil layer, instead being a duricrust of bauxite / laterite bedrock, which was previously the site for an exploratory mining operation. Ground surface visibility was reasonably good due to the lack of vegetation.

While the environmental conditions of the surrounding area suggests better potential for Aboriginal archaeological sites, specific environmental conditions at the proposed borehole location are such that there is no potential for Aboriginal archaeological sites to be present in this location. No historic potential was identified at this location.

Plate 36: Borehole AI16 with duricrust of bauxite / laterite (view west).

Plate 37: Borehole AI16 with duricrust of bauxite / laterite (view north).

Archaeological Sites at Borehole AI16

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

None identified.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological or cultural heritage values.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological or cultural heritage sites at Borehole AI16. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI16. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI17			**Open hole (rotary drill hole drilled with air rig)**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Undulating Plateau	High	0%	0%	None identified

Description

Borehole AI17 is located adjacent to a coal wash road on a gently undulating plateau. Vegetation in the surrounding area is Coastal Upland Swamp, but within the borehole area is regenerating species and grass (Biosis Research 2008). Coal wash has been placed over the borehole site and ground surface visibility is zero. No natural ground surface is visible at this location.

No Aboriginal or historical archaeological sites were identified at this location. The high disturbance and environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 38: Borehole AI17 with coal wash road (view east).

Plate 39: Borehole AI17 with grass covered coal wash and power pole (view south).

Archaeological Sites at Borehole AI17

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

None identified.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological or cultural heritage values.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological or cultural heritage sites at Borehole AI17. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI17. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

BOREHOLE AI18			**Open hole (rotary drill hole drilled with air rig) OR Cored hole - top of hole drilled with air rig**		
Landform	***Context***	***Disturbance***	***Exposure %***	***Visibility %***	***Archaeology***
Plateau	Open Plateau	Low	0%	0%	None identified

Description

Borehole AI18 is located on an open plateau with a gentle slope to the north west (less than 5º). Vegetation is Coastal Sandstone Ridgetop Woodland in good condition (Biosis Research 2008), however there is a thick persoonia shrub unit and the vegetation is very spiky and painful to move through. There appears to be little disturbance in this area.

The area was semi-inundated at the time of survey. Ground surface visibility was zero given the thick vegetation growth in the area.

No Aboriginal or historical archaeological sites were identified at this location. Environmental conditions suggest there is little potential for Aboriginal or historic sites at this location.

Plate 40: Borehole AI18 with thick vegetation (view east).

Plate 41: Borehole AI18 with thick vegetation (view east).

Archaeological Sites at Borehole AI18

No Aboriginal or historic sites were identified at this location. There is no identified archaeological potential at this location.

Nearby Archaeological Sites

None identified.

Cultural Values

Borehole AI18 is situated in an area of good condition native vegetation, which may be considered of cultural importance to Aboriginal people.

Impacts

The proposed works will not impact any identified Aboriginal or historic archaeological values.

Proposal will require clearance of a discrete area of native vegetation. This may impact cultural values associated with native vegetation, however this location is not publicly accessible, and as such, impacts to cultural values are considered low.

Recommendations

Aboriginal

- There are no identified Aboriginal archaeological sites at Borehole AI18. Should unanticipated Aboriginal archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist should be contacted to assess the find. DECC and Aboriginal stakeholders will also require notification.
- Cultural values placed on native vegetation require that the area be made good at the conclusion of works. A seed bank comprising the A0 horizon should be collected at commencement of works and dispersed over the site at the conclusion of the testing programme.

Historic

- There are no identified historic archaeological or cultural heritage sites at Borehole AI18. Should unanticipated historical archaeological material be identified, all works should cease in the vicinity of the find and a qualified archaeologist and the Heritage Branch, NSW Department of Planning should be contacted.

Appendix 2: Aboriginal Community Comment

TO BE INCORPORATED WHEN RECEIVED.

APPENDIX IV

(No. of pages excluding this page = 29)

Apex Energy, Illawarra Exploration Drilling and Gas Monitoring Project: Noise and Vibration Assessment, December 2008

Heggies Pty Limited

HEGGIES

REPORT 10-7464-R2

Revision 0

Apex Energy, Illawarra
Exploration Drilling and Gas Monitoring Project
Noise and Vibration Assessment

PREPARED FOR

Apex Energy
c/- Olsen Environmental Consulting Pty Ltd
Unit 6 25 Victoria Street
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8 JANUARY 2009

HEGGIES PTY LTD
ABN 29 001 584 612

Apex Energy, Illawarra
Exploration Drilling and Gas Monitoring Project
Noise and Vibration Assessment

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DOCUMENT CONTROL

Reference	Status	Date	Prepared	Checked	Authorised
10-7464-R2	Revision 0	8 January 2009	Mikel Lacis	Mark Blake	Mark Blake

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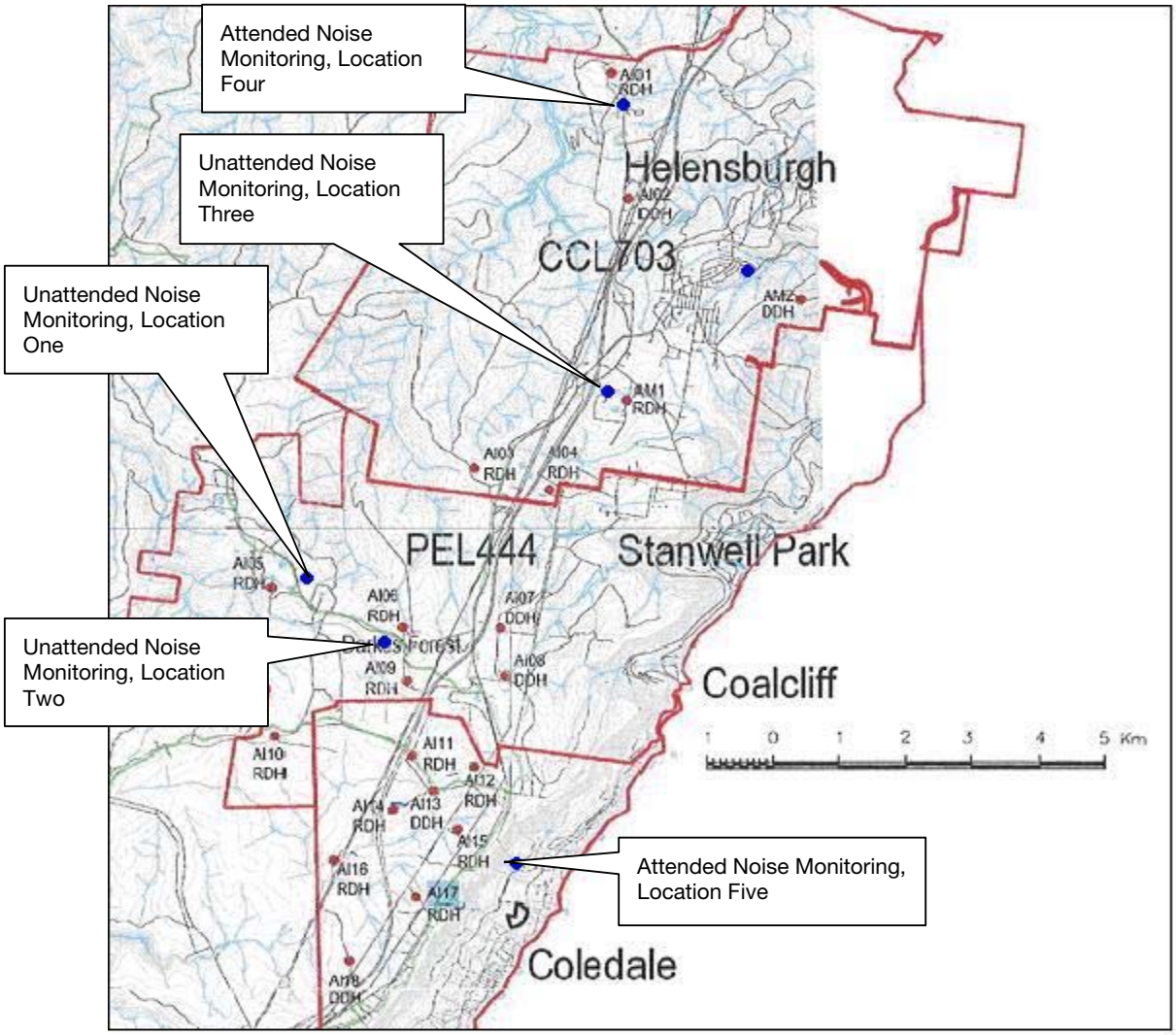
1 INTRODUCTION

Apex Energy NL (Apex) proposes to undertake an exploration drilling and gas monitoring program (the Project) in a sector of the Illawarra Coal Measures. The Project would involve the establishment of 18 boreholes across a region stretching approximately 15 km along the plateau of the Illawarra Range between Helensburgh and Coledale, situated between Sydney and Wollongong. **Figure 1** presents the spread of the Project, the proposed boreholes and ambient noise monitoring locations.

Figure 1 Proposed Borehole Locations



Each borehole would be extended to the base of the Illawarra Coal Measures and, in addition to defining the regional gas potential, would provide more detail on the regional geology. The boreholes would be configured to enable ongoing gas monitoring, which would assess gas quality, quantity and flow rates. This data is essential for planning future gas energy projects.

Heggies Pty Ltd (Heggies) has been commissioned by Olsen Environmental Consulting Pty Limited (OEC) on behalf of Apex to undertake a Noise and Vibration Assessment for the Project to address the Requirements of the Director-General, NSW Department of Planning.

2 PROJECT OVERVIEW

2.1 Proposed Borehole Locations

The Project comprises the establishment of 18 boreholes extending to the base of the Illawarra Coal Measures in order to enable ongoing coal seam gas monitoring. The proposed program of each borehole involves both core drilling for initial data gathering and exploration drilling for reserve testing. Each borehole would take a maximum six weeks to establish.

The proposed boreholes can be divided into three types, each of which will require different equipment and duration on site. The location and type of each proposed borehole, as illustrated in **Figure 1**, is listed in **Table 1** with a description of each borehole type following.

Table 1 Borehole Type and Location

Borehole ID	Borehole Type	Location (m, MGA)	
		Easting	Northing
AI 01	3	312900	6218300
AI 02	3	313100	6216400
AI 03	3	310250	6212100
AI 04	2	311795	6210610
AI 05	1	308115	6209565
AI 06	2	309650	6209240
AI 07	1	310960	6209510
AI 08	1	311460	6208620
AI 09	1	311350	6207630
AI 10	1	308675	6207750
AI 11	1	309600	6207260
AI 12	1	310575	6206805
AI 13	1	309845	6206820
AI 14	1	309150	6206690
AI 15	2	310550	6205900
AI 16	3	308560	6205730
AI 17	1	309690	6205000
AI 18	1	308700	6204000

2.1.1 Type 1 Boreholes

These are open hole boreholes drilled directly into goaf areas. They function as goaf gas exploration wells and are designed to determine goaf gas quality and quantity. These boreholes require air-drilling by a large rig such as the Schramm T685 or equivalent. Proposed boreholes AI 05, AI 07, AI 08, AI 09, AI 10, AI 11, AI 12B, AI 13, AI 14, AI 17 and AI 18 are of this type.

2.1.2 Type 2 Boreholes

These are cored holes drilled into remnant coal pillars in abandoned mine workings or goafs. They are open holes from which seam core samples will be extracted. They can be developed further at some future time using the zero radius drilling technology. They would be used to determine goaf gas characteristics in underlying old Bulli Seam workings. Additional drilling would then be undertaken at a later date to obtain core samples from lower seams. Drilling through and sealing off abandoned goafs requires additional equipment and procedures. This includes a larger diameter hole from the surface to allow placement of additional bore casings. This would require a larger rig and additional time on site. Proposed boreholes AI 04, AI 06 and AI 15 are of this type.

2.1.3 Type 3 Boreholes

These are cored holes of approximately 100 mm diameter, drilled over un-worked areas. These holes will enable core samples from the coal seams within the Illawarra Coal Measures. They would provide stratigraphical data, desorption testing of gas content and seam permeability testing. Proposed holes AI 01, AI 02, AI 03 and AI 16 are of this type.

3 EXISTING BACKGROUND NOISE ENVIRONMENT AND AIRBORNE NOISE GOALS

Following the DECC requirements and the DGR's, a background noise monitoring programme was undertaken between 4 December and 15 December 2008 at three unattended and two operator-attended locations. The noise measurement procedures employed throughout the monitoring programme were in accordance with the requirements of AS 1055-1997 *"Acoustics - Description and Measurement of Environmental Noise"* and the EPA Industrial Noise Policy, 2000 (INP).

3.1 Instrumentation and measurement parameters

All acoustic instrumentation employed throughout the monitoring programme was designed to comply with the requirements of AS 1259.2-1990, "*Sound Level Meters*" and carry current NATA or manufacturer calibration certificates.

All instrumentation was programmed to continuously record statistical noise level indices in 15 minute intervals, which included the L_{Amax}, L_{A1}, L_{A5}, L_{A10}, L_{A50}, L_{A90}, L_{A99}, L_{Amin} and the L_{Aeq}. Instrument calibration was checked before and after each measurement survey, with the variation in calibrated levels not exceeding ±0.5 dBA (AS 1055).

Table 2 presents a list of the acoustic equipment used to undertake the background noise monitoring programme.

Table 2 Background Noise Monitoring Equipment

Instrumentation	Type	Serial Number
ARL 215 Environmental Noise Logger	Type 2	194581
ARL 215 Environmental Noise Logger	Type 2	194447
ARL 215 Environmental Noise Logger	Type 2	194626
Brüel & Kjær 2260 Observer Sound Level Meter	Type 1	2414604
Brüel & Kjær Acoustical Calibrator	-	2022772

3.2 Noise Monitoring Locations

Unattended Monitoring Locations

Unattended continuous noise loggers were positioned at three of the nearest residential receivers to the proposed drill sites. **Table 3** presents a summary of the unattended noise monitoring locations. The monitoring locations are also presented graphically in **Figure 1**.

Table 3 Unattended Noise Monitoring Locations

Receiver Location	Nearest Borehole	Logger Location (m, MGA)	
		Easting	Northing
Location One Glenbernie Orchard, Darkes Forest	AI05	308282	6209623
Location Two Off Darkes Forest Road, Darkes Forest	AI06	309424	6209053
Location Three 257 Princes Highway, Helensburgh	AI03	312644	6216061

Operator-Attended Monitoring Locations

To complement the unattended noise monitoring two operator-attended noise surveys were conducted during the daytime, evening and night-time periods. The locations were chosen to gain an understanding of the acoustical environment in the vicinity of the Project drill sites. **Table 4** presents a summary of the unattended noise monitoring locations. The monitoring locations are also presented graphically in **Figure 1**.

Table 4 Operator-Attended Noise Monitoring Locations

Receiver Location	Nearest Borehole	Logger Location (m, MGA)	
		Easting	Northing
Location Four Old Illawarra Road, Helensburgh	AI01	312910	6217852
Location Five Saywell Place, Wombarra	AI15	311340	6205569

3.3 Noise Monitoring Results

The results of the noise monitoring are summarised in **Table 5** to **Table 7**. The background noise data has been segregated into the relevant times of day to assist in setting noise criteria for the Project noise emissions. The L_{A90} noise levels are the Rating Background noise Levels (RBL), determined using the procedures set out in the DECC's INP.

The complete set of unattended ambient noise and weather data for each monitoring location are presented graphically in **Appendix B** to **Appendix D**.

The meteorological conditions during the operator-attended noise monitoring periods were appropriate for testing, in accordance with the INP, and are summarised in **Appendix A**.

Table 5 Unattended Statistical Ambient Noise Levels (4 December 2008 to 15 December 2008)

Location, Closest Receiver to	Daytime (dBA)				Evening (dBA)				Night-time (dBA)			
	LA1	LA10	LA90	LAeq	LA1	LA10	LA90	LAeq	LA1	LA10	LA90	LAeq
Location One, AI05	59	49	35	53	55	44	35	53	43	40	31	43
Location Two, AI06	53	47	38	52	48	42	34	47	43	38	29	43
Location Three, AI03	57	50	37	55	53	48	34	52	44	38	30	49

Table 6 Daytime Operator Attended Noise Monitoring

Location Date Time	Noise Descriptor (dBA)						Description of Noise Emission and Typical Maximum Noise Levels (LAmax)
	L_1	L_{10}	L_{50}	L_{90}	L_{eq}	L_{max}	
Location Four 4 December 2008 1337 hours	65	52	45	40	53	82	Princes Hwy Traffic: 46-58 dBA Local Road Traffic: 56-71 dBA Wind in trees: 42-44 dBA Birds: 46-65 dBA Planes: 42-47 dBA
Location Five 4 December 2008 1421 hours	57	50	42	41	48	72	Local Traffic: 60 dBA Birds: 40-57 dBA People: 40-52 dBA Freight Train: 47-73 dBA Wind in trees: 45 dBA Helicopter: 57-59 **Ocean just discernable at times**

Table 7 Evening Operator Attended Noise Monitoring

Location Date Time	Noise Descriptor (dBA)						Description of Noise Emission and Typical Maximum Noise Levels (LAmax)
	L_1	L_{10}	L_{50}	L_{90}	L_{eq}	L_{max}	
Location Four 15 December 2008 2147 hours	54	44	35	33	41	58	Insects: 34-39 dBA Freeway Traffic: 33-38 dBA Princes Hwy Traffic: 36-58 dBA Local Traffic: 38-57 dBA People: 57 dBA
Location Five 15 December 2008 2052 hours	51	44	43	42	44	65	Ocean: 42-43 dBA Insects: 43-45 dBA People: 44-56 dBA Local Traffic: 46-57 dBA **The ocean is the dominant noise source**

4 NOISE ASSESSMENT

4.1 Overview

4.2 General Approach to Noise Modelling

Noise modelling for this assessment has been undertaken using the SoundPLAN computer noise modelling software (V6). The noise modelling includes ground topography and is based on the representative source noise levels listed in **Table 8** and **Table 9**. In accordance with the INP requirements, predictive noise modelling has been computed for both calm and noise enhancing weather conditions.

The calculated operational noise levels have been predicted based on a typical drill site layout, obtained from "Acoustics and Greenhouse Gas Assessments - Brief for Consultants". The drill site sound power levels were obtained though measurements of representative drill rigs conducted by Heggies on 7 November 2008.

The calculated construction noise levels will inevitably depend upon the number of plant items and equipment operating at any one time and their location relative to the receiver of interest. Predicted noise levels were based on typical operations using appropriate plant placed within the works area. In practice, construction noise levels will vary due to the fact that plant and equipment will move about the site and will not all be operating concurrently.

4.3 Representative Noise Levels for Operational Drill Rigs and Construction Plant

Drill Rigs

Sound pressure levels of both a core drill and an air-drill were measured on 7 November 2008. From the measured sound pressure levels the associated sound power levels were determined and are presented in **Table 8**.

Table 8 Drill Rig Sound Power Levels

Date Measured	Plant	Calculated A-Weighted Sound Power Level (dB ref 10^{-12}W)
7/11/2008	Air Drill	114
7/11/2008	Core Drill	102

Construction Equipment

Sound pressure levels for typical items of plant used in the construction phase are presented in **Table 9**. These noise levels are representative of modern plant operating with noise control measures in good condition. The sound pressure levels are indicative only and have been obtained from Heggies previous experience in similar projects.

Table 9 Typical Sound Pressure Levels

Item	Typical Plant Type	Noise Level at 7 m (dBA)	
		Typical Maximum Level (L_{Amax})	L_{A10} Noise Level for Modelling
Semi Trailer	25-28 Tonne	87	82
Crane	Truck Mounted	85	80
Hand-tools	-	79	73
Excavator	KATO 750	86	83
Water Cart	-	80	75

4.4 Construction Noise

The main construction phases would be associated with each of the following sites:

- A general site establishment phase including:
  - Clearing of existing vegetation
  - Setting up working areas and boundary fences
  - The construction of contractor's temporary facilities
- Drill assembly/setup

4.4.1 Construction Noise Metrics

The two primary noise metrics used to describe construction noise emissions in the modelling and assessments are:

$L_{A10(15\ minute)}$ the "Average Maximum Noise Level" during construction activities. This parameter is used to assess the construction noise impacts.

L_{A90} the "Background Noise Level" in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The $L_{A10(15\ minute)}$ construction noise goals are based on the L_{A90} background noise levels.

The subscript "A" indicates that the noise levels are filtered to match normal human hearing characteristics (ie A-weighted).

4.4.2 Construction Noise Criteria

The DECC has published guidelines in its Environmental Noise Control Manual (Chapter 171-1) for the control of construction noise.

In summary, the DECC's preferred approach to the control of construction noise involves the following:

- Level restrictions
- Time restrictions
- Silencing

a. Level Restrictions

- For a cumulative period of exposure to noise from construction activity of up to 4 weeks in duration, the $L_{A10(15minute)}$ noise level emitted by the works, when measured at a residential receiver, should not exceed the $L_{A90(15minute)}$ RBL by more than 20 dBA.

- For a cumulative period of exposure to noise from construction activity of between 4 weeks and 26 weeks duration, the $L_{A10(15minute)}$ noise level emitted by the works, when measured at a residential receiver, should not exceed the $L_{A90(15minute)}$ RBL more than 10 dBA.
- For a cumulative period of exposure to noise from construction activity in excess of 26 weeks duration, the $L_{A10(15minute)}$ noise level emitted by the works, when measured at a residential receiver, should not exceed the $L_{A90(15minute)}$ RBL by more than 5 dBA.

b. Time Restrictions

Monday to Friday	0700 hours to 1800 hours
Saturday	0700 hours to 1300 hours if inaudible at residential premises; otherwise, 0800 hours to 1300 hours

No work on Sundays or Public Holidays.

Should any construction works be undertaken outside these hours, a separate assessment of their impacts will be carried out once the nature and extent of those works is known.

c. Silencing

All practical measures should be used to silence construction equipment, particularly in instances where extended hours of operation are required.

4.4.3 Construction Noise Goals

Considering that the duration of the construction activity at any drill site would be less than 4 weeks, the airborne noise objective for residential receivers indicates that noise from construction activities should be managed such that the L_{A10} noise level, measured over a period of not less than 15 minutes, should not exceed the background L_{A90} noise level by more than 20 dBA.

For commercial and retail buildings, it is generally accepted that receivers are 5 dBA to 10 dBA less sensitive to construction noise emissions than residential receivers. For commercial and retail receivers an $L_{A10(15minute)}$ noise objective of $L_{A90(15minute)}$ RBL + 25 dBA has conservatively been adopted.

Table 10 presents the daytime construction noise goals for residential and commercial receivers.

Table 10 Daytime Construction Noise Goals

Background Noise Monitoring Location	Residential Receivers	Commercial Receivers
Location One	55 dBA	60 dBA
Location Two	58 dBA	63 dBA
Location Three	57 dBA	62 dBA
Location Four	60 dBA	65 dBA
Location Five	61 dBA	66 dBA

4.4.4 Predicted Construction Noise Levels

Indicative "worst case" construction noise levels at sensitive receivers are shown in **Table 11**. The predictions have been calculated assuming adverse weather conditions (ie 3 m/s and wind direction source to receiver) and all construction sites operating concurrently. Graphical representations for the drill sites with residential receivers within 500 m, ie AI01, AI05 and AI06 have also been provided in **Appendix E**, overlayed on an aerial photograph of the existing land use.

Table 11 Predicted Construction Related Noise Levels

Drill Site	Representative Background Noise Monitoring Location	Typical Nearest Receiver	Approximate Distance from Drill Site (m)	L_{A10} Daytime Construction Noise Objectives (dBA)	Predicted L_{A10} Construction Noise Levels (dBA)	Assessment
AI 01	Four	Old Illawarra Road, Garrawarra Centre	440	65	44	Complies
AI 02	Four	Fletcher Street, Helensburgh	940	60	38	Complies
AI 03	Three	Princes Highway	1220	57	40	Complies
AI 04	Three		920	57	39	Complies
AI 05	One	Darkes Forest Road, Glenbernie Orchard	160	60	57	Complies
AI 06	Two	Darkes Forest Road, Darkes Forest	310	58	49	Complies
AI 07	Two	Illawarra Golf Course[1]	860	63	44	Complies
AI 08	Two	Boomerang Golf Course[1]	700	63	46	Complies
AI 09	Two		625	63	50	Complies
AI 10	Two	Illawarra Golf Course[1]	1400	63	44	Complies
AI 11	Two		1400	63	44	Complies
AI 12	Five	Dam Road, Wombarra	1400	61	22	Complies
AI 13	Two	Boomerang Golf Course	1600	63	44	Complies
AI 14	Five	Morrison Avenue, Wombarra	2300	61	22	Complies
AI 15	Five	Saywell Place, Wombarra	660	61	22	Complies
AI 16	Five	Morrison Avenue, Coledale	2400	61	20	Complies
AI 17	Five		830	61	20	Complies
AI 18	Five	Buttenshaw Drive, Austinmer	1400	61	20	Complies

Note 1: Nearest residential receiver greater than 1500 m away.

4.4.5 Construction Noise Assessment

The project construction noise emission levels are predicted to comply with the construction noise goals at all of the proposed drill sites.

4.5 Operational Noise

The duration of drilling operations are anticipated to be up to six (6) weeks.

4.5.1 Operational Noise Metrics

As well as the L_{A90} statistical noise levels defined in **Section 4.4.1**, noise metrics used to describe operational noise emissions in the modelling and assessments are:

L_{Aeq} Is the A-weighted equivalent continuous noise level (basically the average noise level). It is defined as the steady sound level that contains the same amount of acoustical energy as the corresponding time-varying sound.

L_{A90} See **Section 4.4.1**.

4.5.2 Operational Noise Criteria

The INP outlines industrial noise criteria in two categories, an intrusive criterion and an amenity criterion. These criteria will be used in assessing the noise impacts associated with each operating drill site and are summarised below.

Intrusive Criterion

$L_{Aeq(15\ minute)}$ should not exceed the RBL by more than 5 dBA. **Table 12** presents a summary of the location and time specific intrusive criteria.

Table 12 Location and Time Specific Intrusive Criteria

Background Noise Monitoring Location	Day[1] $L_{Aeq(15minute)}$ (dBA)	Evening[1] $L_{Aeq(15minute)}$ (dBA)	Night[1] $L_{Aeq(15minute)}$ (dBA)
Location One	40	40	36
Location Two	43	39	34
Location Three	42	39	35
Location Four	45	38	38
Location Five	46	47	47

Note 1: Daytime: 0700 to 1800 hours (Monday to Saturday), or 0800 to 1800 hours (Sundays and public holidays). Evening: 1800 to 2200 hours. Night-time: the remaining periods

Amenity Criteria

Table 13 Summary of Relevant Amenity Criterion[1]

Type of Receiver	Indicative Noise Amenity Area	Time of Day[2]	Recommended LAeq Noise Level, dBA	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
School classroom - internal	All	Noisiest 1-hour period when in use	35	40
Active Recreation area (eg school playground, golf course)	All	When in use	55	60

Note 1: Sourced from table 2.1 in the NSW INP

Note 2: Daytime: 0700 to 1800 hours (Monday to Saturday), or 0800 to 1800 hours (Sundays and public holidays). Evening: 1800 to 2200 hours. Night-time: the remaining periods.

Inspection of **Table 12** and **Table 13**, with the exception of the golf course, demonstrates that the intrusive criterion is the limiting criterion and will represent the operational noise goals for this project.

4.5.3 Predicted Operational Noise Levels

Indicative operational noise levels for both calm and noise enhancing weather conditions (ie a wind speed of 3 m/s and direction source to receiver) at the nearest sensitive receivers to each drill site are presented in **Table 14**. In accordance with the INP the indicative noise levels were determined at the most affected point within the property boundary, however if the boundary was greater than 30 m from the residence, the noise levels were assessed as the most affected point within 30 m of the residence. Graphical representations for the drill sites with receivers within 500 m, ie AI01, AI05 and AI06 have also been provided in **Appendix E**, overlayed on an aerial photograph of the existing land use.

Table 14 Indicative Daytime[1] Drilling Operational Noise Levels

Drill Site, Corresponding Background Noise Monitoring Location	Typical Nearest Receiver	Approx Distance (m)	L_{Aeq} Daytime Operational Noise Objectives (dBA)	Predicted Calm L_{Aeq} Operational Noise Levels (dBA)	Predicted Worst L_{Aeq} Operational Noise Levels (dBA)	Assessment
AI 01 Four	Old Illawarra Road, Garrawarra Centre	440	45	31	35	Complies
AI 02 Four	Fletcher Street, Helensburgh	940	45	26	32	Complies
AI 03 Three	Princes Highway	1220	42	29	36	Complies
AI 04 Three		920	42	30	37	Complies
AI 05 One	Darkes Forest Road, Glenbernie Orchard	160	40	59	59	Up to 19 dBA above
AI 06 Two	Darkes Forest Road, Darkes Forest	310	43	39	43	Complies
AI 07 Two	Illawarra Golf Course[1]	950	55	40	46	Complies
AI 08 Two	Boomerang Golf Course[1]	345	55	43	48	Complies
AI 09 Two		250	55	48	52	Complies
AI 10 Two	Illawarra Golf Course[1]	1400	55	40	46	Complies
AI 11 Two		1400	55	40	46	Complies
AI 12 Five	Dam Road, Wombarra	1400	46	13	19	Complies
AI 13 Two	Boomerang Golf Course[1]	1600	55	40	46	Complies
AI 14 Five	Morrison Avenue, Wombarra	2300	46	13	19	Complies
AI 15 Five	Saywell Place, Wombarra	660	46	13	19	Complies
AI 16 Five	Morrison Avenue, Coledale	2400	46	16	22	Complies
AI 17 Five		830	46	16	22	Complies
AI 18 Five	Buttenshaw Drive, Austinmer	1400	46	16	22	Complies

Note 1: Daytime: 0700 to 1800 hours (Monday to Saturday), or 0800 to 1800 hours (Sundays and public holidays).

Note 2: Nearest residential receiver greater than 1500 m away.

Table 15 Indicative Evening[1] Drilling Operational Noise Levels

Drill Site, Corresponding Background Noise Monitoring Location	Typical Nearest Receiver	Approx Distance (m)	L_{Aeq} Evening Operational Noise Objectives (dBA)	Predicted Calm L_{Aeq} Operational Noise Levels (dBA)	Predicted Worst L_{Aeq} Operational Noise Levels (dBA)	Assessment
AI 01 Four	Old Illawarra Road, Garrawarra Centre	440	38	31	35	Complies
AI 02 Four	Fletcher Street, Helensburgh	940	38	26	32	Complies
AI 03 Three	Princes Highway	1220	39	29	36	Complies
AI 04 Three		920	39	30	37	Complies
AI 05 One	Darkes Forest Road, Glenbernie Orchard	160	40	59	59	Up to 19 dBA above
AI 06 Two	Darkes Forest Road, Darkes Forest	310	39	39	43	Up to 4 dBA above
AI 07 Two	Illawarra Golf Course[2]	950	NA[3]	NA[3]	NA[3]	NA[3]
AI 08 Two	Boomerang Golf Course[2]	345	NA[3]	NA[3]	NA[3]	NA[3]
AI 09 Two		250	NA[3]	NA[3]	NA[3]	NA[3]
AI 10 Two	Illawarra Golf Course[2]	1400	NA[3]	NA[3]	NA[3]	NA[3]
AI 11 Two		1400	NA[3]	NA[3]	NA[3]	NA[3]
AI 12 Five	Dam Road, Wombarra	1400	47	13	19	Complies
AI 13 Two	Boomerang Golf Course[2]	1600	NA[3]	NA[3]	NA[3]	NA[3]
AI 14 Five	Morrison Avenue, Wombarra	2300	47	13	19	Complies
AI 15 Five	Saywell Place, Wombarra	660	47	13	19	Complies
AI 16 Five	Morrison Avenue, Coledale	2400	47	16	22	Complies
AI 17 Five		830	47	16	22	Complies
AI 18 Five	Buttenshaw Drive, Austinmer	1400	47	16	22	Complies

Note 1: Evening: 1800 to 2200 hours

Note 2: Nearest residential receiver greater than 1500 m away.

Note 3: Not applicable through the evening and night time periods.

Table 16 Indicative Night-time[1] Drilling Operational Noise Levels

Drill Site, Corresponding Background Noise Monitoring Location	Typical Nearest Receiver	Approx Distance (m)	L_{Aeq} Night-time Operational Noise Objectives (dBA)	Predicted Calm L_{Aeq} Operational Noise Levels (dBA)	Predicted Worst L_{Aeq} Operational Noise Levels (dBA)	Assessment
AI 01 Four	Old Illawarra Road, Garrawarra Centre	440	38	31	35	Complies
AI 02 Four	Fletcher Street, Helensburgh	940	38	26	32	Complies
AI 03 Three	Princes Highway	1220	35	29	36	Complies
AI 04 Three		920	35	30	37	Complies
AI 05 One	Darkes Forest Road, Glenbernie Orchard	160	36	59	59	Up to 23 dBA above
AI 06 Two	Darkes Forest Road, Darkes Forest	310	34	39	43	Up to 9 dBA above
AI 07 Two	Illawarra Golf Course[1]	950	NA[3]	NA[3]	NA[3]	NA[3]
AI 08 Two	Boomerang Golf Course[1]	345	NA[3]	NA[3]	NA[3]	NA[3]
AI 09 Two		250	NA[3]	NA[3]	NA[3]	NA[3]
AI 10 Two	Illawarra Golf Course[1]	1400	NA[3]	NA[3]	NA[3]	NA[3]
AI 11 Two		1400	NA[3]	NA[3]	NA[3]	NA[3]
AI 12 Five	Dam Road, Wombarra	1400	47	13	19	Complies
AI 13 Two	Boomerang Golf Course[1]	1600	NA[3]	NA[3]	NA[3]	NA[3]
AI 14 Five	Morrison Avenue, Wombarra	2300	47	13	19	Complies
AI 15 Five	Saywell Place, Wombarra	660	47	13	19	Complies
AI 16 Five	Morrison Avenue, Coledale	2400	47	16	22	Complies
AI 17 Five		830	47	16	22	Complies
AI 18 Five	Buttenshaw Drive, Austinmer	1400	47	16	22	Complies

Note 1: Night-time:2200 to 0700 hours (Monday to Saturday), 2200 to 0800 (Sunday and public holidays).

Note 2: Nearest residential receiver greater than 1500 m away.

Note 3 Not applicable through the evening and night time periods.

4.5.4 Noise Impact Assessment

It is anticipated that while drilling is in operation noise exceedances are likely at the nearest receivers to drill site AI05 through the daytime, evening and night-time periods. It is also anticipated that at AI06 noise exceedances are likely through the evening and night time periods. It should be noted that these noise levels are of a worst case and once the drill pushes deeper the predicted noise levels will decrease.

4.5.5 Potential Operational Noise Mitigation Measures

Due to the likely exceedances of up to 23 dBA at drill sites AI05 and AI06 some mitigation measures will need to be implemented.

In accordance with the INP there are essentially three main mitigation strategies for noise control:

- **Controlling noise at the source**

  There are two approaches: Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA).

- **Controlling the transmission of noise**

  There are two approaches: the use of barriers and land-use controls which attenuate noise by increasing the distance between source and receiver.

- **Controlling noise at the receiver**

  There are two approaches: negotiating an agreement with the landholder or acoustic treatment of dwellings to control noise.

Controlling Noise at the Source

Best management practice (BMP) is the adoption of particular operational procedures that minimise noise while retaining productive efficiency. When an appropriate mitigation strategy that incorporates expensive engineering solutions is being considered, the extent to which cheaper, non engineering - oriented BMP can contribute to the required reduction of noise should be taken into account.

Application of BMP includes the following types of practice:

- Sitting noisy equipment behind structures that act as barriers, or at the greatest distance from the noise-sensitive area; or orienting the equipment so that noise emissions are directed away from any sensitive areas, to achieve the maximum attenuation of noise.
- Where there are several noisy pieces of equipment, scheduling operations so they are used separately rather than concurrently.
- Keeping equipment well maintained.
- Employing “quiet” practices when operating equipment for example, positioning idling trucks in appropriate areas.
- Running operator-education programs on the effects of noise and the use of quiet work practices.

Controlling Noise in Transmission

Barriers are more effective if they are near the source or the receiver. Their effectiveness is also determined by their height, the materials used (absorptive or reflective), and their density. The relationship of these design features to attenuation is well documented. Barriers can take a number of forms including free-standing walls along roads, grass or earth mounds or bunds, and trenches or cuttings within which noise sources are sited. They are employed when source and receiver control is either impractical or too costly. At drill sites AI05 and AI06 this method of controlling noise during drill operation is a possibility.

5 VIBRATION ASSESSMENT

As part of the DGR's a vibration assessment of the proposed drilling is required. The subsequent assessment has been produced in accordance with the DECC's guidelines.

5.1 Overview

The main source of ground-borne vibration would occur during the operation of the drill rig.

The effects of vibration in buildings can be divided into three main categories:

a. Those in which the occupants or users of the building are inconvenienced or possibly disturbed (human perception or human comfort vibration).

b. Those where the building contents may be affected.

c. Those in which the integrity of the building or the structure itself may be prejudiced.

5.2 Vibration Damage Criteria - Surface Structures

5.2.1 British Standard 7385: Part 2 - 1993 Guidelines

British Standard 7385: Part 2-1993 "*Evaluation and measurement for vibration in buildings Part 2*" provides criteria against which the likelihood of building damage from ground vibration can been assessed.

The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in **Table 17** and graphically in **Figure 2**.

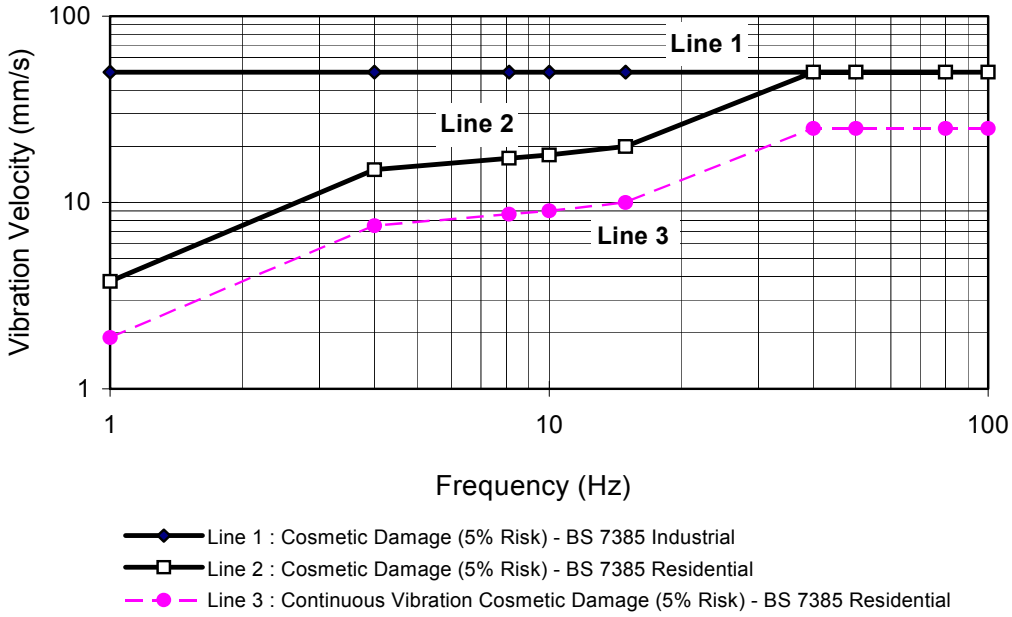
Table 17 Transient Vibration Guide Values - Minimal Risk of Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4 Hz to 15 Hz	15 Hz and Above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The standard states that the guide values in **Table 17** relate predominantly to transient vibration which does not give rise to resonant responses in structures and low-rise buildings.

Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in **Table 17** may need to be reduced by up to 50%.

Figure 2 Graph of Transient Vibration Guide Values for Cosmetic Damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 17**, and major damage to a building structure may occur at values greater than four (4) times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 17** should not be reduced for fatigue considerations.

It is noteworthy that extra to the guide values nominated in **Table 17**, the standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

5.3 Human Comfort Vibration Criteria

5.3.1 General

Humans are far more sensitive to vibration than is commonly realised. They can detect vibration levels which are well below those causing any risk of damage to a building or its contents.

Human tactile perception of random motion, as distinct from human comfort considerations, was investigated by Diekmann and subsequently updated in German Standard DIN 4150 Part 2-1975. On this basis, the resulting degrees of perception for humans are suggested by the vibration level categories given in **Table 18**.

Table 18 Peak Vibration Levels and Human Perception of Motion

Approximate Vibration Level	Degree of Perception
0.10 mm/s	Not felt
0.15 mm/s	Threshold of perception
0.35 mm/s	Barely noticeable
1 mm/s	Noticeable
2.2 mm/s	Easily noticeable
6 mm/s	Strongly noticeable
14 mm/s	Very strongly noticeable

Note: These approximate vibration levels (in floors of building) are for vibration having a frequency content in the range of 8 Hz to 80 Hz.

Table 18 indicates that people will just be able to feel floor vibration at levels of about 0.15 mm/s and that the motion becomes "noticeable" at a level of approximately 1 mm/s.

5.3.2 Human Comfort Criteria for Continuous Vibration

Guidance in relation to assessing potential disturbance from ground-borne vibration is set out in British Standard 6472-1992 "*Evaluation of Human Exposure to Vibration in Buildings (1 Hz to 80 Hz)*". This standard, preferred by the DECC and which forms the basis of the DECC's "Assessing Vibration a Technical Guideline", nominates criteria for various categories of disturbance, the most stringent of which are the levels of building vibration associated with a "low probability of adverse comment" from occupants.

In relation to an equivalent Australian Standard, whilst BS 6472 and AS 2670 contain the same criteria for human exposure to continuous vibration, BS 6472 also includes detailed guidance on the use of vibration dose values (VDVs) which allow an assessment of the severity of intermittent vibration to be carried out. This analysis and assessment procedure is most relevant to the character of the vibration generated during drilling.

Satisfactory Magnitudes for Intermittent Vibration

Where vibration comprises a number of events, a Vibration Dose (Dv) may be calculated for each event by the following formula using vibration measured in weighted rms acceleration:

$$Dv = 1.4 \times a\,(rms) \times t^{0.25} \quad m/s^{1.75}$$

Where, a (rms) = rms acceleration (m/s^2)

t = Total cumulative time (seconds) of the vibration event or period of vibration

Over the frequency range 8 Hz to 80 Hz, the formula may also be expressed in terms of unweighted rms vibration velocity:

$$Dv = 0.07\ V\,(rms) \times t^{0.25} \quad m/s^{1.75}$$

Where, V (rms) = rms particle velocity (mm/s)

t = Total cumulative time (seconds) of the vibration event or period of vibration

The total vibration dose is then calculated using the following formula:

$$Dv = \left(\sum_{n=1}^{n=N} Dv_n^4 \right)^{0.25}$$

Where, Dv = Total vibration dose value for the day

Dvn = Vibration dose value for each vibration dose event

N = Total number of vibration dose events

Vibration Dose Limits

The permissible rms particle velocity levels corresponding to the vibration dose value vary according to the duration of exposure. **Table 19** shows the range of satisfactory vibration dose values for which various degrees of adverse comment may be expected in residential buildings.

Table 19 Acceptable Vibration Dose Values ($m/s^{1.75}$) above which Various Degrees of Adverse Comment May Be Expected in Residential Building and Workshops

Location	Daytime (0700-2200 hours)		Night-time (2200-0700 hours)	
	Preferred Value	Maximum Value	Preferred Value	Maximum Value
Residence	0.20	0.40	0.13	0.26
Workshop	0.80	1.60	0.80	1.60

5.4 Indicative Safe Working Distances for Vibration Intensive Plant

The main source of vibration would occur while drilling which would be of intermittent nature. Vibration measurements of a representative drill in operation were conducted on 11 November 2008. A summary of the measured results is provided in **Table 20**.

Table 20 Maximum Vibration Levels for an Operating Air-Drill (7 November 2008)

	Distance m			
	5 m	**7 m**	**10 m**	**20 m**
Peak Maximum Component Particle Velocity (PPV)	9.5 mm/s	4.8 mm/s	2.9 mm/s	0.4 mm/s
Maximum PPV	6.8 mm/s	3.0 mm/s	1.8 mm/s	0.2 mm/s

Note: The corresponding frequency range to the measured PPV was 20 Hz and above.

As a guide, in terms of the potential damage (BS 7385) and human comfort (BS 6472), safe working distances have been calculated from the measured data presented in **Table 20**. The indicative safe working distances are presented in **Table 21**.

Table 21 Recommended Safe Working Distances

Receiver	**Period**	**Safe Working Distance**	
		Cosmetic Damage (BS 7385)[2]	**Human Response (BS 6472)[1]**
Residence	Daytime (0700-2200 hours)	5 m	30 m
	Night-time (2200-0700 hours)	5 m	35 m
Workshop	Daytime (0700-2200 hours)	4 m	15 m
	Night-time (2200-0700 hours)	4 m	14 m

Note 1: The safe working distances for Human Response assume that the source of the vibration is continuous throughout the 15-hour daytime period and 9-hour night-time period. The formulae in **Section 5.3.2** indicate that higher levels of vibration are acceptable when the vibration levels are intermittent or impulsive. The safe working distances are therefore considered to be conservative and it is likely that the safe working distances corresponding to a "low probability of adverse comment" would be lower than indicated.

Note 2: The safe working distances for Cosmetic Damage have been determined considering a minimum drill operating frequency of 20Hz. This cut-off frequency was determined based on the vibration measurement made on a representative drill on 7 November 2008, **Table 20**.

5.5 Vibration Assessment

5.5.1 Cosmetic Damage

The risk of cosmetic damage arising from vibration associated with the drilling operations at the nearest residential receivers is negligible.

5.5.2 Human Comfort

Table 22 and **Table 23** present a summary of the estimated VDVs (eVDVs) and an assessment against the corresponding acceptable vibration dose values presented in **Table 19** for the five nearest receivers have.

Table 22 Daytime Vibration Assessment at the Five Nearest Receivers

Drill Site	Receiver	Approximate Distance to Nearest Receiver (m)	eVDV $(m/s)^{1.75}$	Criteria $(m/s)^{1.75}$	Assessment
AI05	Residential	160	0.007	0.2	Complies
	Workshop	115	0.014	0.8	Complies
AI06	Residential	300	0.002	0.2	Complies
AI01	Residential	428	0.001	0.2	Complies

Table 23 Night-time Vibration Assessment at the Five Nearest Receivers

Drill Site	Receiver	Approximate Distance to Nearest Receiver (m)	eVDV $(m/s)^{1.75}$	Criteria $(m/s)^{1.75}$	Assessment
AI05	Residential	160	0.006	0.13	Complies
	Workshop	115	0.012	0.80	Complies
AI06	Residential	300	0.002	0.13	Complies
AI01	Residential	428	0.001	0.13	Complies

As presented in **Table 22** and **Table 23** it is anticipated that human discomfort will be avoided during any vibration intensive activities.

It should be noted that the values that are listed in **Table 21** to **Table 23** assume that the source of vibration is continuous throughout a 16 hour day and 9 hour night. The formulae in **Section 5.3.2** indicate that higher levels of vibration are acceptable when the vibration levels are intermittent. The safe working distances are therefore considered to be conservative and it is likely that the safe working distances corresponding to a "low probability of adverse comment" would be lower than indicated.

6 RESIDENTIAL IMPACT SUMMARY

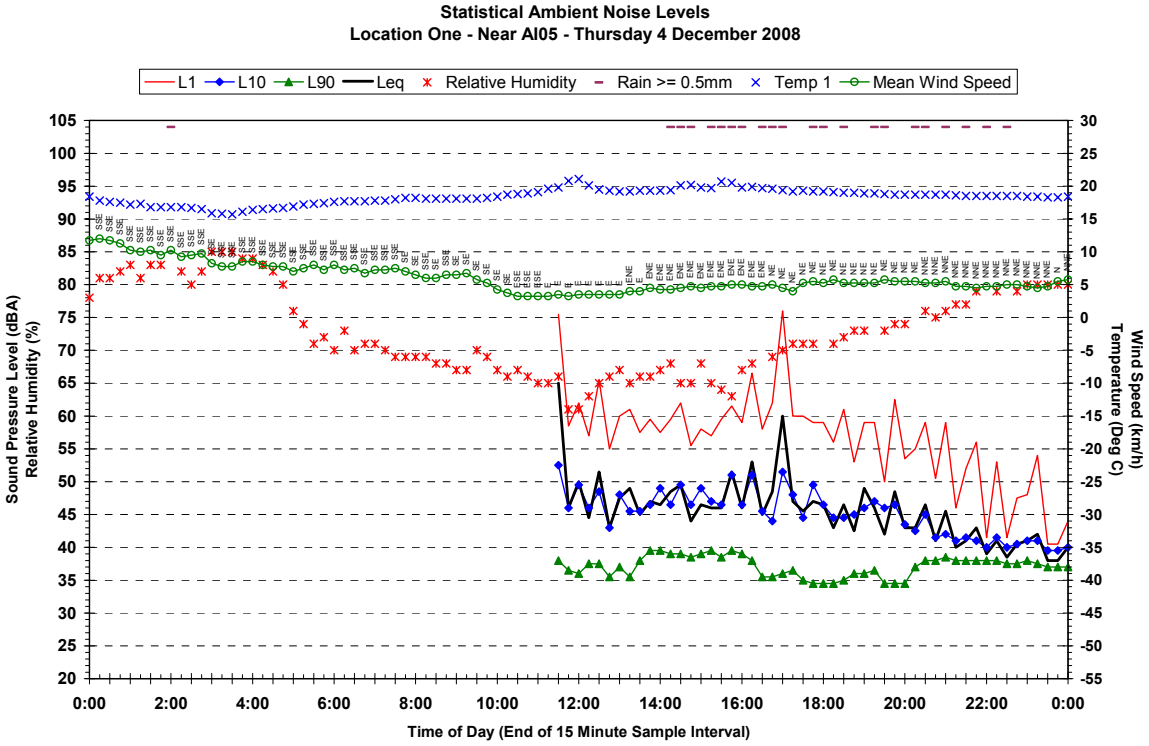
Table 24 Residential Impact Assessment

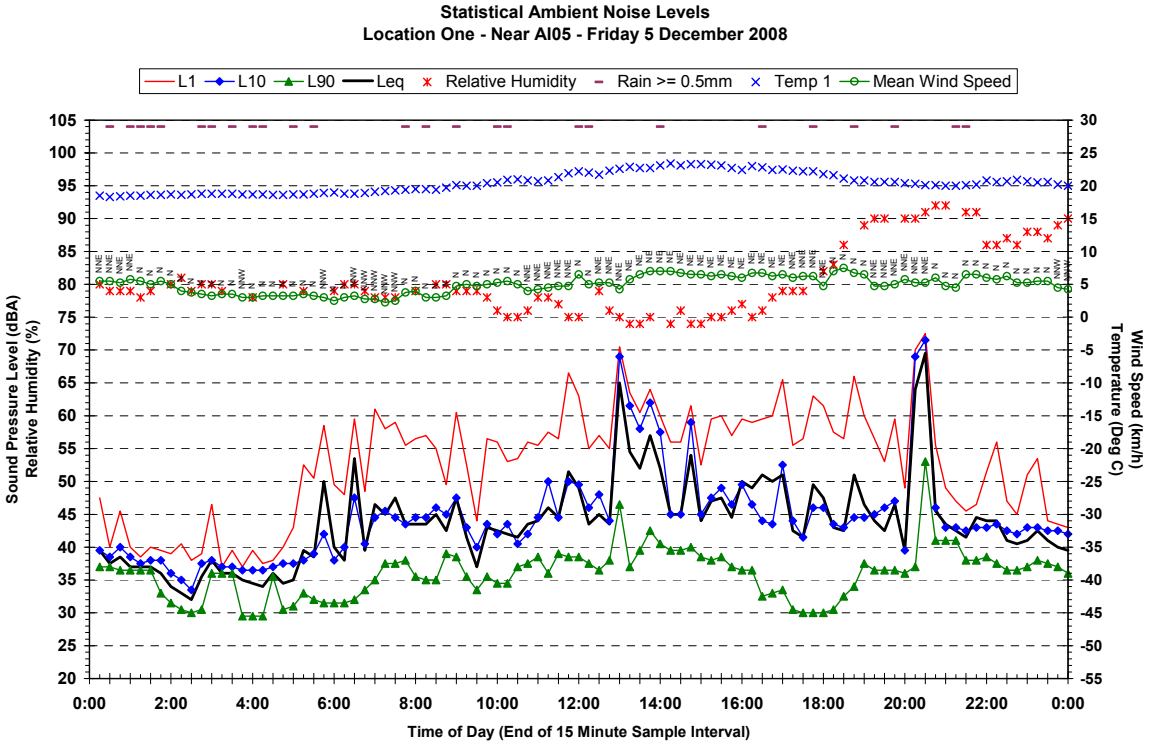
Drill Site	Impact at the nearest residence(s)		Mitigation requirements to conduct 24 hour operations
	Noise	Vibration	
AI 01	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 02	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 03	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 04	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 05	Adverse comment likely	Adverse comment unlikely	Feasible and reasonable mitigation measures need to be implemented including noise monitoring during drill operations, negotiations with the land owner and the use of a temporary noise barrier
AI 06	Night-time adverse comment likely	Adverse comment unlikely	Feasible and reasonable mitigation measures need to be implemented including noise monitoring during drill operations, negotiations with the land owner and the use of a temporary noise barrier
AI 07	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 08	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 09	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 10	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 11	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 12	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 13	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 14	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 15	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 16	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 17	Adverse comment unlikely	Adverse comment unlikely	No mitigation required
AI 18	Adverse comment unlikely	Adverse comment unlikely	No mitigation required

Meteorological Data for each Operator-Attended Noise Survey

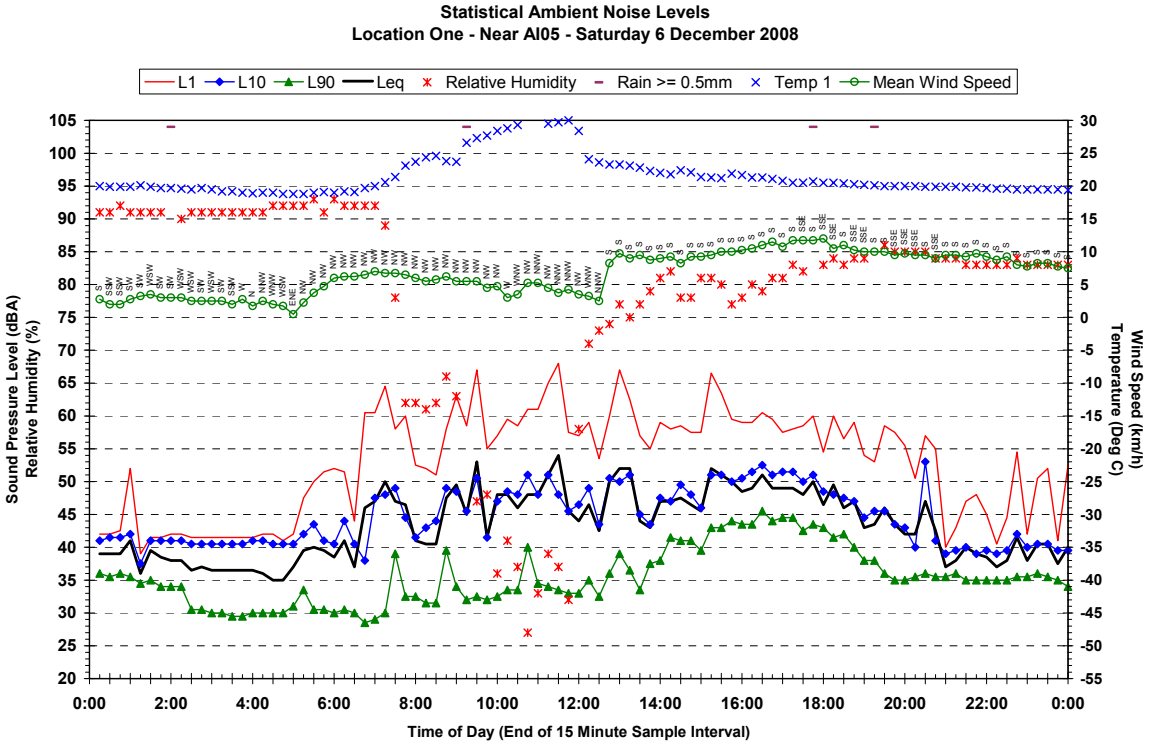
Monitoring Location	Date	Time	Wind Speed	Wind Direction	Cloud Cover	Temperature	Relative Humidity
Location Four	4 December 2008	1337 hours	<2 m/s	NE	8 okta	22°C	63%
Location Five	4 December 2008	1421 hours	<2 m/s	NE	8 okta	21°C	60%
Location Four	15 December 2008	2147 hours	Calm	-	1 okta	15°C	79%
Location Five	15 December 2008	2052 hours	Calm	-	1okta	17°C	65%

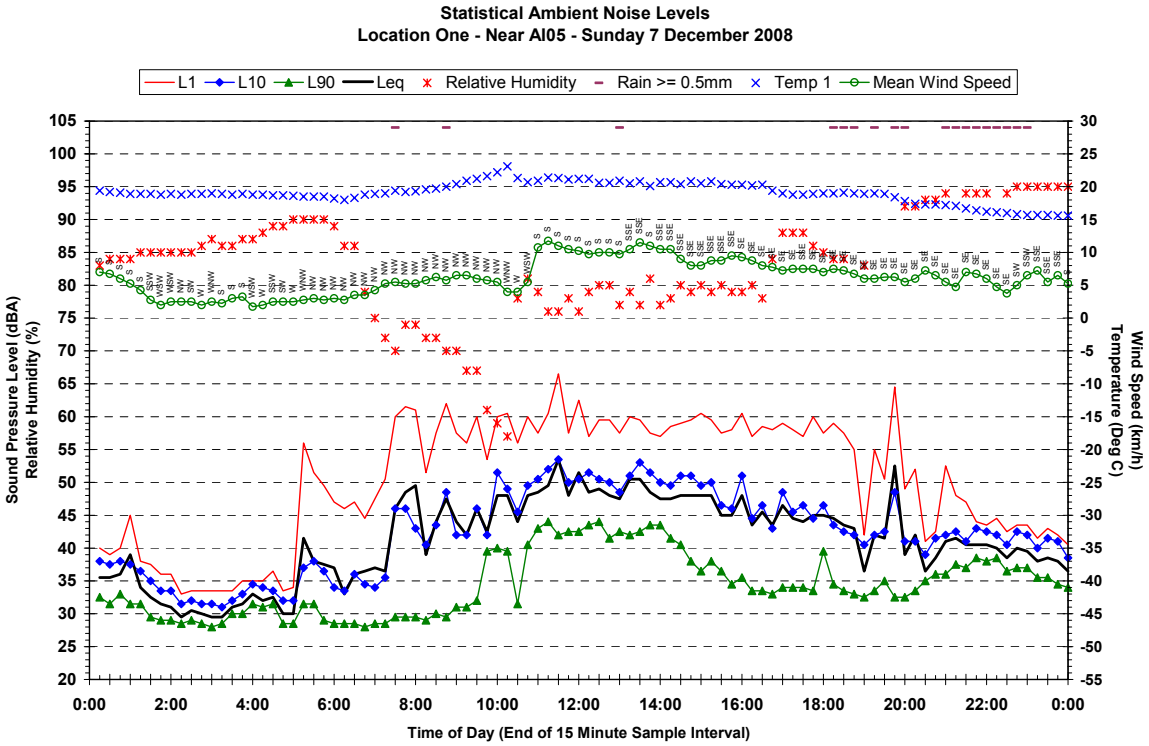
Location One – Near AI05





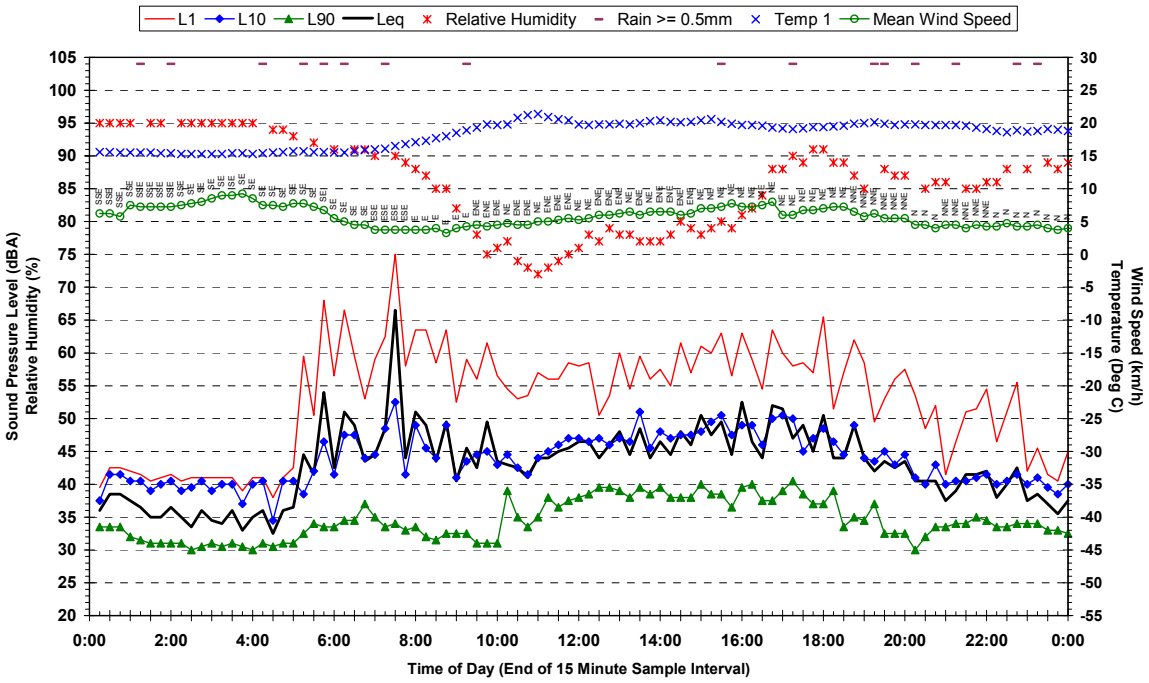
Location One – Near AI05



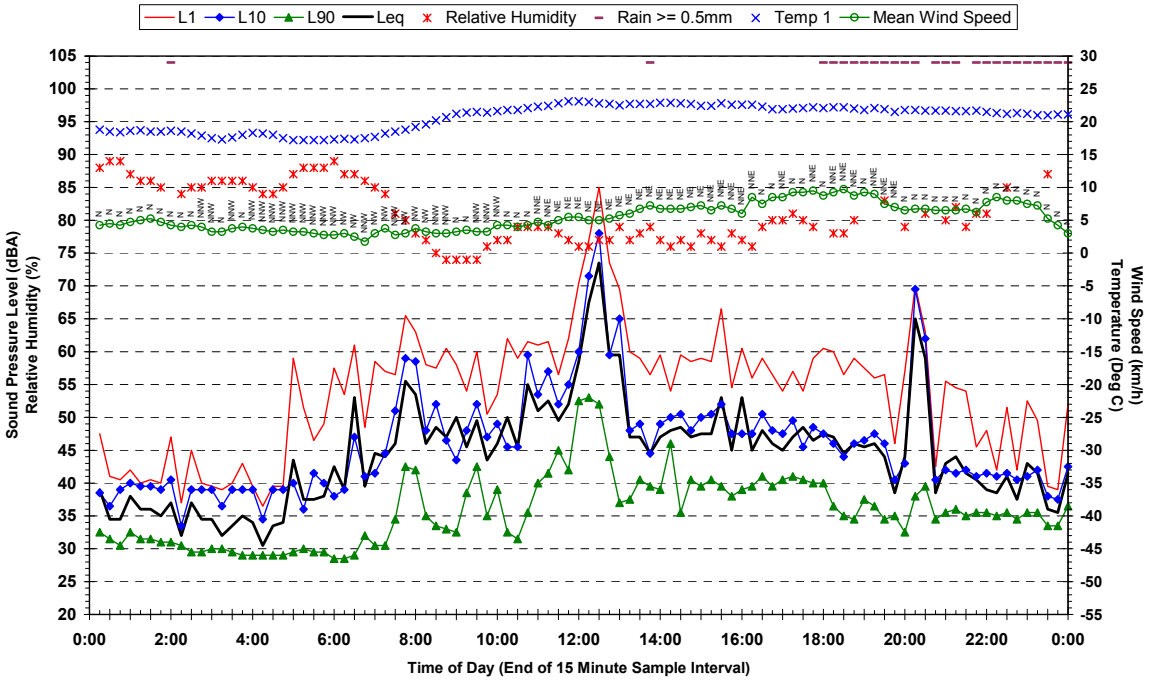


Location One – Near AI05

Statistical Ambient Noise Levels
Location One - Near AI05 - Monday 8 December 2008

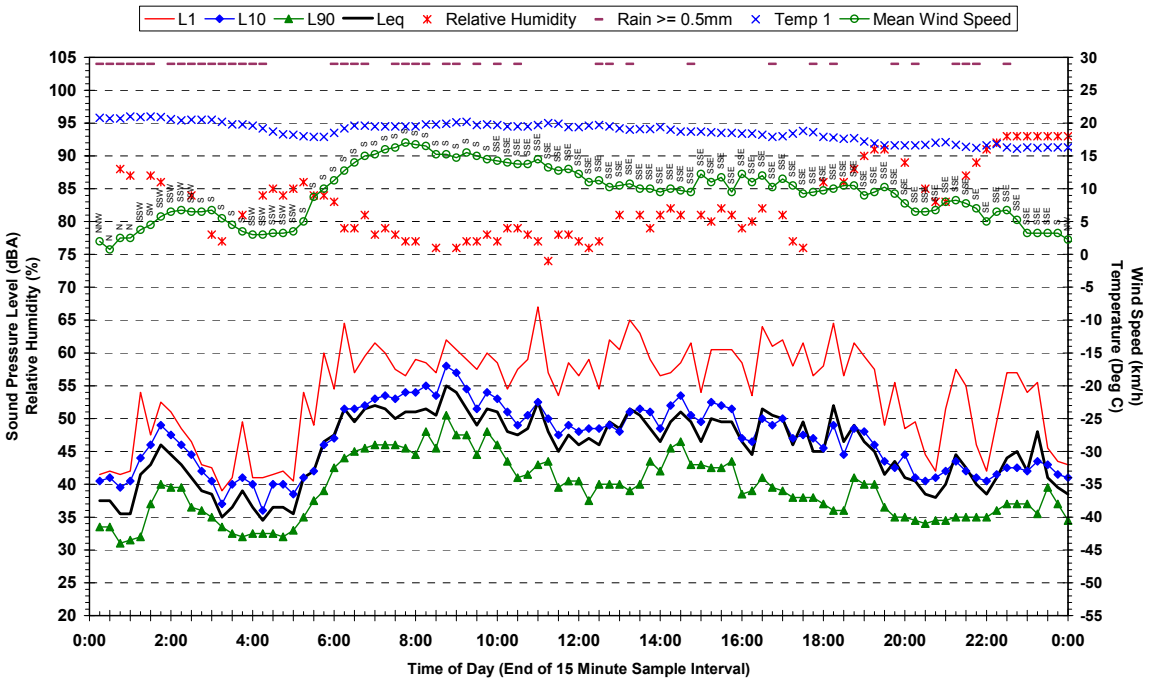


Statistical Ambient Noise Levels
Location One - Near AI05 - Tuesday 9 December 2008

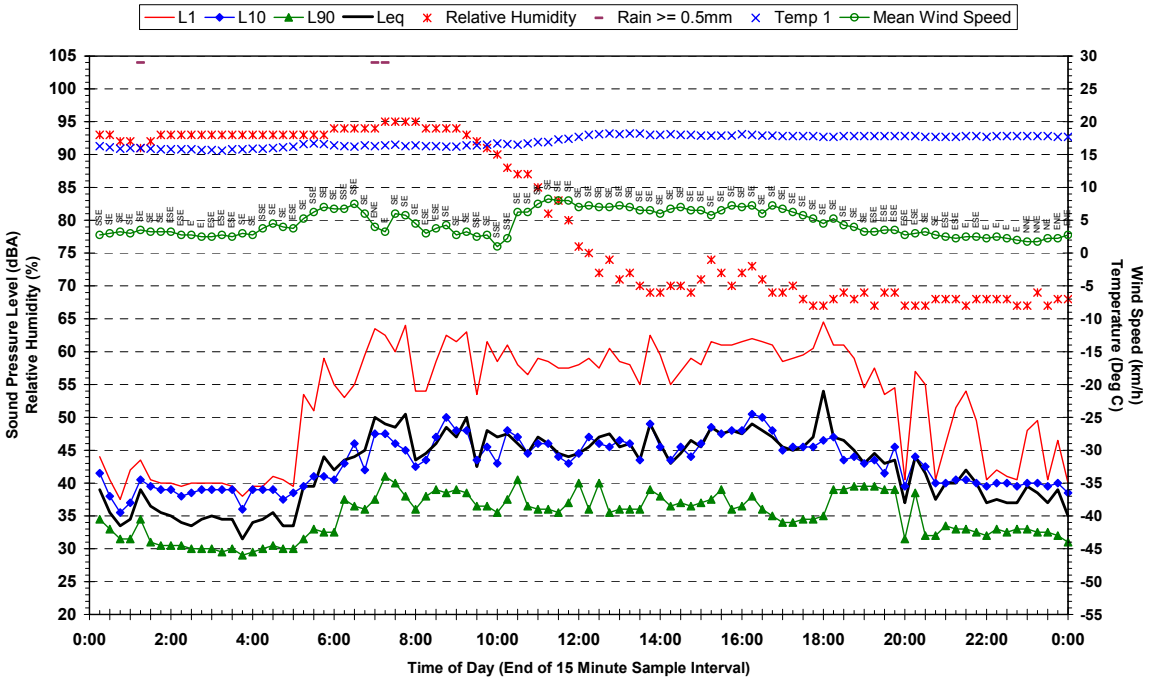


Location One – Near AI05

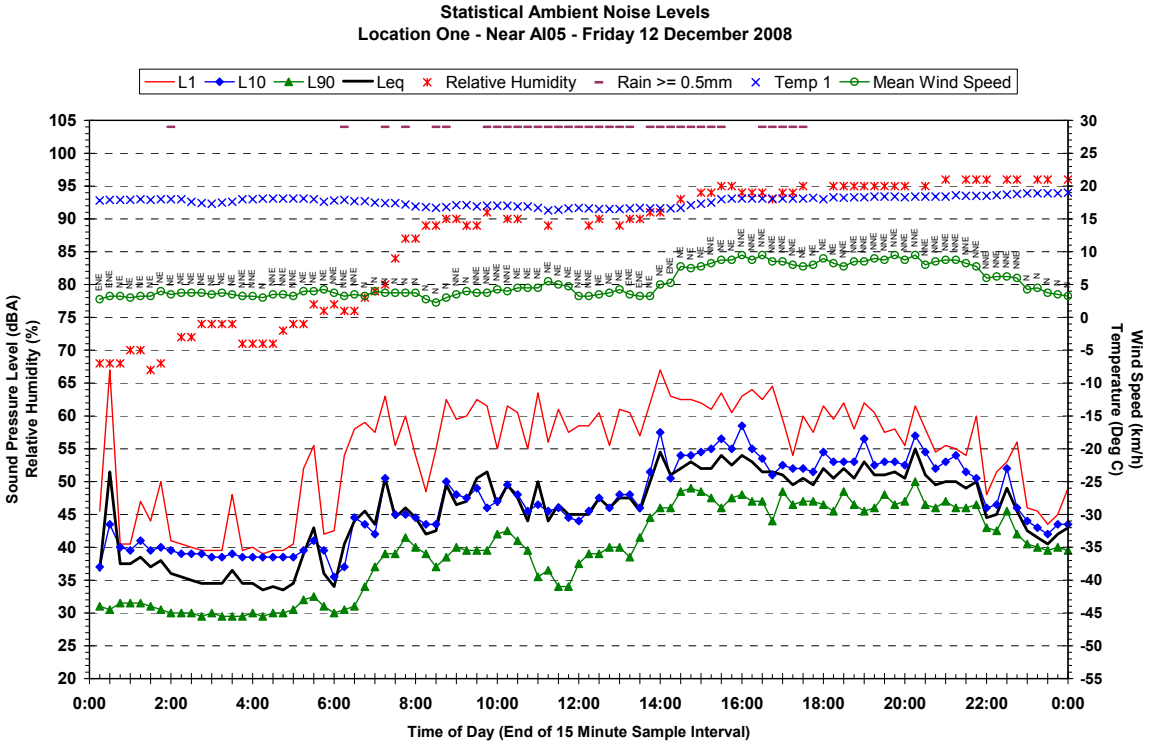
Statistical Ambient Noise Levels
Location One - Near AI05 - Wednesday 10 December 2008

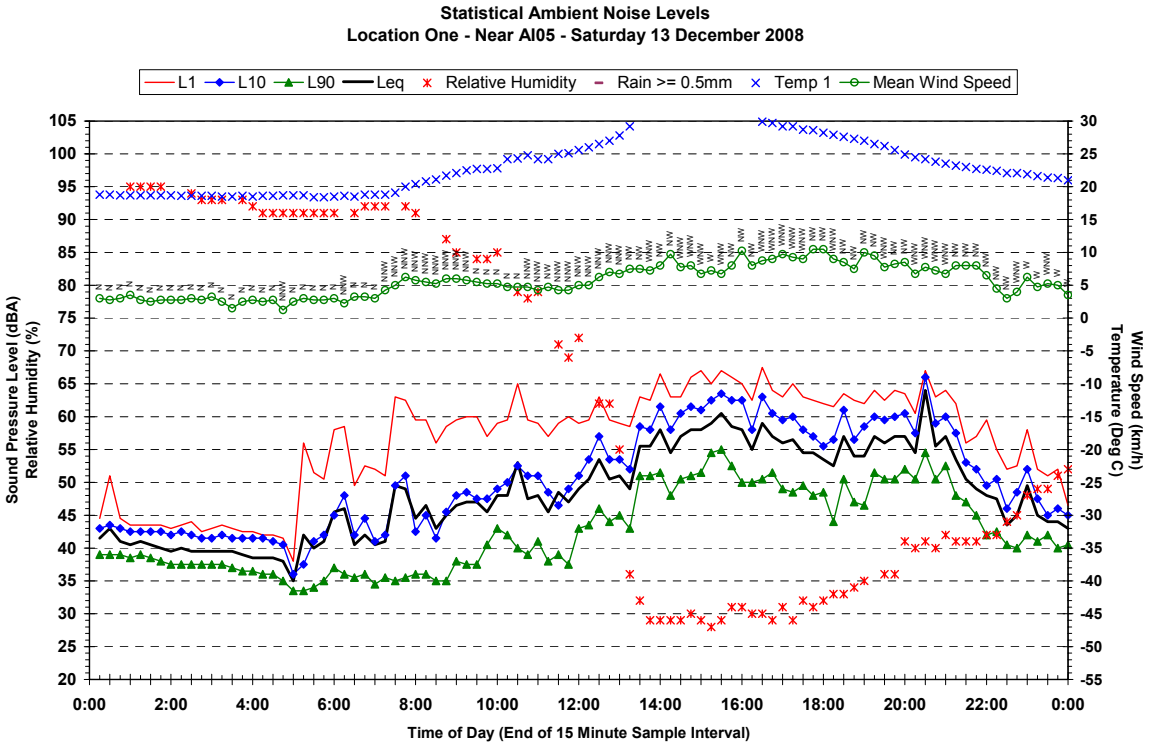


Statistical Ambient Noise Levels
Location One - Near AI05 - Thursday 11 December 2008

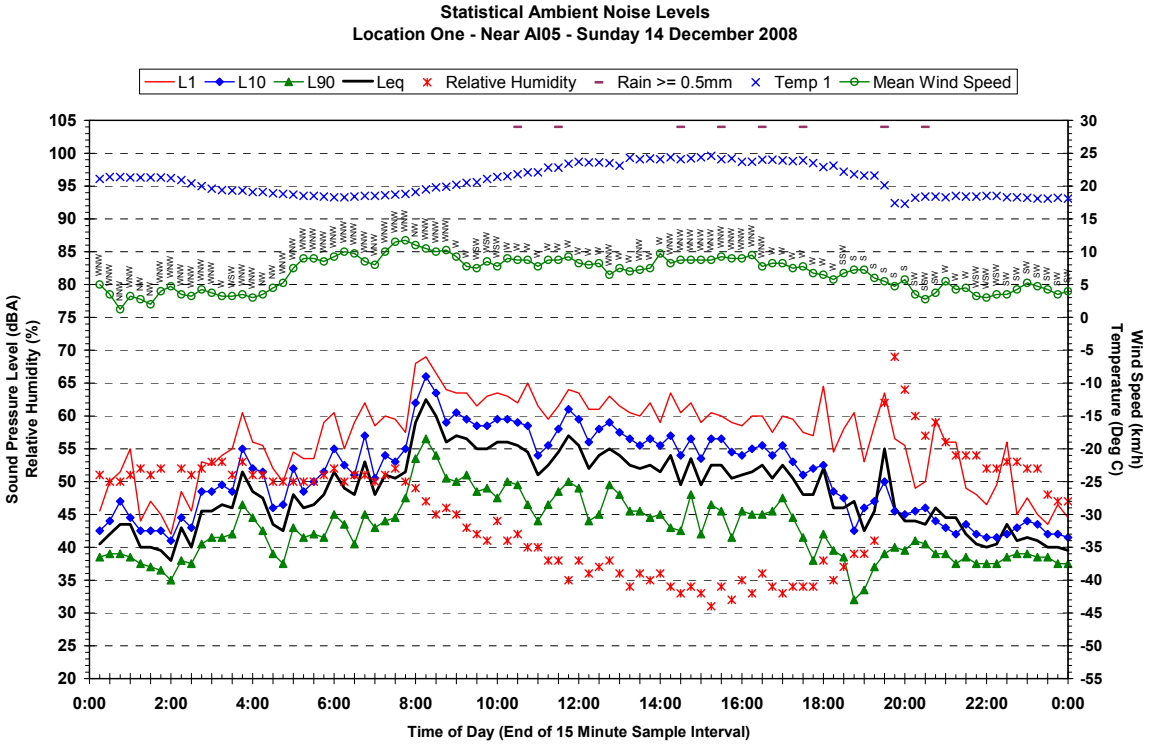


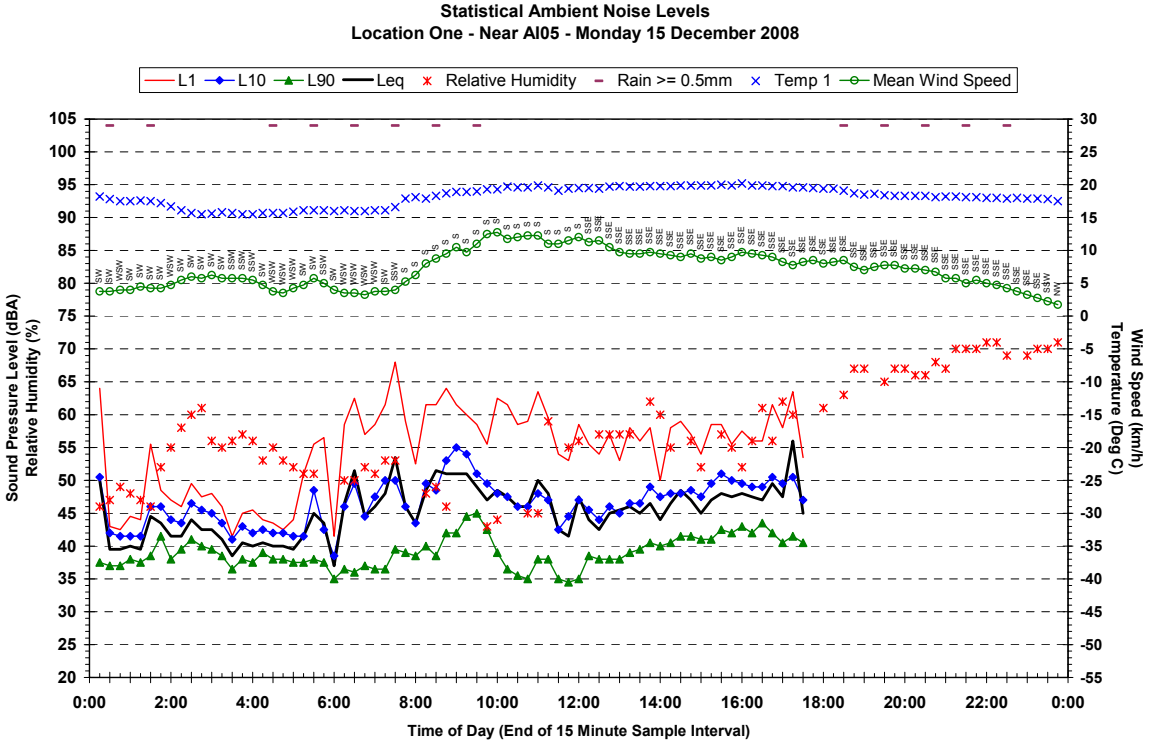
Location One – Near AI05



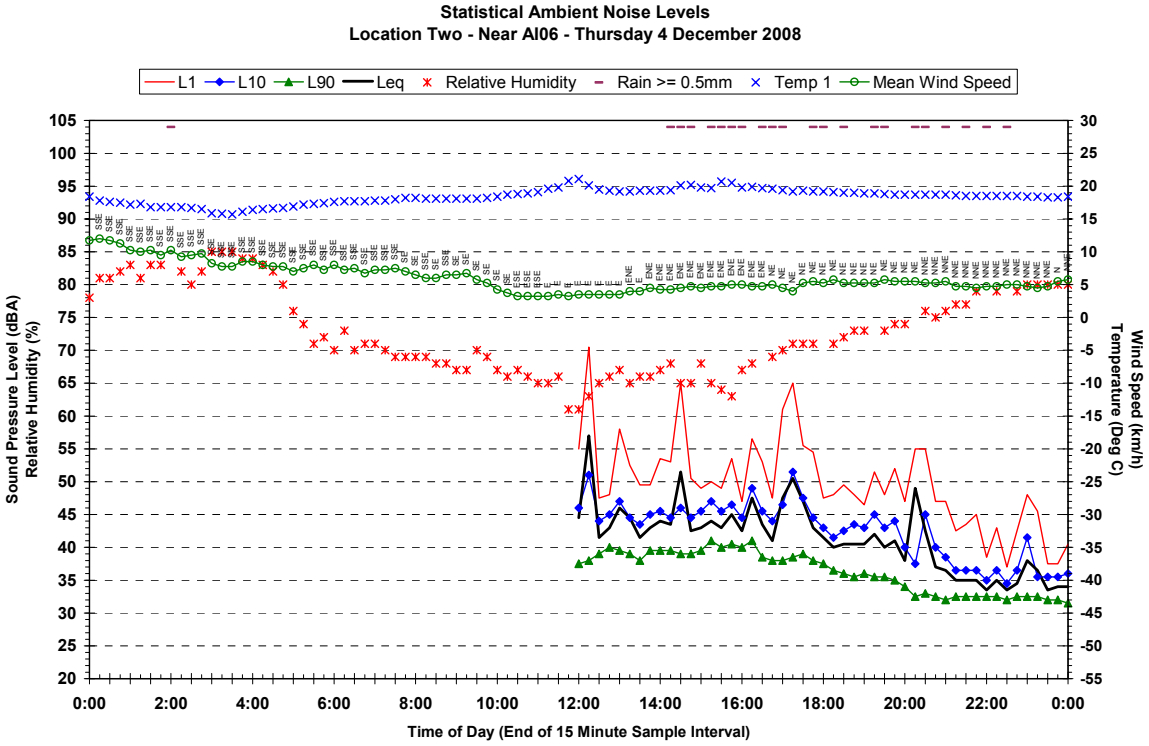


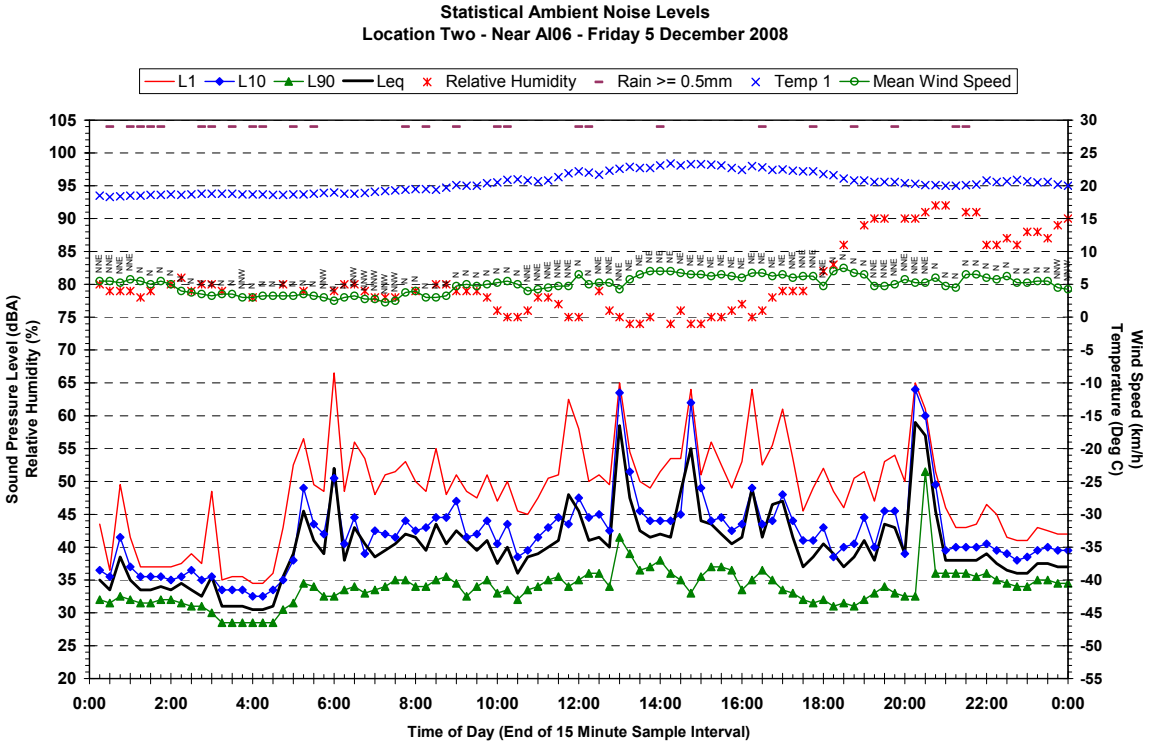
Location One – Near AI05





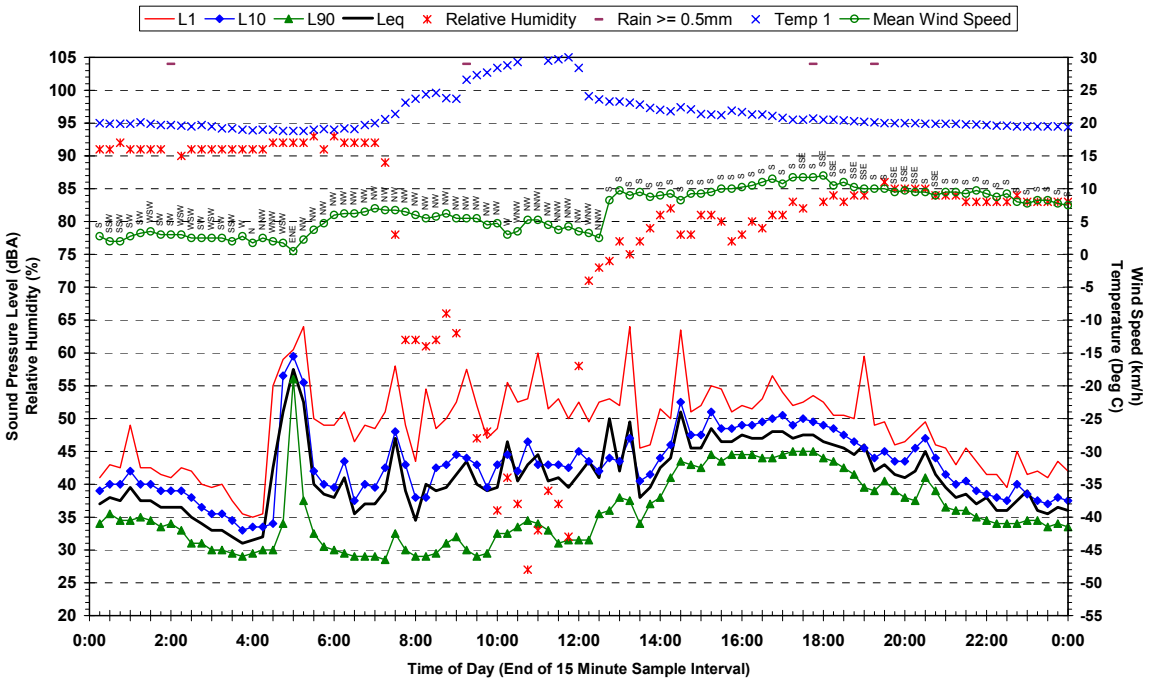
Location Two – Near AI06



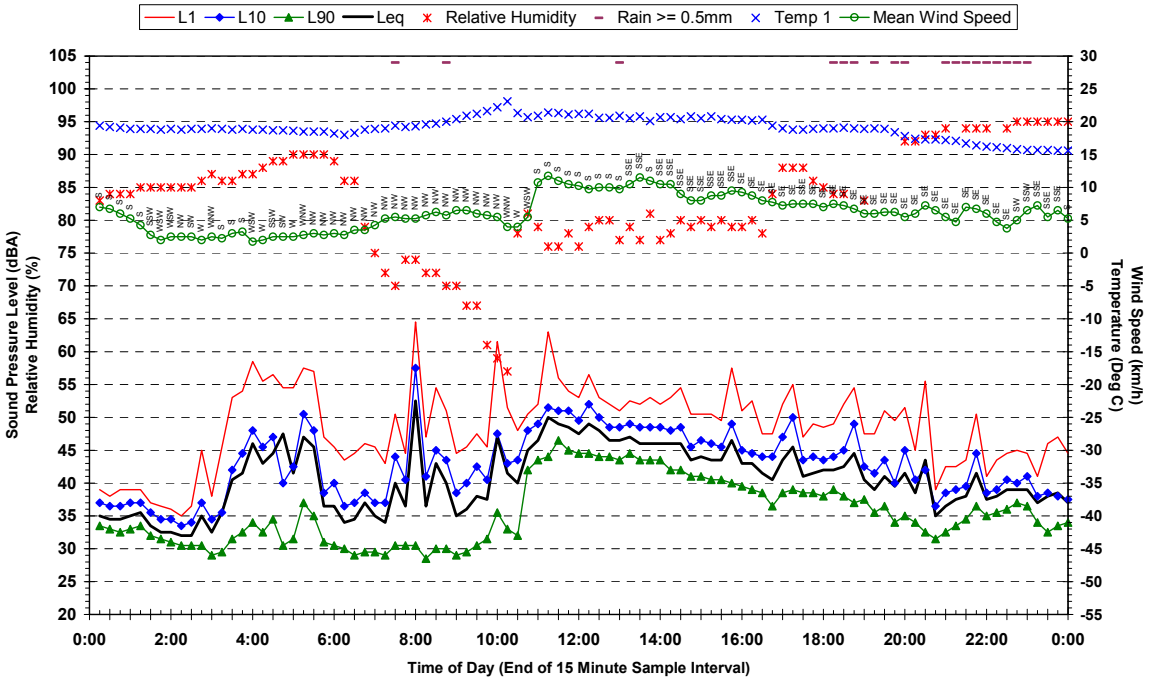


Location Two – Near AI06

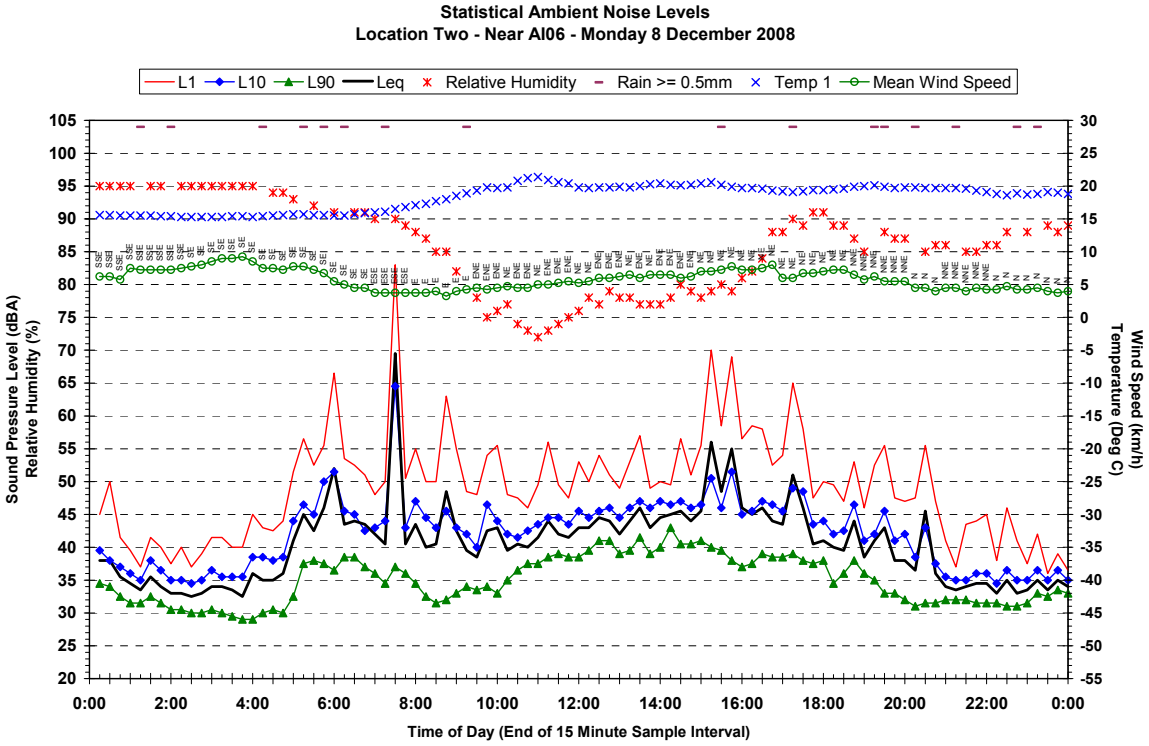
Statistical Ambient Noise Levels
Location Two - Near AI06 - Saturday 6 December 2008

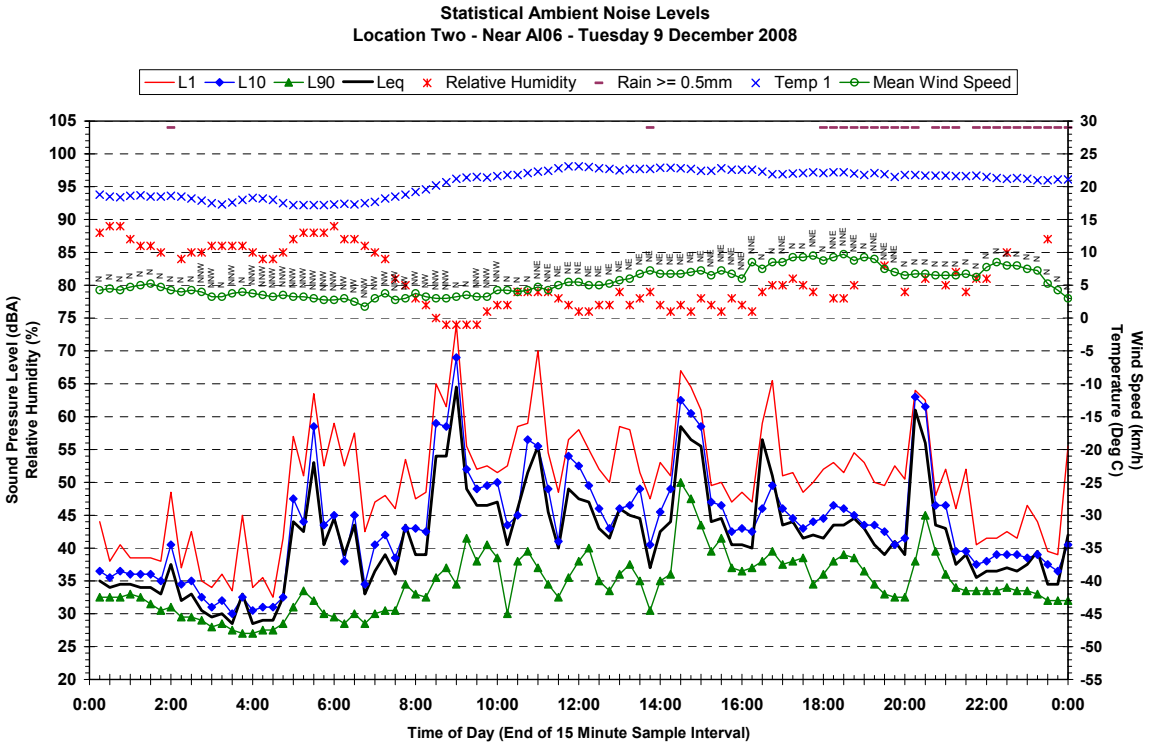


Statistical Ambient Noise Levels
Location Two - Near AI06 - Sunday 7 December 2008



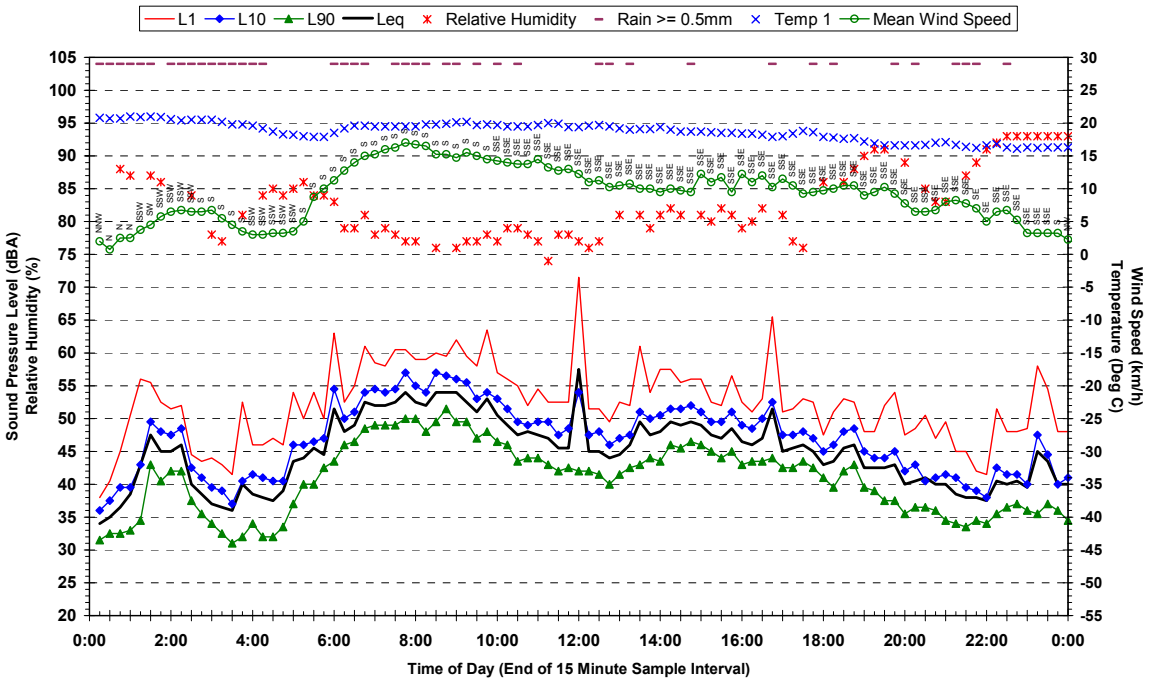
Location Two – Near AI06



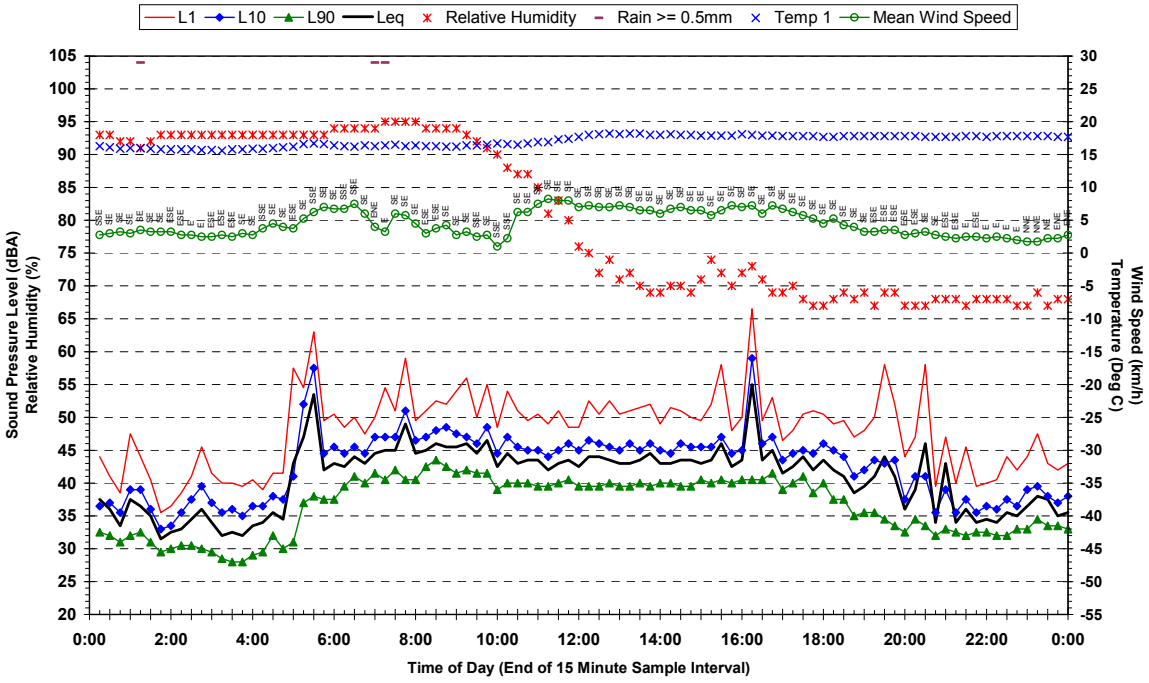


Location Two – Near AI06

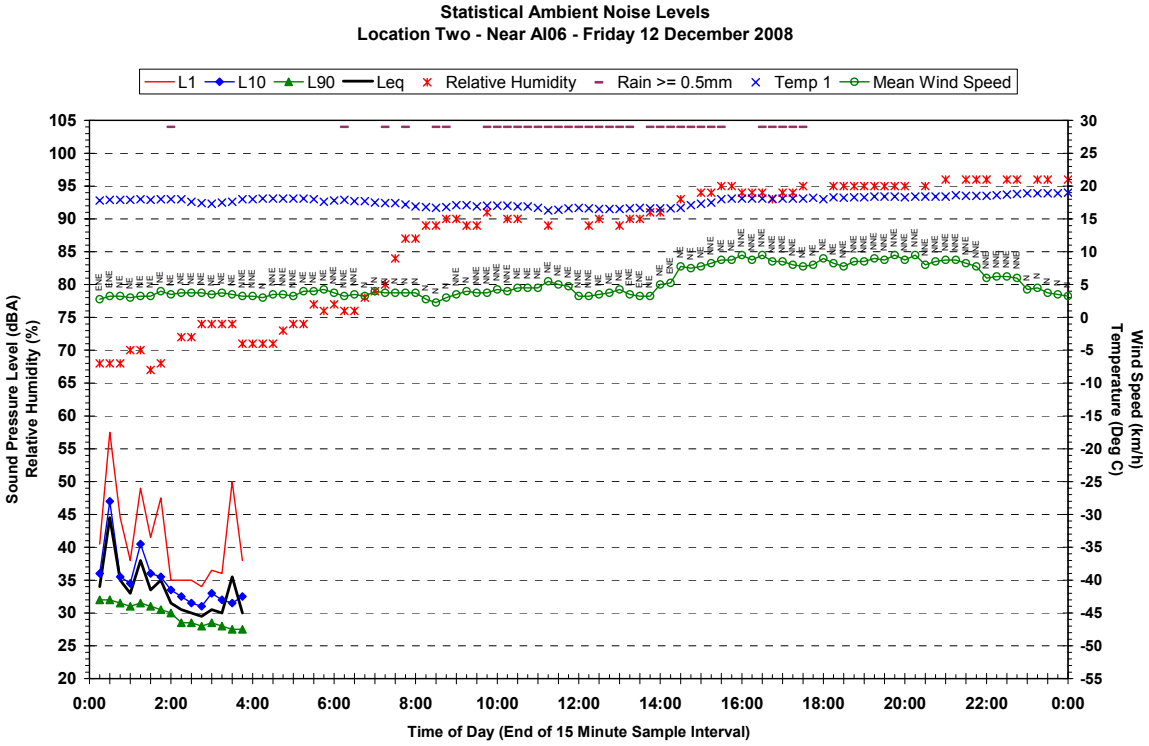
Statistical Ambient Noise Levels
Location Two - Near AI06 - Wednesday 10 December 2008

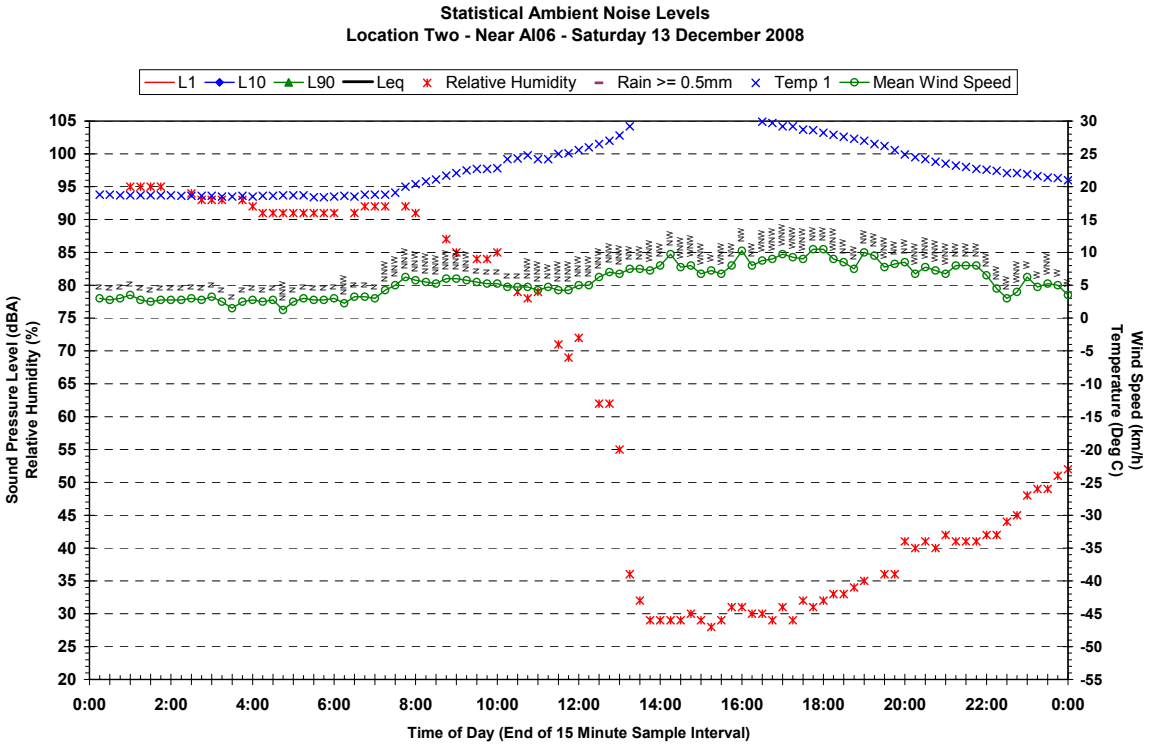


Statistical Ambient Noise Levels
Location Two - Near AI06 - Thursday 11 December 2008

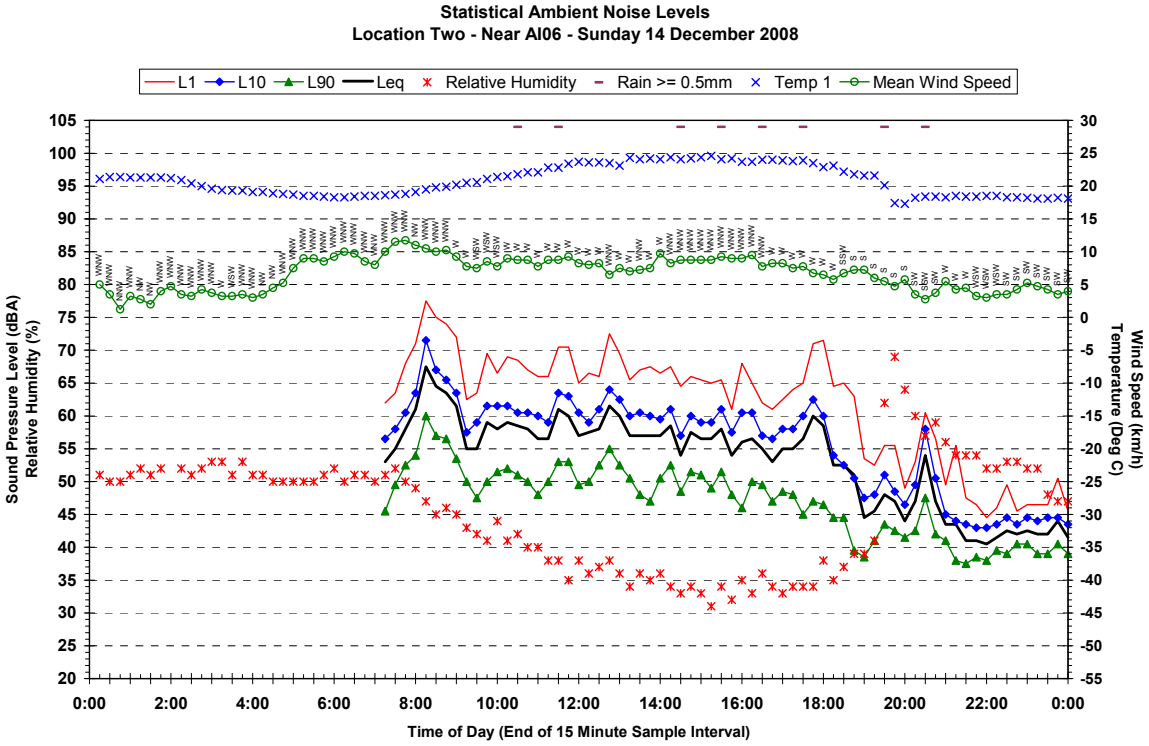


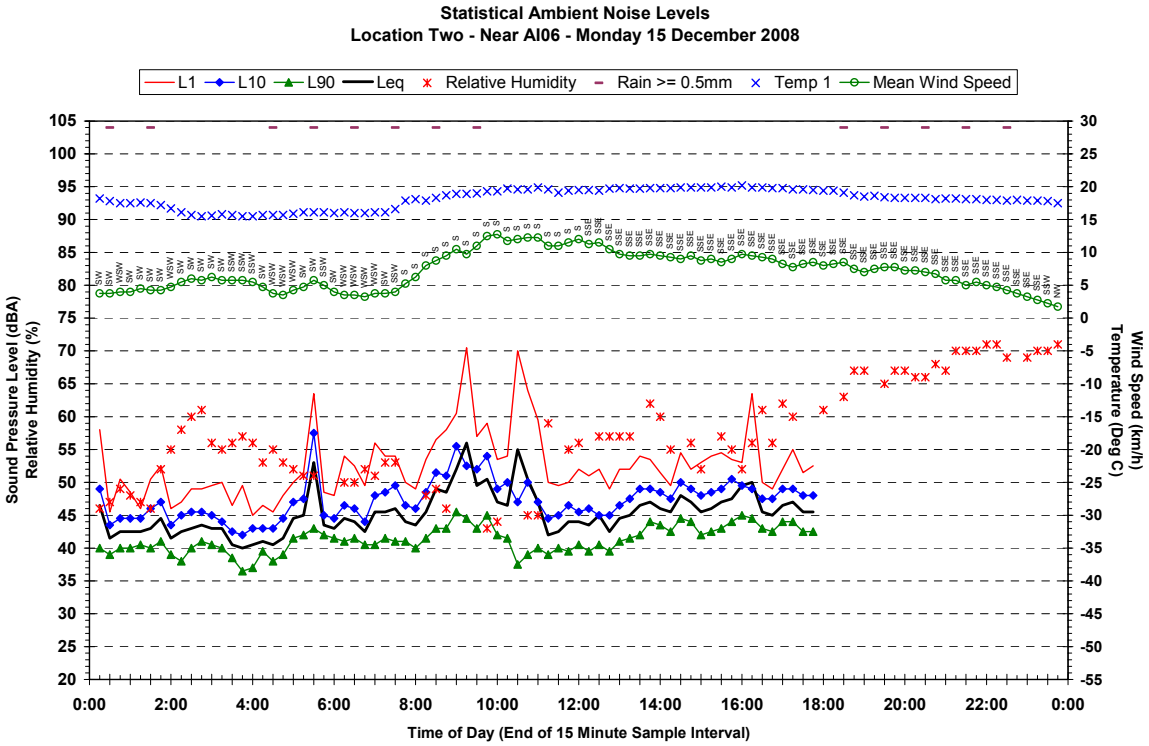
Location Two – Near AI06



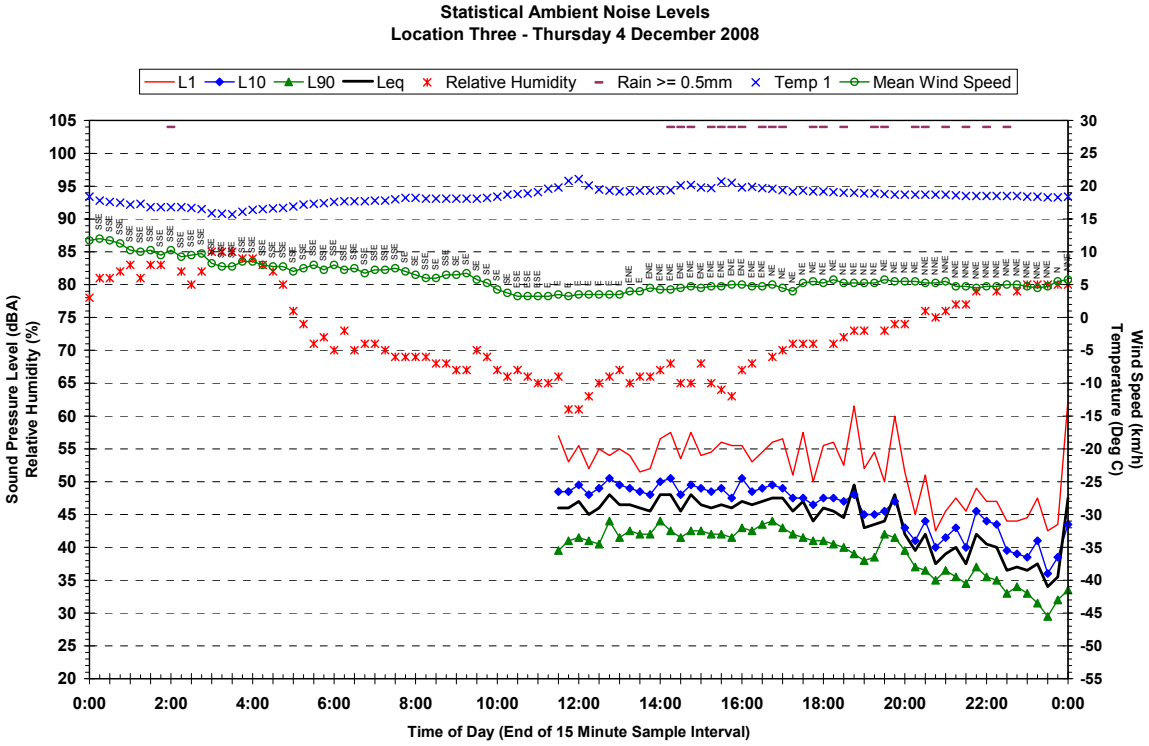


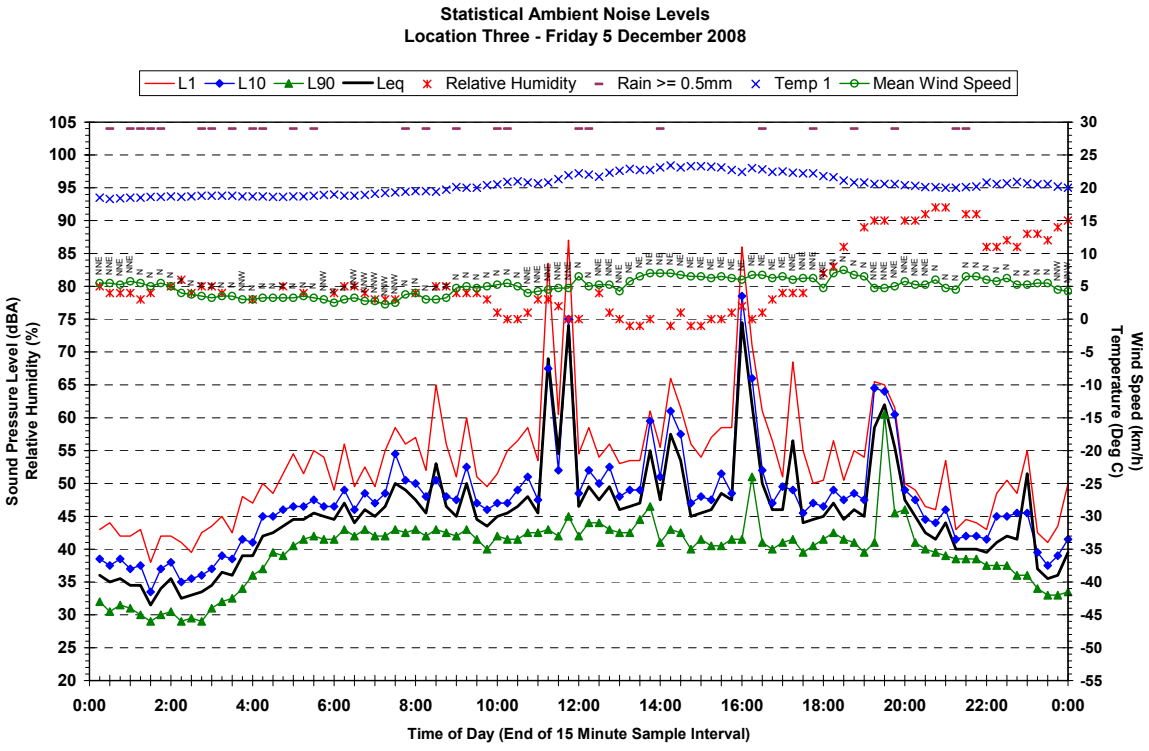
Location Two – Near AI06





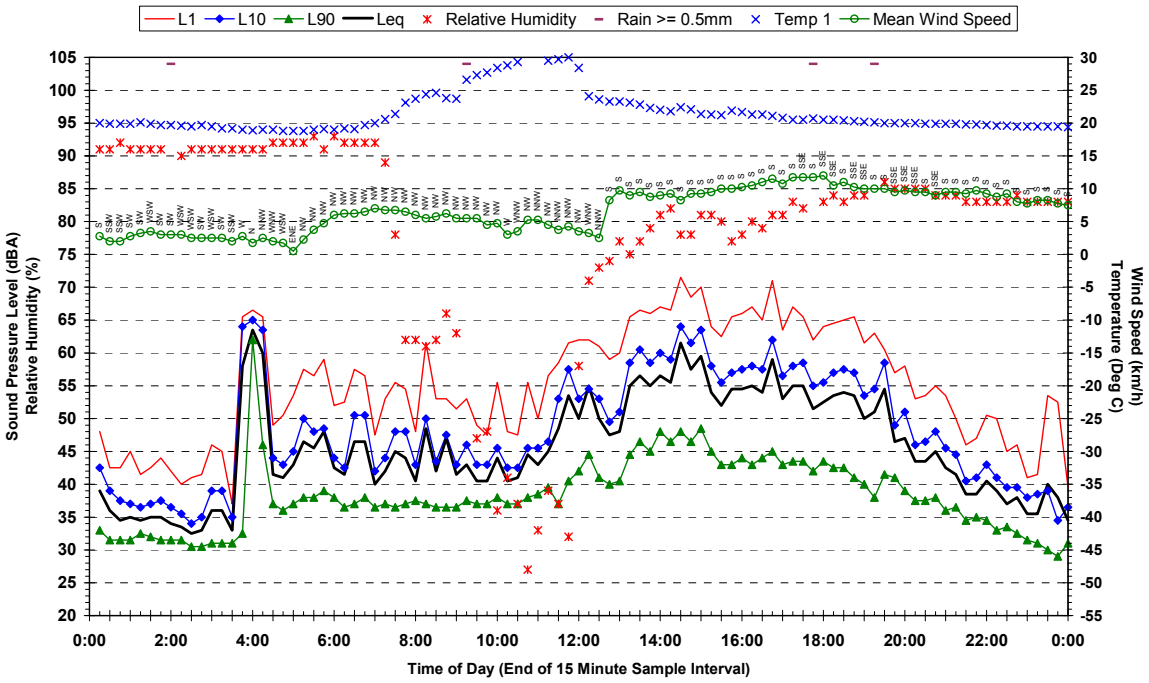
Location Three



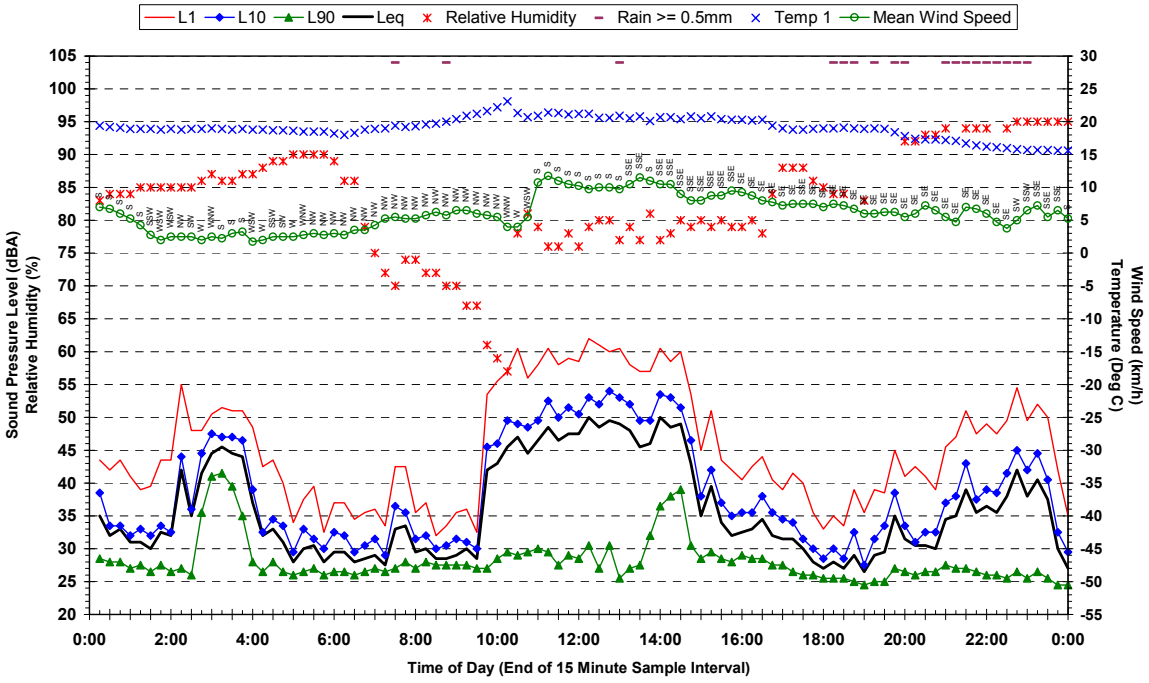


Location Three

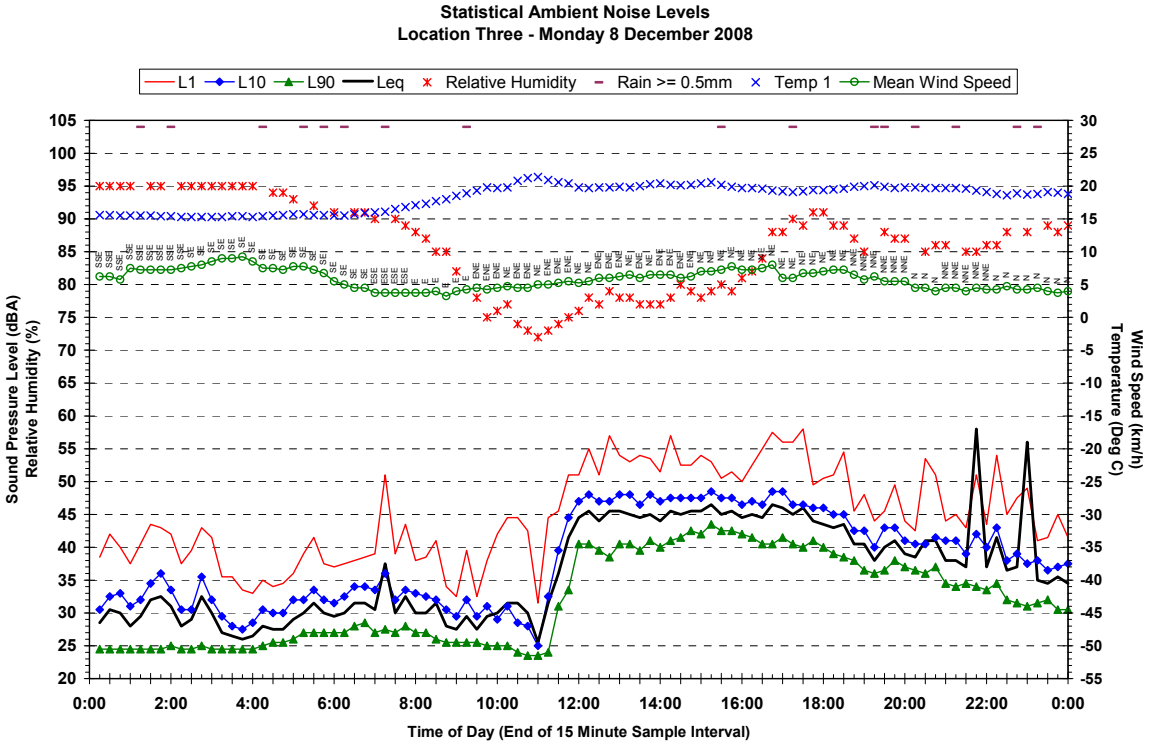
Statistical Ambient Noise Levels
Location Three - Saturday 6 December 2008

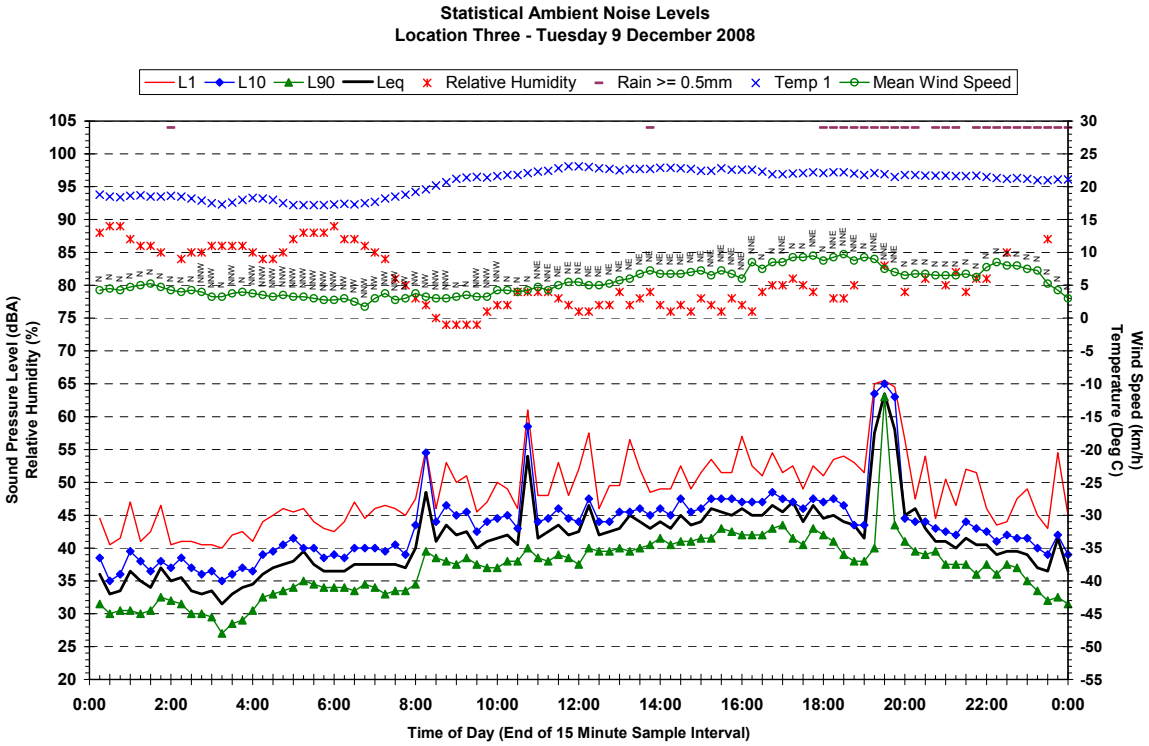


Statistical Ambient Noise Levels
Location Three - Sunday 7 December 2008



Location Three





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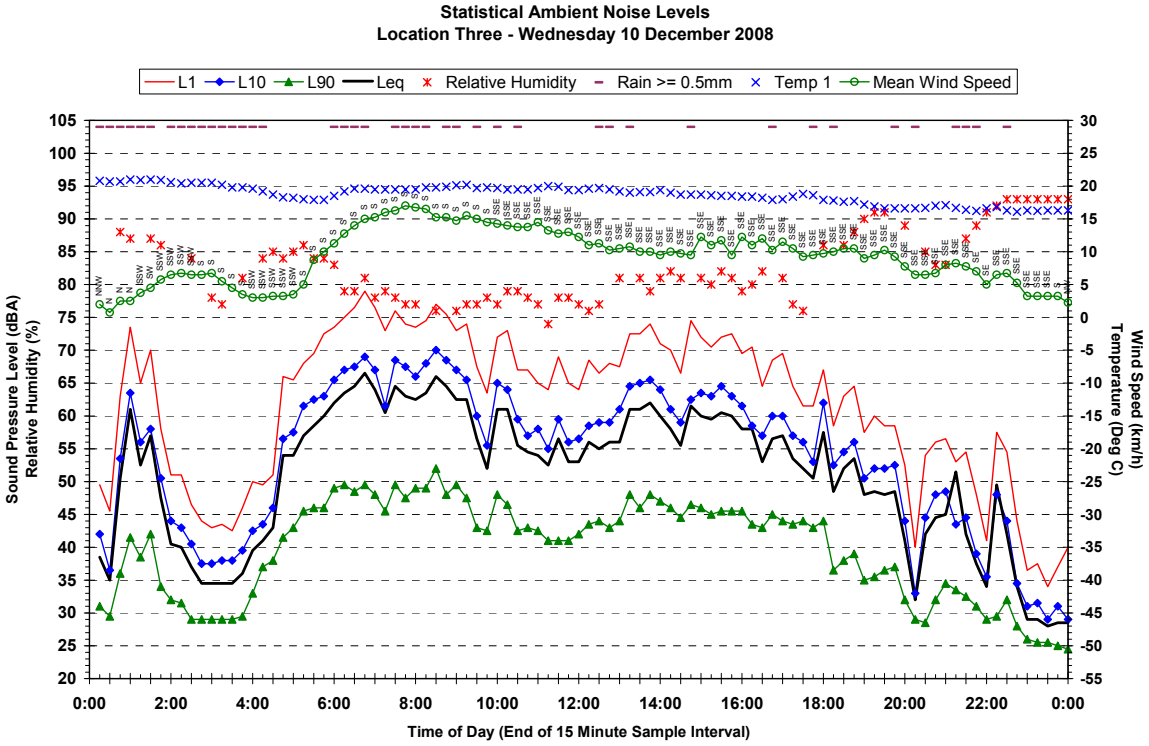

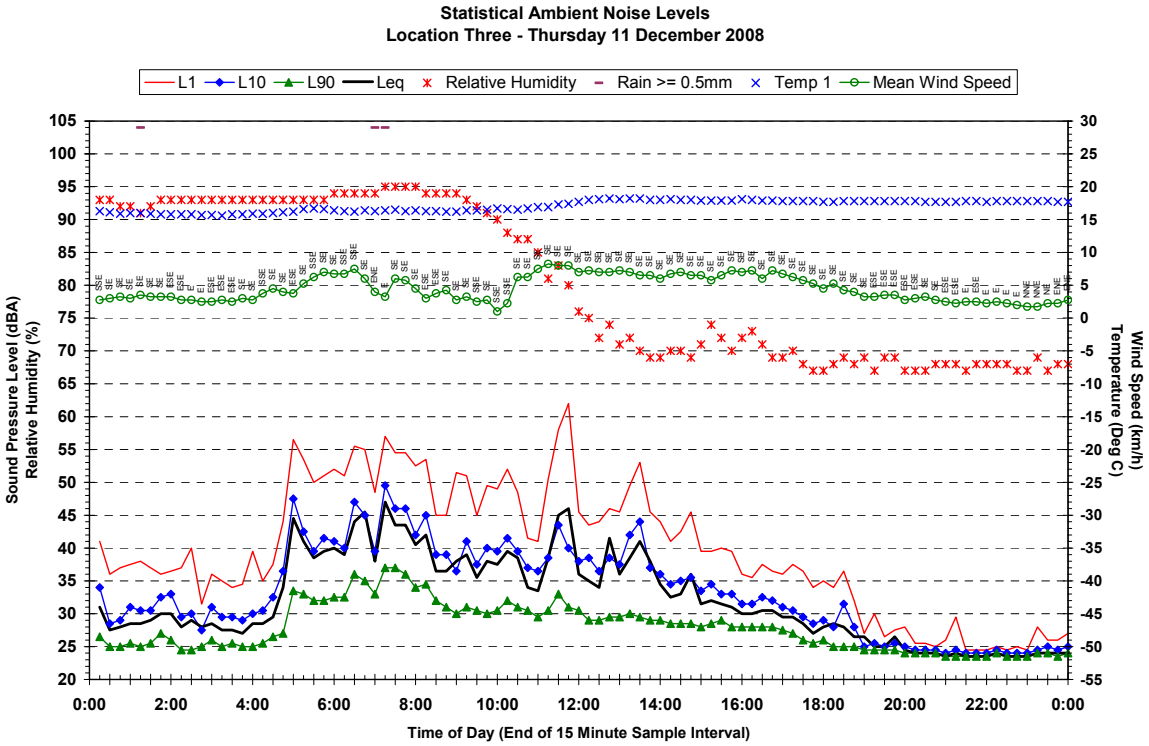

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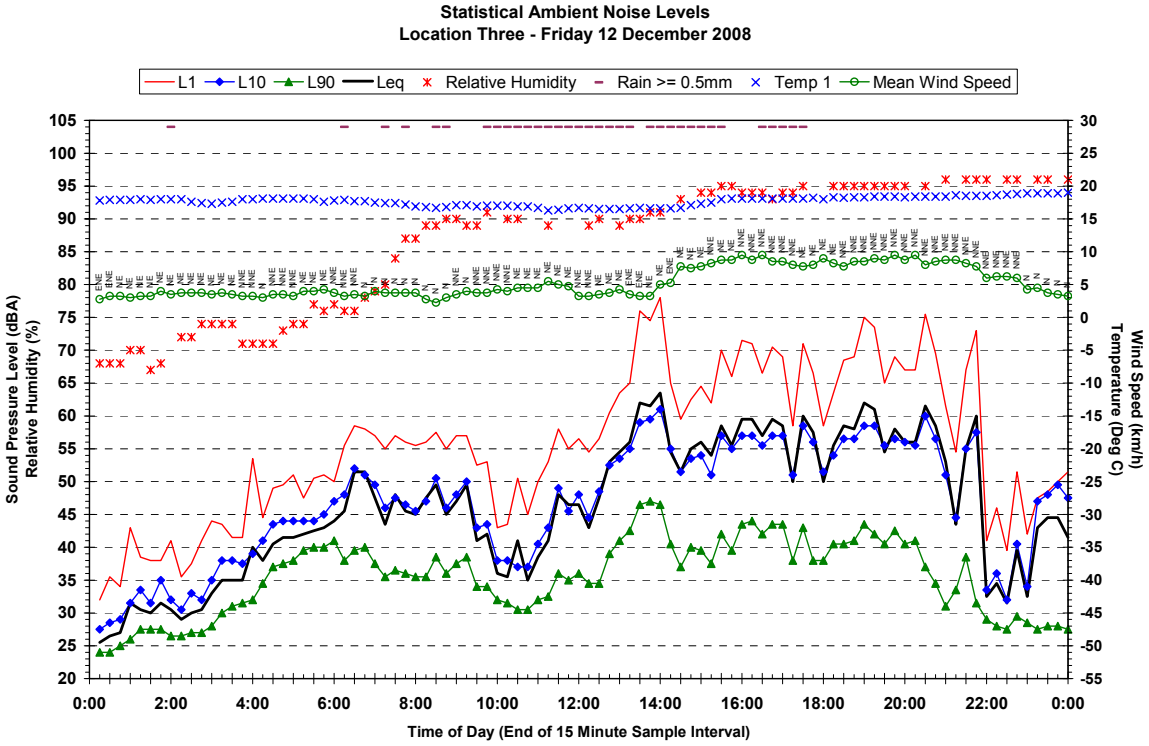

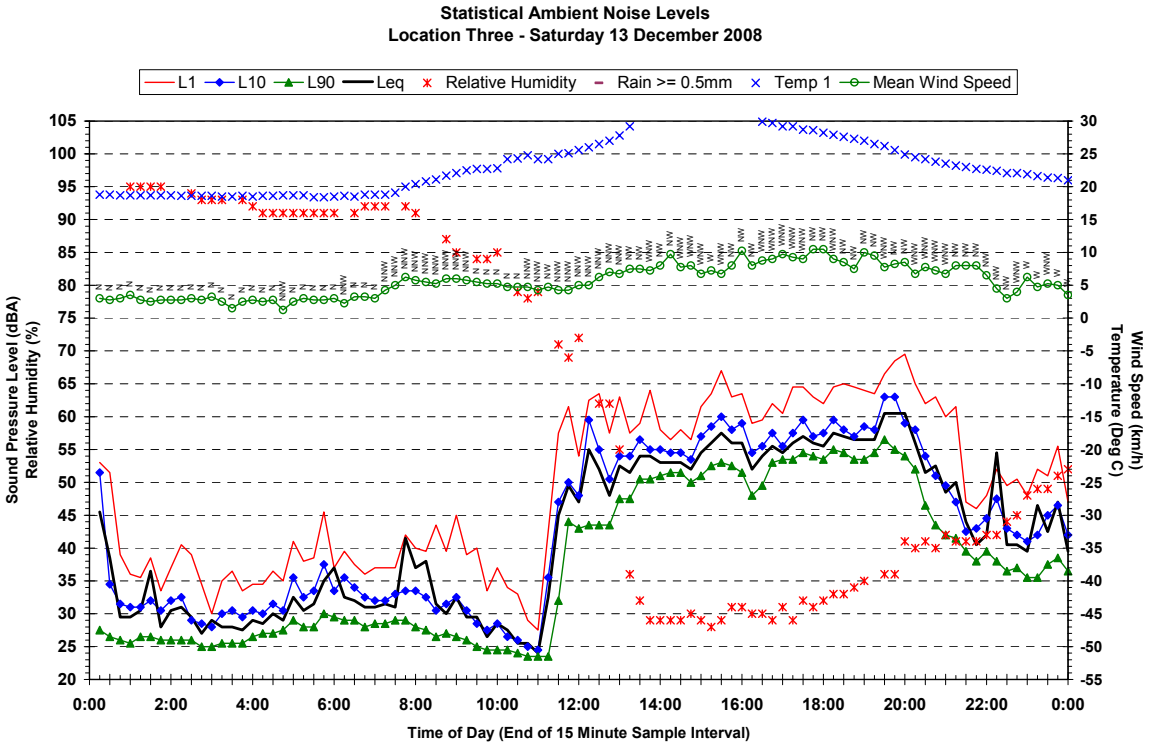

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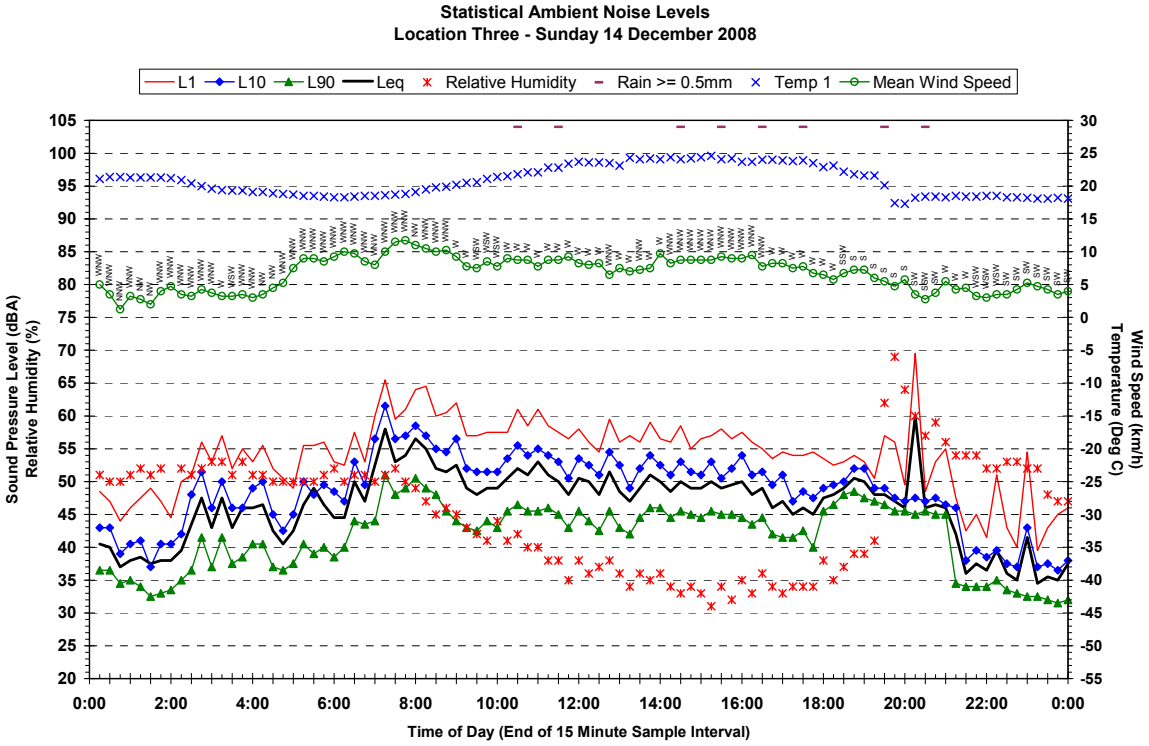

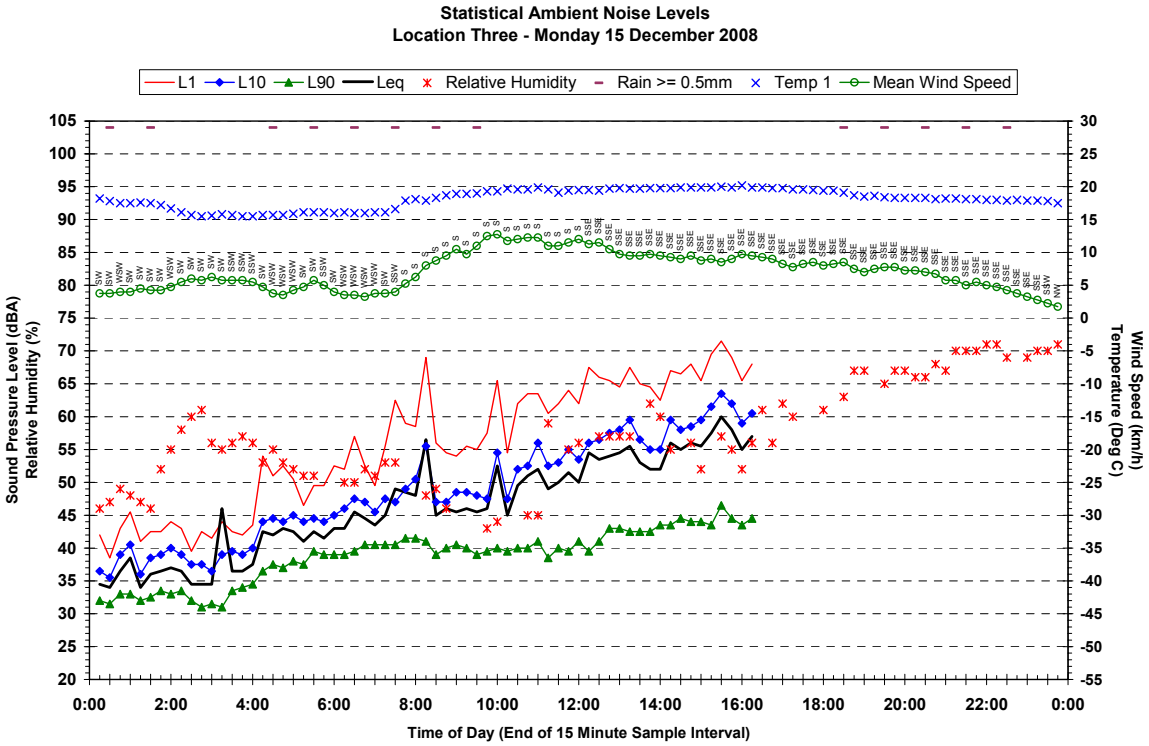

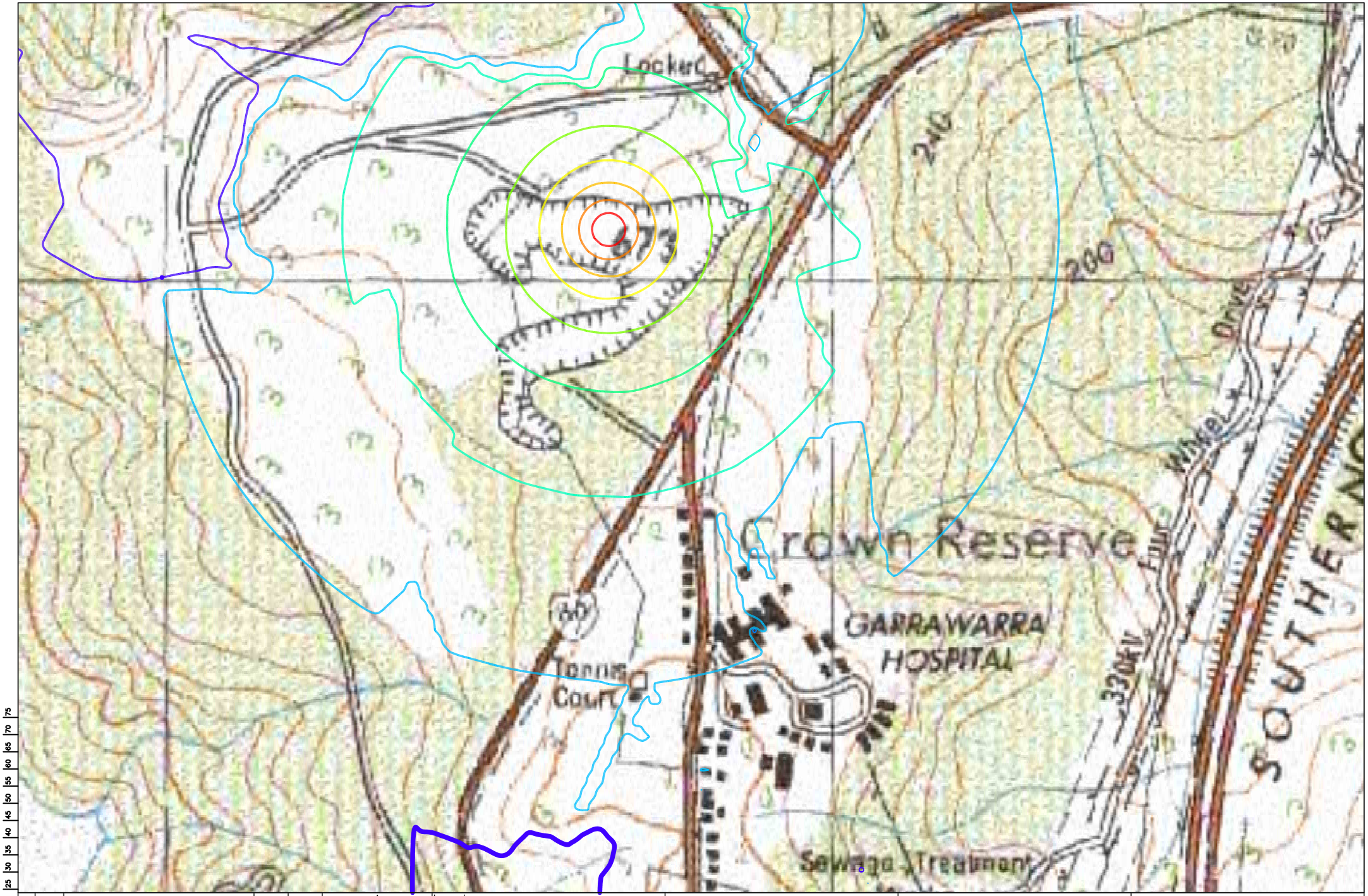

75 mm ON ORIGINAL

REV.	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
0	05/05/05			

Legend

- 30 dBA Noise Contour
- 35 dBA Noise Contour
- 40 dBA Noise Contour
- 45 dBA Noise Contour
- 50 dBA Noise Contour
- 55 dBA Noise Contour
- 60 dBA Noise Contour
- 65 dBA Noise Contour
- 70 dBA Noise Contour
- 75 dBA Noise Contour

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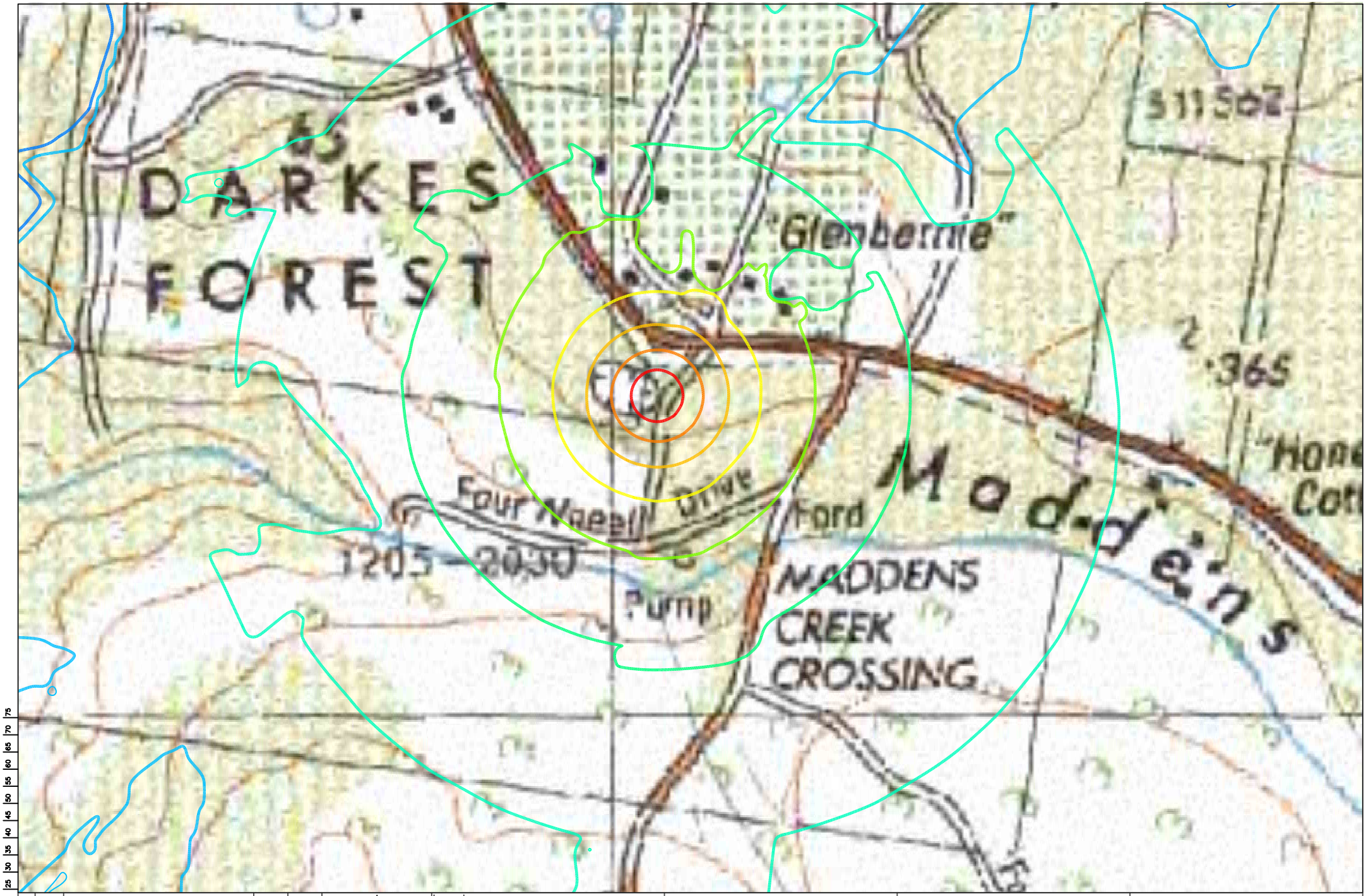
10-7464
Drill Operation Noise Contours
Construction - AI01

FILE NAME: Worst Case Construction AI01.dwg
DRAWING No.: 10-7464 Appendix E
REVISION: 0



75 mm ON ORIGINAL

REV.	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
0	05/05/05			

0

Legend

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- 35 dBA Noise Contour
- 40 dBA Noise Contour
- 45 dBA Noise Contour
- 50 dBA Noise Contour
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- 70 dBA Noise Contour
- 75 dBA Noise Contour

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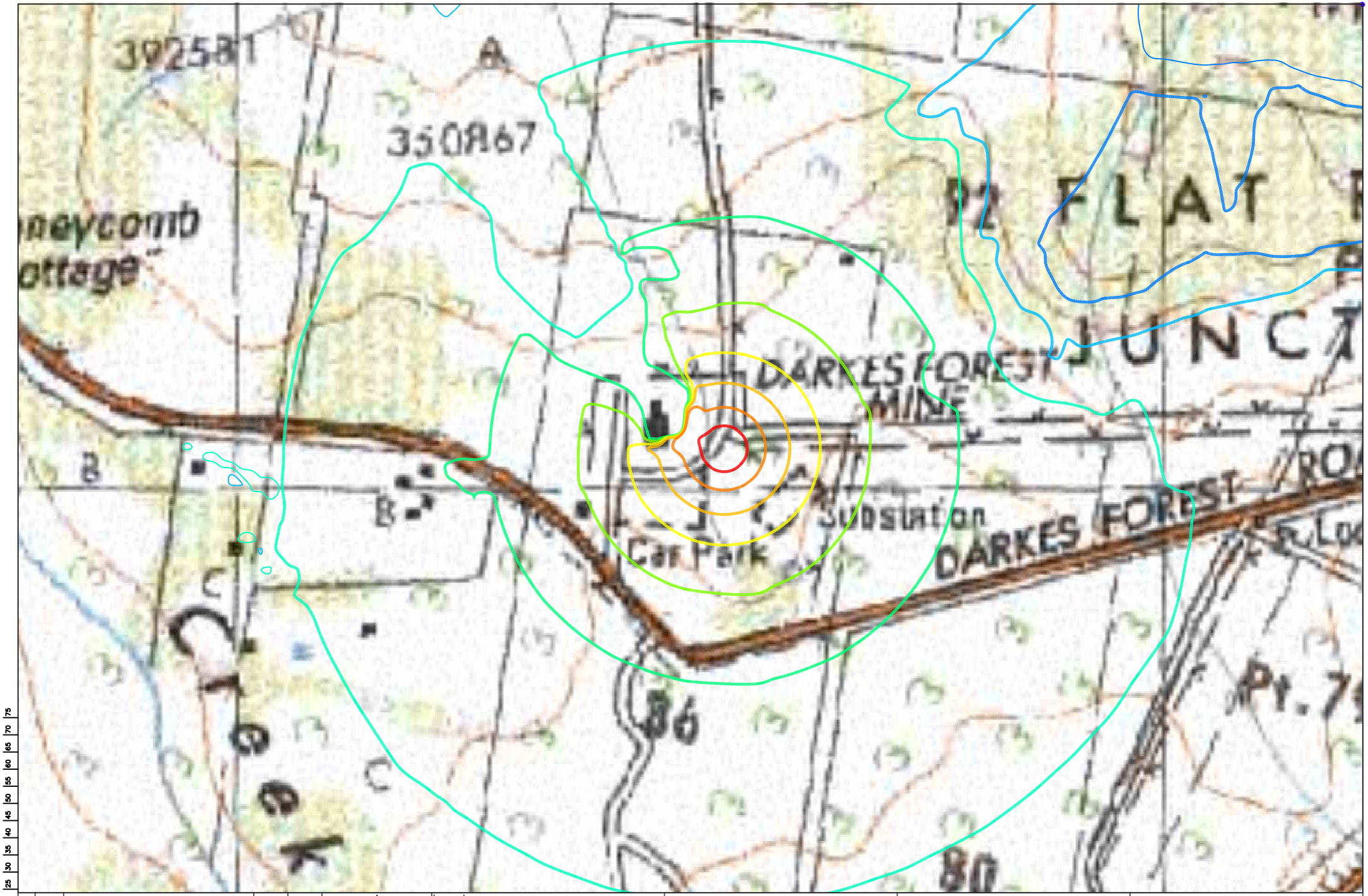
10-7464
Drill Operation Noise Contours
Construction - AI05

FILE NAME: Worst Case Construction AI05.dwg
DRAWING No.: 10-7464 Appendix E
REVISION: 0



75 mm ON ORIGINAL

REV.	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
0	05/05/05			

0

Legend

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- 70 dBA Noise Contour
- 75 dBA Noise Contour

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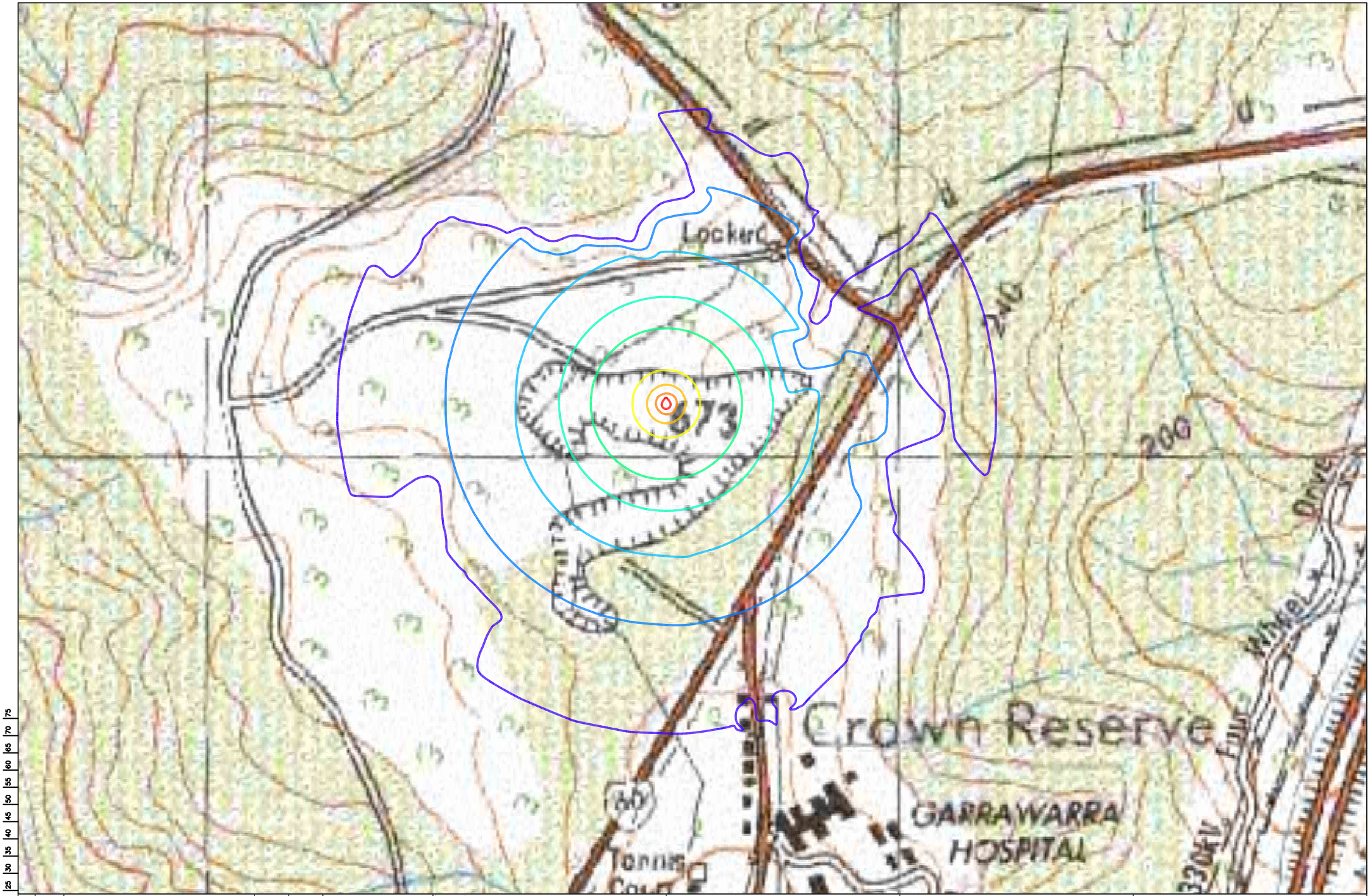
10-7464
Drill Operation Noise Contours
Construction - AI06

FILE NAME: Worst Case Construction AI06.dwg

DRAWING No.: 10-7464 Appendix E

REVISION: 0



75 mm ON ORIGINAL

REV.	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
0	05/09/05			

0

Legend

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- 35 dBA Noise Contour
- 40 dBA Noise Contour
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- 70 dBA Noise Contour
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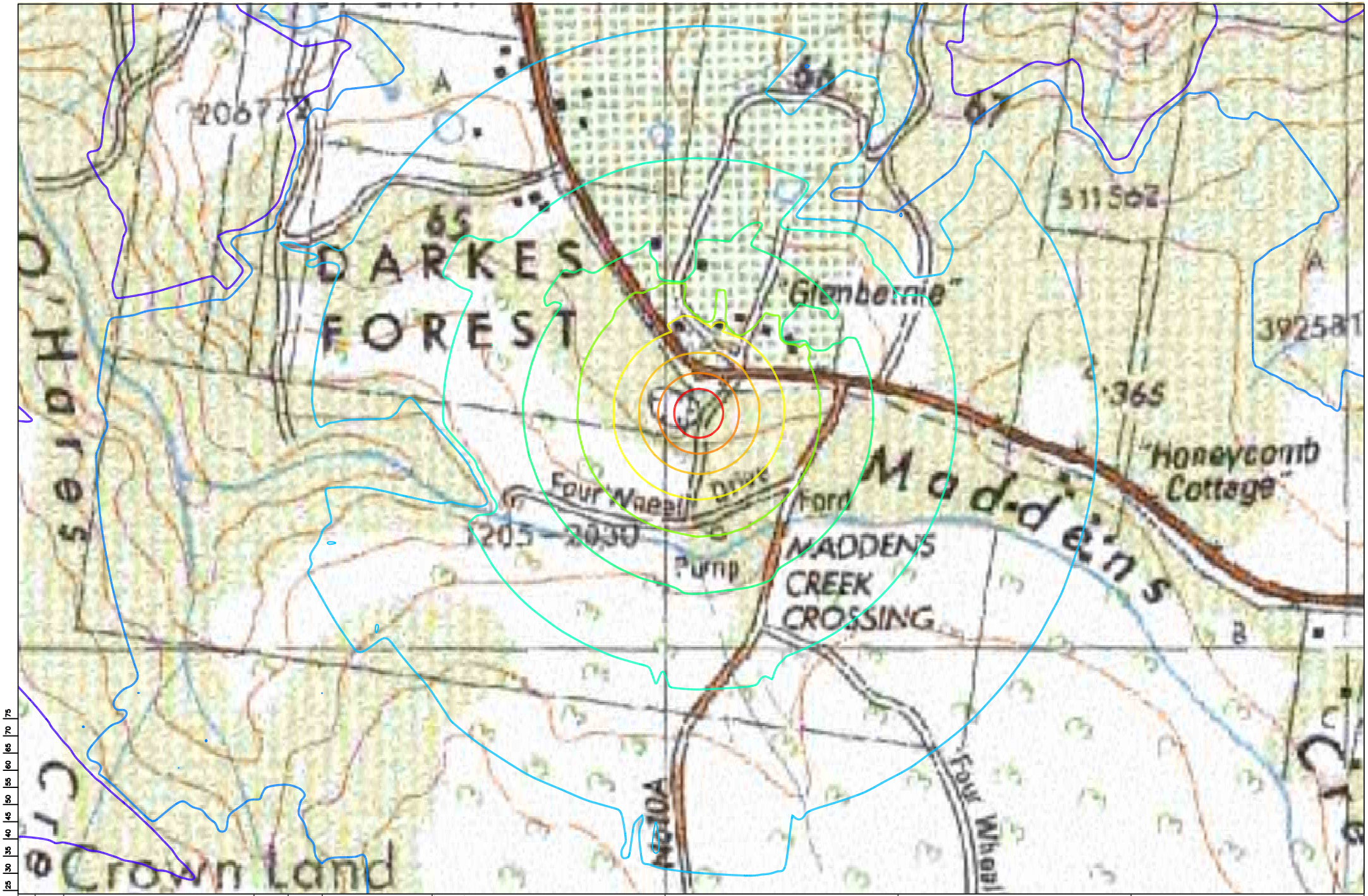
10-7464
Drill Operation Noise Contours
Calm Weather Condition - AI01

FILE NAME: Calm Operation AI01.dwg
DRAWING No.: 10-7464 Appendix F
REVISION: 0



75 mm ON ORIGINAL

REV.	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
0	05/05/05			

Legend

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- 40 dBA Noise Contour
- 45 dBA Noise Contour
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- 75 dBA Noise Contour

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10-7464
Drill Operation Noise Contours
Calm Weather Condition - AI05

FILE NAME	DRAWING No.	REVISION
Calm Operation AI05.dwg	10-7464 Appendix F	0

75 mm ON ORIGINAL

REV.	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
0	05/05/05			

Legend

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- 35 dBA Noise Contour
- 40 dBA Noise Contour
- 45 dBA Noise Contour
- 50 dBA Noise Contour
- 55 dBA Noise Contour
- 60 dBA Noise Contour
- 65 dBA Noise Contour
- 70 dBA Noise Contour
- 75 dBA Noise Contour

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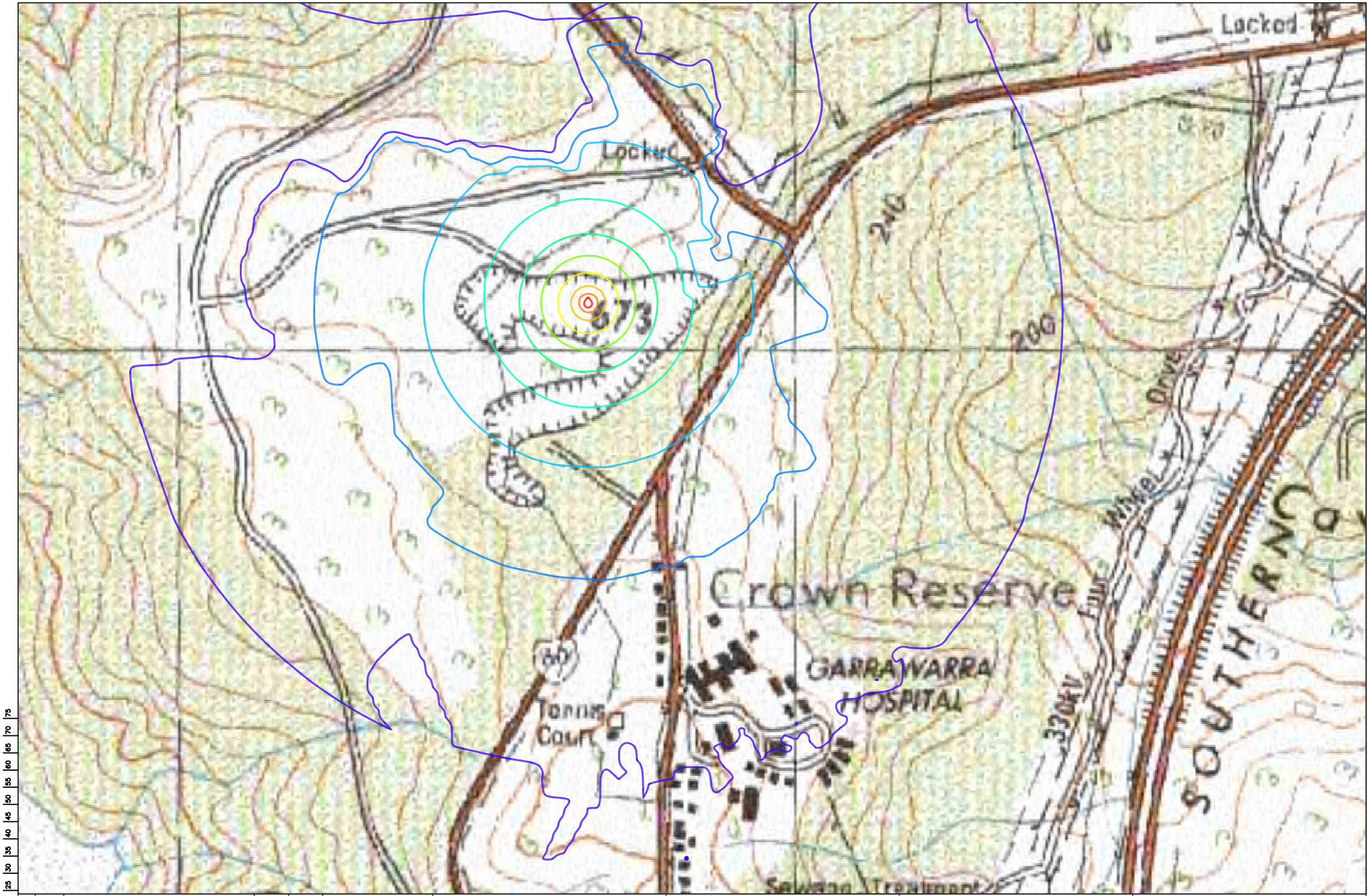
10-7464
Drill Operation Noise Contours
Calm Weather Condition - AI06

FILE NAME: Calm Operation AI06.dwg
DRAWING No.: 10-7464 Appendix F
REVISION: 0



Legend

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- 35 dBA Noise Contour
- 40 dBA Noise Contour
- 45 dBA Noise Contour
- 50 dBA Noise Contour
- 55 dBA Noise Contour
- 60 dBA Noise Contour
- 65 dBA Noise Contour
- 70 dBA Noise Contour
- 75 dBA Noise Contour

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REV.	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
0	05/09/05			

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10-7464
Drill Operation Noise Contours
Worst Case Weather Conditions - AI01

FILE NAME: Worst Case Operation AI01.dwg
DRAWING No.: 10-7464 Appendix F
REVISION: 0

75 mm ON ORIGINAL
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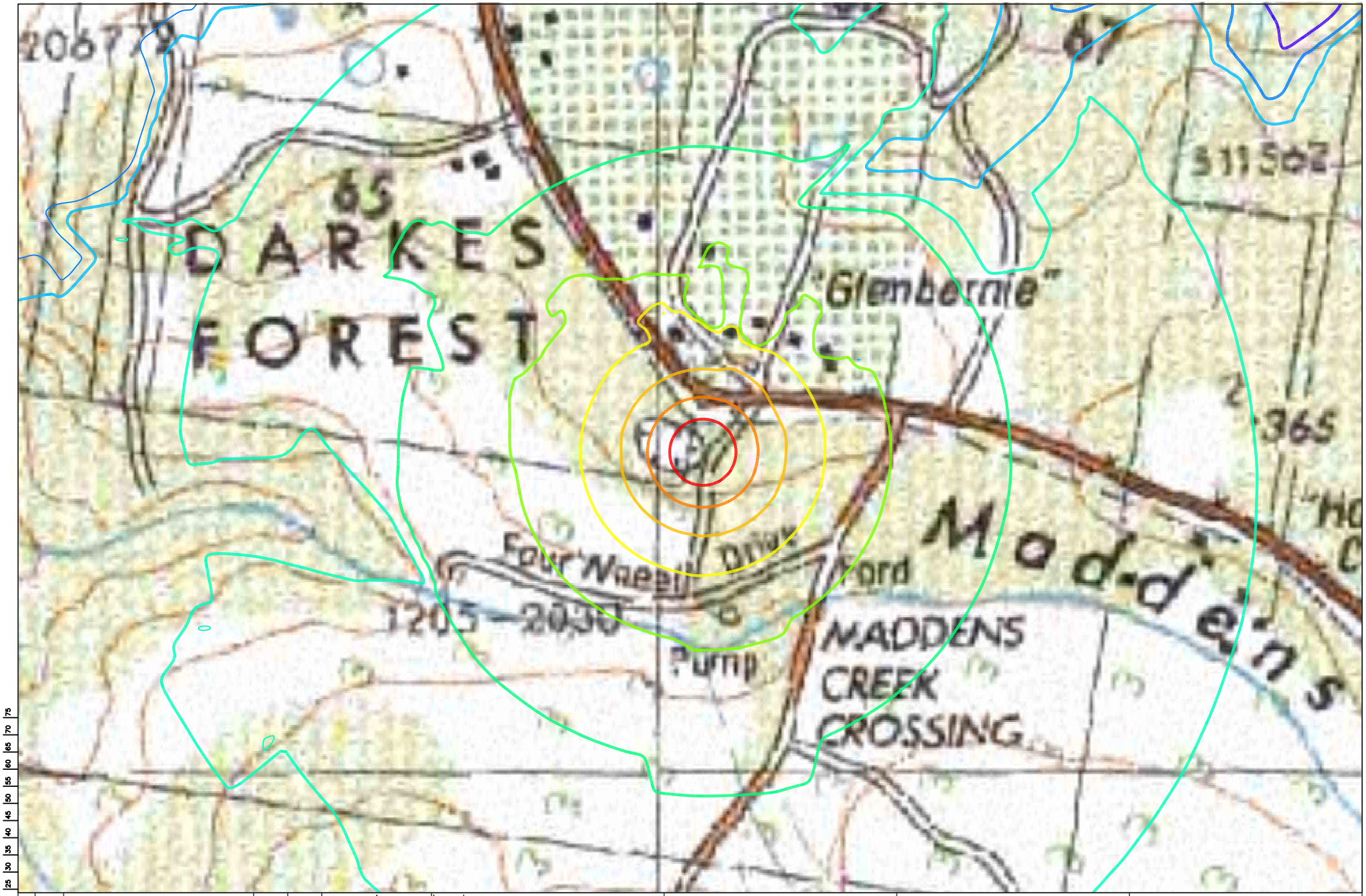

75 mm ON ORIGINAL

REV.	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
0	05/05/05			

Legend

- 30 dBA Noise Contour
- 35 dBA Noise Contour
- 40 dBA Noise Contour
- 45 dBA Noise Contour
- 50 dBA Noise Contour
- 55 dBA Noise Contour
- 60 dBA Noise Contour
- 65 dBA Noise Contour
- 70 dBA Noise Contour
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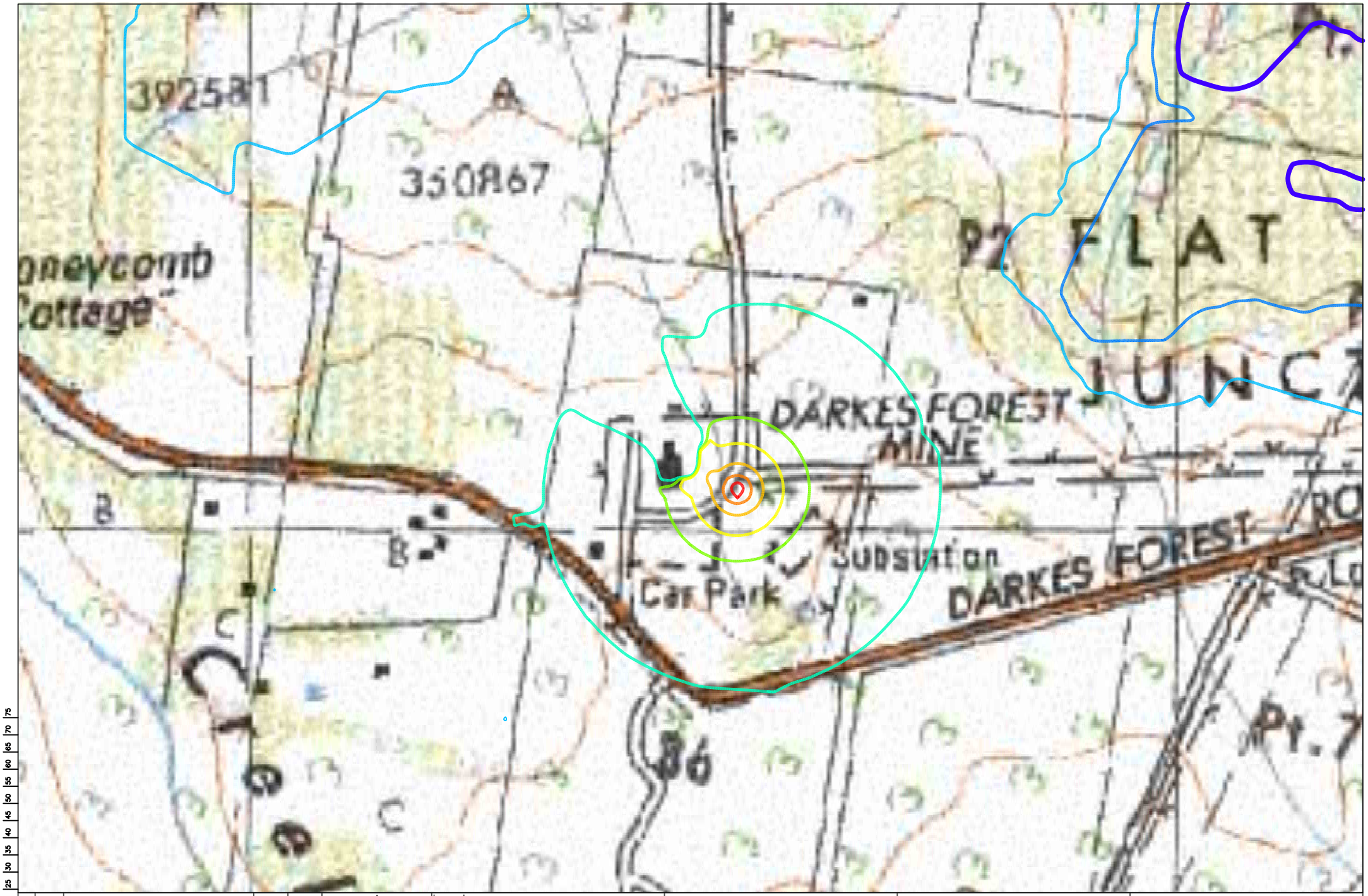
10-7464
Drill Operation Noise Contours
Worst Case Weather Conditions - AI05

FILE NAME: Worst Case Operation AI05.dwg
DRAWING No.: 10-7464 Appendix F
REVISION: 0



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REV.	DATE	AMENDMENT / ISSUE DESCRIPTION	PREPARED	CHECKED
0	05/05/05			

Legend

- 30 dBA Noise Contour
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- 40 dBA Noise Contour
- 45 dBA Noise Contour
- 50 dBA Noise Contour
- 55 dBA Noise Contour
- 60 dBA Noise Contour
- 65 dBA Noise Contour
- 70 dBA Noise Contour
- 75 dBA Noise Contour

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10-7464
Drill Operation Noise Contours
Worst Case Weather Conditions - AI06

FILE NAME: Worst Case Operation AI06.dwg
DRAWING No.: 10-7464 Appendix F
REVISION: 0

References

- BS 6472-1992 "*Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)*"
- BS 7385:Part 1-1990 "*Evaluation and for vibration in buildings. Part 1: Guide for measurement of vibrations and evaluation of their effects on buildings*"
- BS 7385:Part 2-1993 "*Evaluation and measurement for vibration in buildings. Part 2: Guide to damage levels from ground-borne vibration*"
- DIN 4150:Part 3-1993 "*Structural vibration. Part 3: Effects of vibration on structures*"
- Environmental Protection Authority, "*NSW Industrial Noise Policy*"
- AS1259-1990 "*Sound Level Meters*"
- AS1055-1997 "*Acoustics Description and Measurement of Environmental Noise*"
- DECC "*Environmental Noise Control Manual*"
- DECC "*Assessing Vibration a Technical Guideline*"

APPENDIX V

(No. of pages excluding this page = 11)

Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Project: Greenhouse Gas Assessment, December 2008

Heggies Pty Limited

HEGGIES

REPORT 10-7464-R1

Revision 0

Illawarra Coal Seam Gas
Exploration Drilling and Gas Monitoring Project
Greenhouse Gas Assessment

PREPARED FOR

Apex Energy NL
Suite 14, Level 5
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SYDNEY NSW 2000

5 JANUARY 2009

HEGGIES PTY LTD
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Illawarra Coal Seam Gas
Exploration Drilling and Gas Monitoring Project
Greenhouse Gas Assessment

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DOCUMENT CONTROL

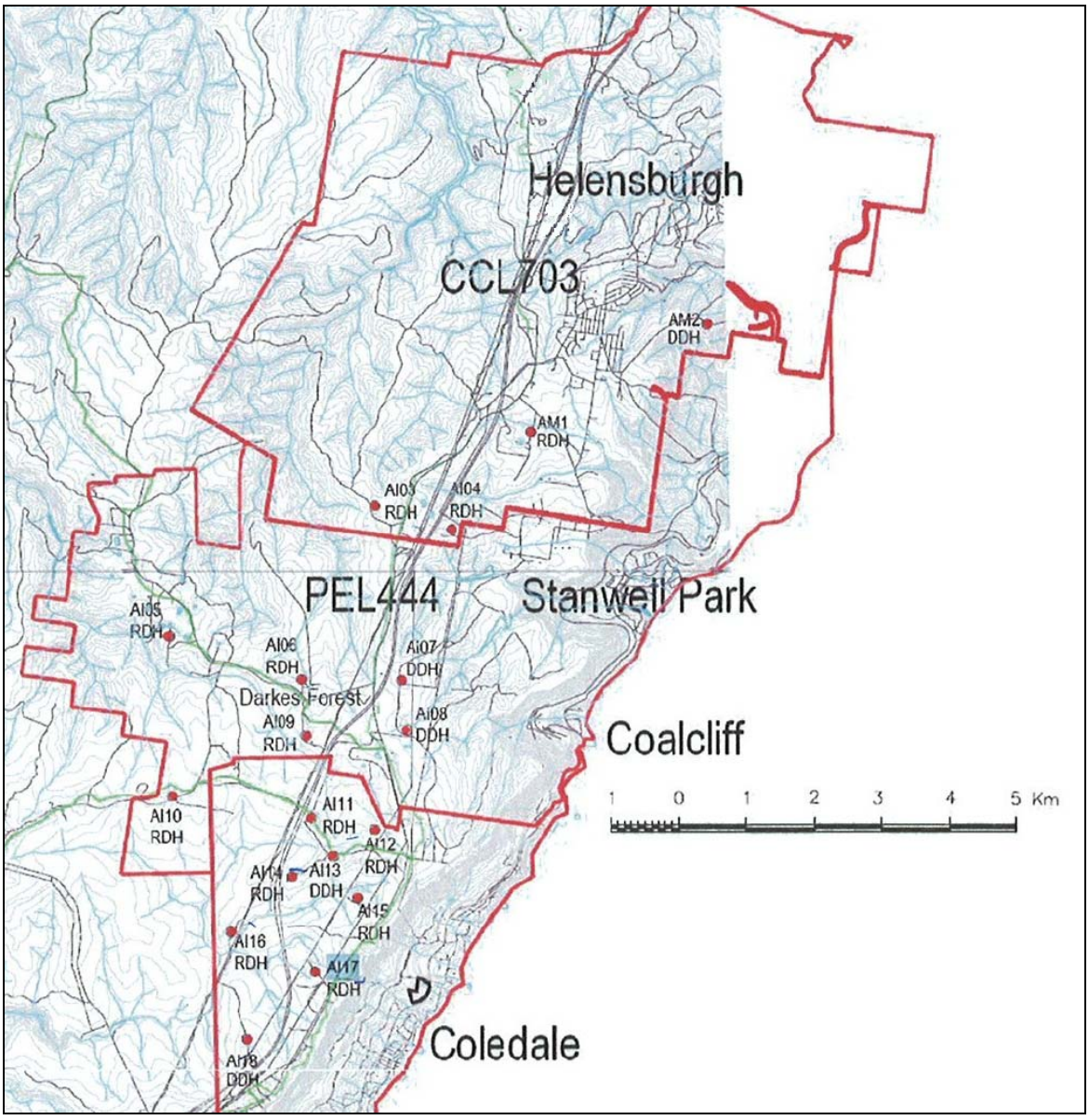
Reference	Status	Date	Prepared	Checked	Authorised
10-7464-R1	Revision 0	5 January 2009	Scott Fishwick	Ronan Kellaghan	Ronan Kellaghan

TABLE OF CONTENTS

1 INTRODUCTION

Apex Energy NL (hereafter, "Apex") proposes to undertake a drilling exploration project in a sector of the Illawarra Coal Measures. The drilling project (hereafter, "the Project") will involve the establishment of 18 boreholes across a region stretching approximately 15 km along the plateau of the Illawarra Range between Helensburgh and Coledale, situated between Sydney and Wollongong. **Figure 1** presents the spread of the Project and the proposed boreholes.

Figure 1 Proposed Borehole Locations



Each borehole will be extended to the base of the Illawarra Coal Measures and, in addition to defining the regional gas potential, will provide more detail on the regional geology. The boreholes will be configured to enable ongoing gas monitoring, which will assess gas quality, quantity and flow rates. This is essential data for planning future gas energy projects.

Heggies Pty Ltd (hereafter, "Heggies") has been commissioned by Olsen Environmental Consulting Pty Limited (hereafter, "OEC") on behalf of Apex to undertake a Greenhouse Gas Assessment for the Project to address the Requirements of the Director-General, NSW Department of Planning.

2 PROJECT OVERVIEW

2.1 Proposed Borehole Locations

As previously detailed, the Project comprises of the establishment of 18 boreholes extending to the base of the Illawarra Coal Measures in order to enable ongoing coal seam gas monitoring. The proposed program of each borehole involves both core drilling for initial data gathering and exploration drilling for reserve testing. Each borehole will take a maximum six weeks to establish.

The proposed boreholes can be divided into three types, each of which will require different equipment and duration on site. The location and classification of each proposed borehole, as illustrated in **Figure 1**, is listed in **Table 1**, with a description of each borehole type following.

Table 1 Borehole Classification and Location

Borehole ID	Borehole Classification	Location (m, MGA)	
		Easting	Northing
AI 01	3	312900	6218300
AI 02	3	313100	6216400
AI 03	3	310250	6212100
AI 04	2	311795	6210610
AI 05	1	308115	6209565
AI 06	2	309650	6209240
AI 07	1	310960	6209510
AI 08	1	311460	6208620
AI 09	1	311350	6207630
AI 10	1	308675	6207750
AI 11	1	309600	6207260
AI 12	1	310575	6206805
AI 13	1	309845	6206820
AI 14	1	309150	6206690
AI 15	2	310550	6205900
AI 16	3	308560	6205730
AI 17	1	309690	6205000
AI 18	1	308700	6204000

2.1.1 Type 1 Boreholes

These are open hole boreholes drilled directly into goaf areas. They function as goaf gas exploration wells and are designed to determine goaf gas quality and quantity. These boreholes require air-drilling by a large rig such as the Schramm T685 or equivalent. Proposed boreholes AI 05, AI 07, AI 08, AI 09, AI 10, AI 11, AI 12B, AI 13, AI 14, AI 17 and AI 18 are of this type.

2.1.2 Type 2 Boreholes

These are cored holes drilled into remnant coal pillars in abandoned mine workings or goafs. They are open holes from which seam core samples will be extracted. They can be developed further at some future time using the zero radius drilling technology. They will be used to determine goaf gas characteristics in underlying old Bulli Seam workings. Additional drilling will then be undertaken at a later date to obtain core samples from lower seams. Drilling through and sealing off abandoned goafs requires additional equipment and procedures. This includes a larger diameter hole from the surface to allow placement of additional bore casing. This will require a larger rig and additional time on site. Proposed boreholes AI 04, AI 06 and AI 15 are of this type.

2.1.3 Type 3 Boreholes

These are cored holes of approximately 100mm diameter, drilled over un-worked areas. These holes will enable core samples from the coal seams within the Illawarra Coal Measures. They will provide stratigraphic data, desorption testing of gas content and seam permeability testing. Proposed holes AI 01, AI 02, AI 03 and AI 16 are of this type.

2.2 Coal Seam Gas

OEC and Apex have provided information relating to the composition of the coal seam gas contained within the Illawarra Coal Measures. It is expected that coal seam gas to be accessed will comprise of the following:

- 80% Methane (CH_4)
- 10% Carbon Dioxide (CO_2)
- 10% Inert Gases

Furthermore, it is expected that each borehole will produce a coal seam flow rate of between 11,000 m^3 and 28,000 m^3 per day, with an estimated average rate of 14,000 m^3 per day. Following the establishment of each borehole, coal seam gas flow testing will commence for approximately one week before the borehole is capped and flow is stopped.

Flaring of coal seam gas is proposed for implementation at each of the boreholes. While it is expected that between 90% to 100% of coal seam gas flow will be flared, the potential for some venting directly to the atmosphere exists.

2.3 Diesel Fuel Consumption

A variety of plant, both mobile and fixed, will be required for use in the establishment of the proposed boreholes. All associated plant will be powered by the combustion of diesel fuel. A list of expected plant and associated diesel consumption, provided by Apex, is presented in **Table 2**.

Table 2 Projected Diesel Consumption per Borehole

Plant Type	Diesel Consumption per Borehole (kL)
Drill Rig	1.8
Mobile Equipment	0.4
Air Compressor	2.0
Generator	0.5

3 GREENHOUSE GAS ASSESSMENT

The greenhouse gas assessment has been conducted in accordance with the methodologies established by the various policies and guidelines which are detailed in **Appendix A**. Provision is made in such methodologies for three greenhouse gas emission scopes, which are defined as follows:

- Scope 1 emissions are those which result from activities under a company's control or from sources which they own. (E.g. coal seam gas emissions occurring during coal extraction).
- Scope 2 emissions are those which relate to the generation of purchased electricity consumed in its owned or controlled equipment or operations.
- Scope 3 emissions are defined as those which do not result from the activities of a company although arise from sources not owned or controlled by the company. (E.g. off-site extraction of fuel combusted at the site.)

Project-related greenhouse gas sources include the following

- Venting to atmosphere of coal seam gas (Scope 1).
- Combustion of coal seam gas during flaring operations (Scope 1).
- Diesel combustion during borehole establishment (Scope 1).
- Off-site emissions associated with extraction operations occurring due to on-site diesel use (Scope 3).

Diesel combustion will be used to generate power for the operation of the drill rigs and associated plant during the establishment of the proposed boreholes. As the sourcing of mains electricity will not be a neccessary for the Project, greenhouse gas sources associated with off-site electricity generation (Scope 2) are therefore not included in the assessment.

The Scope 3 emissions associated with the diesel to be consumed during the Project are minor in comparison with the Scope 1 emissions from the onsite diesel combustion. As the only source of such emissions, it is therefore considered that Scope 3 greenhouse gas emissions from the Project will not be a key factor.

As detailed in Section **2.2**, the coal seam gas to be accessed during the Project is expected to comprise primarily of CH_4 (80%) and CO_2 (10%). Consequently, these will be the primary greenhouse gasses associated with this Project.

Other greenhouse gases emitted as a result of project operations may include carbon monoxide (CO), oxides of nitrogen (NO_X) and non-methane volatile organic compounds (NMVOCs). These are produced by incomplete fuel combustion, reactions between air and fuel constituents during fuel combustion, and post-combustion reactions. Fugitive emissions of NMVOCs may also be expected due to fuel evaporation but are considered negligible in this case.

In accordance with the Department of Climate Change *National Greenhouse Accounts (NGA) Factors – February 2008* (DCC, 2008a) (hereafter NGA Factors), the greenhouse gas emissions that are required for measurement from the Project are Direct (Scope 1) emissions relating to on-site diesel combustion and coal seam gas venting and flaring, and Indirect (Scope 3) emissions related to off-site extraction emissions associated with combustion of diesel fuel.

For comparative purposes, non-CO_2 greenhouse gases are awarded a "CO_2-equivalence" based on their contribution to the enhancement of the greenhouse effect. The CO_2-equivalence (CO_2-e) of a gas is calculated using an index called the Global Warming Potential (GWP). The GWPs for a variety of non-CO_2 greenhouse gases are contained within Table 24 of the NGA Factors. The GWP of relevance to this assessment is that for CH_4, which possess a GWP of 21 (i.e. CH_4 is 21 times more effective as a greenhouse gas than CO_2).

The short-lived gases such as CO and NMVOCs vary spatially and it is consequently difficult to quantify their global radiative forcing impacts. For this reason, GWP values are generally not attributed to these gases nor have they been considered further as part of this assessment.

An assessment of the predicted greenhouse gas emissions from project operations has been undertaken for each of the aforementioned sources. Coal seam gas emissions were estimated based on NGA Factors and on gas emission and composition data provided by Apex and OEC.

3.1 Emission Scenarios

Due to uncertainty relating to coal seam gas emissions, particularly regarding variability in potential gas flow rate, percentage of gas flow to be flared and the length of time for venting, greenhouse gas emissions will be calculated for a range of scenarios, defined by:

- Expected maximum, minimum and average gas flow rates (see **Section 2.2**); and
- Flaring rates of 0%, 70% and the expected proportions of 90% and 100% (as per **Section 2.2**).

It is considered that these scenarios will provide a broad indication of greenhouse gas emissions that could be expected from the Project. It is noted that for the purposes of this assessment, testing at each borehole is assumed to occur for a period of one week. Diesel combustion-related greenhouse gas emissions will remain constant for each scenario.

3.2 Coal Seam Gas Emissions

In order to calculate the fugitive emissions associated with the direct venting of coal seam gas to the atmosphere (occurring in 0%, 70% and 90% flaring scenarios), the quoted coal seam gas composition (see **Section 2.2**) and the GWP for CH_4 has been used to determine the associated CO_2-e emissions. Gas density for CH_4 and CO_2 at standard state (25°C, 1 atm) of 0.65 kg/m^3 and 1.8 kg/m^3 respectively were assumed.

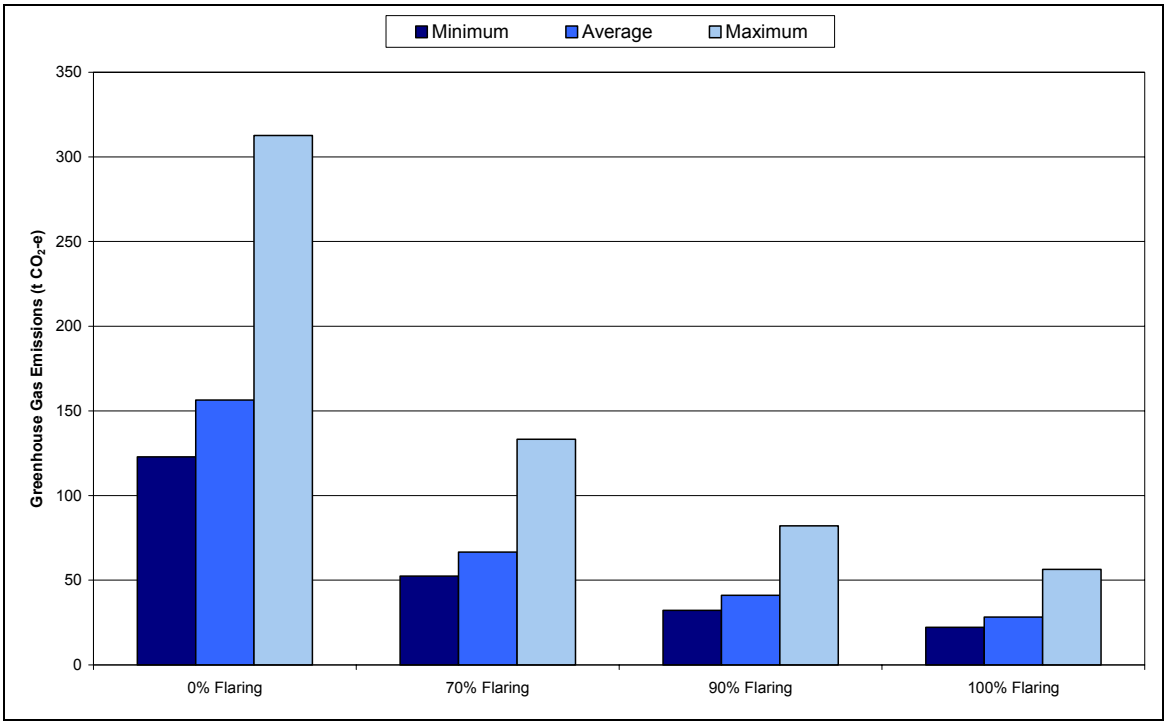
Greenhouse gas emissions associated with the flaring of coal seam gas were estimated using the appropriate within Table 1 of the NGA Factors (DCC, 2008a).

Greenhouse gas emissions associated with coal seam gas borehole monitoring by scenario are presented in **Table 3**. Additionally, a comparison of daily greenhouse gas emissions is presented in **Figure 2**.

Table 3 Daily Greenhouse Gas Emissions – Coal Seam Gas Venting and Flaring per Borehole

Percentage Flaring	Greenhouse Gas Emissions (t CO_2-e / day / Borehole)		
	Minimum (11,000 m^3/day)	Average (14,000 m^3/day)	Maximum (28,000 m^3/day)
0% Flaring	123	156	313
70% Flaring	52	67	133
90% Flaring	32	41	82
100% Flaring	22	28	56

Figure 2 Comparison of Daily Greenhouse Gas Emissions by Percentage Gas Flaring and Gas Flow Rate



It is clear from the data presented in **Table 3** and **Figure 2** that greenhouse gas emissions are drastically reduced as the level of flaring is increased. Total greenhouse gas emissions associated with all coal seam gas boreholes, assuming that each borehole is open for a period of one week, is presented in **Table 4**.

Table 4 Total Greenhouse Gas Emissions – Coal Seam Gas Venting and Flaring (One Week)

Percentage Flaring	Greenhouse Gas Emissions (t CO_2-e)		
	Minimum (11,000 m^3/day)	Average (14,000 m^3/day)	Maximum (28,000 m^3/day)
0% Flaring	15,478	19,699	39,399
70% Flaring	6,599	8,399	16,799
90% Flaring	4,063	5,171	10,341
100% Flaring	2,794	3,556	7,113

It can be seen from the results presented in **Table 4**, that greenhouse gas emissions associated with the proposed boreholes and venting/flaring of coal seam gas for a one week active period across the Project will generate between approximately 2,794 t CO_2-e and 39,399 t CO_2-e depending on the flow rate and percentage of gas flaring implemented. Based on expected average gas flow rate, the Project has the potential to generate total greenhouse gas emissions of between 3,556 t CO_2-e and 19,699 t CO_2-e, assuming that each borehole is operation for a period of one week.

3.3 Diesel Gas Combustion Emissions

As discussed previously, in order to establish each borehole, a range of diesel-fuelled plant will be required. Greenhouse gas emissions associated with Project-related combustion of diesel were estimated using the appropriate emission factors within Table 1 (for Stationary Sources) and Table 3 (for Transport Related Sources) of the NGA Factors (DCC, 2008a). It is noted that in order to account for both Scope 1 and Scope 3 emissions from the combustion of diesel, the emission factors for the Full Fuel Cycle were adopted.

Table 5 presents the calculated greenhouse emissions associated with the combustion of diesel during the establishment of each borehole.

Table 5 Diesel Combustion Greenhouse Gas Emissions

Plant Type	Diesel Consumption per Borehole (kL)	Greenhouse Gas Emissions (t CO_2-e)
Drill Rig	1.8	5.2
Mobile Equipment	0.4	1.2
Air Compressor	2.0	5.8
Generator	0.5	1.4

Based on the results presented in **Table 5**, the establishment of each borehole will generate approximately 13.6 t CO_2-e through the combustion of diesel fuel. On this basis, diesel combustion associated with the establishment of all 18 boreholes will generate approximately 244.4 t CO_2-e.

3.4 Total Greenhouse Gas Emissions

Based on the results of the preceding sections, the total greenhouse gas emissions associated with the establishment of all boreholes and active monitoring of coal seam gas for a one week period have been calculated and presented in **Table 6**. In addition, the calculated greenhouse gas emissions have been compared with the NSW and Australian total greenhouse gas emissions for 2006, as reported by the DCC.

Table 6 Total Greenhouse Gas Emissions by Operational Scenario (One Week)

Key Emission Scenarios	Greenhouse Gas Emissions (t CO_2-e)			Percentage Comparison with 2006 Total Emissions	
	Borehole	Diesel	Total	NSW	Australia
Expected Minimum (11,000 m^3/day, 100% Flaring)	2,794	244	3,039	0.002%	0.0005%
Expected Average Minimum (14,000 m^3/day, 100% Flaring)	3,556	244	3,801	0.002%	0.0007%
Expected Average (14,000 m^3/day, 90% Flaring)	5,171	244	5,415	0.003%	0.0009%
Expected Average Maximum (14,000 m^3/day, 0% Flaring)	19,699	244	19,944	0.012%	0.0035%
Expected Maximum (28,000 m^3/day, 0% Flaring)	39,399	244	39,643	0.025%	0.0069%

Note: NSW 2006 Total Greenhouse Gas Emissions – 160 Mt CO_2-e (DCC, 2008b)
Australia 2006 Total Greenhouse Gas Emissions – 576 Mt CO_2-e (DCC, 2008c)

As can be seen in **Table 6**, the total greenhouse gas emissions expected to generated by the Project, assuming a one week period of active venting/flaring, will vary extensively based on the level of coal seam gas flow and flaring. Based on maximum and minimum levels of gas flow and flaring, the greenhouse gas emissions associated with the Project are will vary between 2,794 t CO_2-e and 39,399 t CO_2-e.

For likely average conditions (gas flow of 14,000 m^3/day; 90% to 100% flaring), the total greenhouse gas emissions have been calculated to range between 3,556 t CO_2-e and 5,171 t CO_2-e, equating to between 0.002% and 0.003% and between 0.0007% and 0.0009% of total NSW and Australian greenhouse gas emissions for 2006 respectively.

4 CONCLUSIONS

Heggies have been engaged by OEC on behalf of Apex to conduct a greenhouse gas assessment of the proposed Illawarra Coal Measures exploration drilling project. The Project involves the establishment of 18 boreholes for the purpose of ongoing gas monitoring, which will assess gas quality, quantity and flow rates. This is essential data for planning future gas energy projects.

Key sources of greenhouse gas emissions from the Project are:

- Venting to atmosphere of coal seam gas;
- Combustion of coal seam gas during flaring operations;
- Diesel combustion during borehole establishment; and
- Off-site emissions associated with extraction operations occurring due to on-site diesel use.

Greenhouse gas emissions from these sources were quantified using the emission factors prescribed within the Department of Climate Change *National Greenhouse Accounts (NGA) Factors – February 2008*.

According to Apex, each borehole is expected to have an average coal seam gas flow rate of 14,000 m^3/day, with flaring of between 90% to 100% of this gas during monitoring to occur. However, due to the variable nature likely to be associated with both the flow of coal seam gas and the level of flaring to be implemented, a broad range of potential operational scenarios exist.

Consequently, a broad range of greenhouse gas emissions likely to be generated by the Project were calculated. Based on the average expected operational conditions (14,000 m^3/day, 90% to 100% flaring), the greenhouse gas emissions likely to be generated by the Project during the establishment and one-week monitoring of all 18 boreholes will range between 3,556 t CO_2-e and 5,171 t CO_2-e. This equates to between 0.002% and 0.003% and between 0.0007% and 0.0009% of total NSW and Australian greenhouse gas emissions for 2006 respectively.

5 GLOSSARY

Apex	Apex Energy NL
CH_4	Methane
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent emissions
CO	Carbon Monoxide
DCC	Department of Climate Change
Heggies	Heggies Pty Ltd
GWP	Global Warming Potential
m^3	Cubic metre
MGA	Map Grid of Australia
NGA	National Greenhouse Accounts
NGA Factors	National Greenhouse Accounts (NGA) Factors – February 2008
NMVOCs	Non-methane volatile organic compounds
NO_X	Oxides of Nitrogen
OEC	Olsen Environmental Consulting Pty Limited

6 REFERENCES

- Department of Climate Change, Australian Government (2008a), *National Greenhouse Accounts (NGA) Factors, January 2008*.
- Department of Climate Change, Australian Government (2008b), *State and Territory Greenhouse Gas Inventories 2006*.
- Department of Climate Change, Australian Government (2008c), *National Greenhouse Gas Inventory 2006 – Accounting for the Kyoto Target*.

1. The Greenhouse Gas Protocol Initiative

The Greenhouse Gas Protocol Initiative (hereafter, "the GHG Protocol") is a multi-stakeholder partnership of businesses, non-governmental organizations (NGOs), governments, and others convened by the World Resources Institute (WRI), a U.S.-based environmental NGO, and the World Business Council for Sustainable Development (WBCSD), a Geneva-based coalition of 170 international companies. Launched in 1998, the Initiative's mission is to develop internationally accepted greenhouse gas (GHG) accounting and reporting standards for business and to promote their broad adoption. (WBCSD, 2005)

The GHG Protocol comprises two separate but linked standards:

- *GHG Protocol Corporate Accounting and Reporting Standard* (this document, which provides a step-by-step guide for companies to use in quantifying and reporting their greenhouse gas emissions).
- *GHG Protocol Project Quantification Standard* (forthcoming; a guide for quantifying reductions from greenhouse gas mitigation projects).

There are three scopes of emissions that are established for greenhouse gas accounting and reporting purposes, defined as follows.

1.1 Scope 1 Emissions – Direct GHG Emissions

The GHG Protocol defines Scope 1 emissions as those which result from activities under the company's control or from sources which they own. They are principally a result of the following activities:

- generation of electricity, heat or steam. These emissions result from the combustion of fuels in stationary sources, e.g. boilers, furnaces or turbines;
- physical or chemical processing. The majority of these emissions result from the manufacture or processing of chemicals and materials e.g. the manufacture of cement, aluminium, adipic acid and ammonia, or waste processing;
- transportation of materials, products, waste, and employees. These emissions result from the combustion of fuels in company owned/controlled mobile combustion sources (e.g., trucks, trains, ships, airplanes, buses, and cars)
- fugitive emissions. These emissions result from intentional or unintentional releases, e.g., equipment leaks from joints, seals, packing, and gaskets; methane emissions from coal mines and venting; hydrofluorocarbon (HFC) emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport.

1.2 Scope 2 Emissions – Electricity indirect GHG Emissions

Scope 2 emissions are those which relate to the generation of purchased electricity consumed in its owned or controlled equipment or operations. For many companies, purchased electricity represents one of the largest sources of GHG emissions and the most significant opportunity to reduce these emissions.

1.3 Scope 3 Emissions – Other indirect GHG Emissions

The GHG protocol states that Scope 3 reporting is optional and covers all other indirect GHG emissions. Scope 3 emissions are defined as those which do not result from the activities of a company although arise from sources not owned or controlled by the company. Examples of

Scope 3 emissions include the extraction and production of purchased materials, transportation of purchased fuels and the use of sold products and services.

In the case of the coal mining industry, Scope 3 emissions may include the transportation of sold coal and the use of this coal, either at home or overseas.

The GHG protocol flags the issue that the reporting of Scope 3 emissions may result in the double counting of emissions. A second problem is that as their reporting is optional, comparisons between countries and / or projects may become difficult. The GHG protocol also states that compliance regimes are more likely to focus on the "point of release" of emissions (direct emissions) and / or indirect emissions from the use of electricity. However, for GHG risk management and voluntary reporting, double counting is less important.

2. National Greenhouse Accounts (NGA) Factors

The National Greenhouse Accounts (NGA) Factors document, issued by the Department of Climate Change (DCC) in January 2008 and revised in February 2008, updates and replaces the the Australian Greenhouse Office (AGO) Factors and Methods Workbook published in December 2006.

The NGA Factors are generally taken from the *Technical Guidelines for the Estimation of Greenhouse Emissions and Energy at Facility Level*, published by the DCC in December 2007. The NGA Factors have bee designed to support reporting under the *National Greenhouse and Energy Reporting Act 2007*, once the first reporting period under the Act commences on 1 July 2008.

The NGA Factors however have a general application to a broader range of greenhouse emissions inventories, and their use is not intended to be restricted to reporting under the Act. Further information on the emission estimation methods employed in the National Greenhouse Accounts is available in the *Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks* series.

NGA Factors are consistent with international guidelines and are to be subject to international expert review each year.

2.1 Direct Emissions

Direct emissions are defined in the NGA Workbook as those which are produced from sources within the boundary of an organisation and as a direct result of that organisation's activities and arise from the following activities:

- generation of energy, heat steam and electricity, including carbon dioxide (CO_2) and the products of incomplete combustion (methane and nitrous oxide);
- manufacturing processes, which produce emissions (for example, cement, aluminium and ammonia production);
- transportation of materials, products, waste and people; for example, use of vehicles owned and operated by the reporting organisation;
- fugitive emissions – intentional or unintentional GHG releases (such as methane emissions from coal mines, natural gas leaks from joints and seals); and
- on-site waste management, such as emissions from company owned and operated landfill sites.

The NGA 2008 document gives several examples of direct emissions; a company with a vehicle fleet would report the GHG emissions from the combustion of petrol or diesel in these vehicles as direct emissions. A mining company would report methane escaping from a coal seam during mining (fugitive emissions) as direct emissions and a cement manufacturer would report carbon dioxide released during cement production as direct emissions.

2.2 Indirect Emissions

Indirect emissions as those which are defined as being generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation. The most important category of indirect emissions is from the consumption of electricity. Other examples of indirect emissions from an organisation's activities include upstream emissions generated in the extraction and production of fossil fuels, downstream emissions from transport of an organisation's product to customers, and emissions from contracted / outsourced activities. The appropriate emissions factor for these activities depends on the parts of the upstream production and downstream use considered in calculating emissions associated with the activity.

For purposes of harmonisation, the NGA emission factors for indirect emissions have been subdivided into Scope 2 and Scope 3 emissions (adopted by the GHG Protocol).

Broadly, the NGA Workbook defines Scope 3 emissions as including:

- disposal of waste generated (e.g. if the waste is transported outside the organisation and disposed of);
- use of products manufactured and sold;
- disposal (end of life) of products sold;
- employee business travel (in vehicles or aircraft not owned or operated by the reporting organisation);
- employees commuting to and from work;
- extraction, production and transport of purchased fuels consumed;
- extraction, production and transport of other purchased good and materials;
- purchase of electricity that is sold to an end user (reported by electricity retailer);
- generation of electricity that is consumed in a transport and distribution system (reported by end user);
- out-sourced activities; and
- transportation of products, materials and waste.

3. Draft Guidelines for Energy and Greenhouse in EIA

The Draft NSW EIA Guidelines were prepared in August 2002 by the NSW Sustainable Energy Development Authority (SEDA) and Planning NSW (now the Department of Planning (DOP)). The guidelines state that they are an advisory document and should principally be applied to projects which require an EIS under Part 4 and Part 5 of the Environmental Planning and Assessment Act 1979 (NSW) but can also be used for the assessment of other projects.

The Draft NSW EIA Guidelines define four scopes of emissions, the first three being adopted along the lines of the GHG Protocol with the fourth relating to emission abatement.

3.1 Scope 1: Direct Energy Use or GHG Emissions

Scope 1 considers energy use and GHG emissions that occur on site or are under a proponent's direct and immediate control. Scope 1 emissions broadly consist of the energy use and GHG emissions produced by the following activities:

- production of electricity, heat or steam;
- combustion of fossil fuels for any other purpose;
- physical or chemical processing on site;
- transportation of materials, products, waste and employees by proponent controlled vehicles;
- fugitive emissions occurring on site;
- on site landfill wastes or wastewater treatment;
- animal husbandry; and
- on site vegetation or soil disturbance.

3.2 Scope 2: Indirect Energy Use or GHG Emissions from Imports and Exports of Electricity, Heat or Steam

Scope 2 broadly focuses on the indirect emissions associated with the generation of purchased and imported electricity, heat or steam.

3.3 Scope 3: Other Indirect Energy Use or GHG Emissions

Scope 3 considers the indirect energy use or GHG emissions that are a consequence of the Project but do not occur on site or those emissions which are removed from the proponent's direct control. Examples of Scope 3 emissions as described in the Draft NSW EIA Guidelines include the following:

- off site waste management (e.g. land filled waste or waste water treatment);
- transportation of products, materials and waste by vehicles not controlled by the proponent;
- employee related business or commuter travel;
- outsourced activities;
- production of imported materials, plant and equipment; and
- use of products or services produced by the Project (and end of life phases of products).

3.4 Scope 4: GHG Emission Abatement from Offset Opportunities

Scope 4 reporting under the Draft NSW EIA Guidelines allows the reporting of any carbon offsets which have occurred as a direct result of the Project. Proponents may report the following if applicable:

- carbon sequestration performed by the proponents;
- community based energy use or emissions reduction initiatives;
- the use of government endorsed Kyoto Protocol flexibility mechanisms such as Clean Development Mechanism (CDM) and Joint Implementation (JI) (refer **Section 3.4.1** below).

3.4.1 Kyoto Protocol Flexibility Mechanisms

Although Australia has not currently ratified the Kyoto Protocol (KP) and is therefore not bound by its commitments, the GHG offset mechanisms contained within the KP can be used as instruments for carbon reduction and can be reported in Scope 4 of the Draft NSW EIA Guidelines. The following mechanisms are relevant for reporting under Scope 4:

- Clean Development Mechanism (CDM) – Developed countries can invest in greenhouse gas emission reduction projects in developing countries;
- Joint Implementation (JI) – Developed countries can invest in greenhouse gas reduction projects in other developed countries.

4. Policy Instruments

4.1 The NSW Greenhouse Plan

Published in November 2005, the NSW Greenhouse Plan is a strategic document which sets out the NSW Government's aims and initiatives in terms of greenhouse gas emissions abatement over the next 20 to 45 years. The NSW Government state that it would like to meet the following criteria:

- a 60% reduction in greenhouse gas emissions by 2050; and
- cutting greenhouse gas emissions to year 2000 levels by 2025.

The NSW Greenhouse Plan does not set out a methodology for reporting greenhouse gas emissions, rather seeks to:

- increase awareness among those expected to be most affected by the impacts of climate change;
- begin to develop adaptation strategies to those unavoidable climate change impacts; and
- put NSW on track to meeting the targets set out above.

5. References

- Commonwealth of Australia (2006), AGO Factors and Methods Workbook, December 2006.
- Department of Climate Change (2008). National Greenhouse Accounts (NGA) Factors, Updating and Replacing the AGO Factors and Methods Workbook, Commonwealth Government of Australia, February 2008.
- NSW Government (2005), NSW Greenhouse Plan.
- Sustainable Energy Development Authority and Planning NSW (2002), Draft NSW Energy and Greenhouse Guidelines for Environmental Impact Assessment.
- World Business Council for Sustainable Development and World Resources Institute (2005), The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard.

APPENDIX VI

(No. of pages excluding this page = 12)

Apex Energy, Illawarra Exploration Drilling and Gas Monitoring Project: Traffic Impact Summary, January 2009

Olsen Consulting Group Pty Limited

Olsen Consulting Group Pty Ltd

REPORT

Traffic Impact Summary

Illawarra Coal Seam Gas Exploration Drilling & Gas Monitoring Program

Apex Energy NL

January 2009

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LIST OF FIGURES

1. INTRODUCTION

Apex Energy NL (Apex) are proposing to undertake a coal seam gas drilling and gas monitoring program in the NSW Southern Coalfield.

Approval or the program is being sought under the provisions of Part 3A of the ***Environmental Planning and Assessment Act* 1979**. The program is fully described in documentation associated with the approval process.

As part of its Government agency and community consultation in preparing the Environmental Assessment for the program, Apex discussed the proposal with a representative from the Roads and Traffic Authority (RTA). The RTA requested that Apex provide some details of the likely vehicle numbers and an assessment of intersections between borehole site access tracks and major public roads. This Traffic Impact Summary provides the information requested by the RTA.

2. PROJECT TRAFFIC

The program consists of up to 18 exploration boreholes being established to enable gas quality and quantity data to be derived through subsequent monitoring. Traffic will be generated as a result of establishing the boreholes, gas monitoring and regular inspections of the boreholes for safety and maintenance purposes.

Borehole Establishment

Access to each site will be required by the vehicle mounted drilling rigs, service vehicles and by small vehicles transporting the operators to and from the site.

The drill rig would access and leave the site only on one occasion. Heavy vehicles would be required to access the site daily for delivery of supplies, removal of excess water and delivery of fresh water. A maximum of 2 heavy vehicles per day would be required for this function.

Small vehicle access would be required to enable the workforce and Apex supervisory personnel to get to and from the site. This is estimated to require up to 5 light vehicles per day.

Borehole establishment would occur over a 4 to 6 week period.

Regular Inspection

Following establishment of the borehole, one small vehicle access per week would be required to ensure the site is maintained and all safety arrangements are operating.

Gas Monitoring

Some of the boreholes would require a weeks concentrated access to undertake gas flow testing. This would require a trailer mounted gas flaring chamber to be delivered for site immediately prior to and following the one week gas monitoring period. During he weeks gas testing, access by up to 5 small vehicles per day would be required.

This level of predicted traffic does not result in major changes to existing traffic flows.

Access to each site will be provided along existing tracks and fire roads and no new intersections or track access points with existing public roads would be established.

3. EXISTING PUBLIC ROAD INTERSECTIONS

The proposed access points for program traffic re-entering public roads were inspected in detail on 14th January 2009. **Table 3.1** provides a summary of that inspection.

Figure 1 shows the location of the various gates through which the re-entry would be made.

Photographs 1 to 30 show help to understand existing conditions at each gate entry.

Table 3.1 identifies that there are 10 access gates that would be used during the program. The Table also lists the boreholes that are accessed through each gate, the public road that is accessed by each gate and summarises comments about traffic conditions around each gate.

Table 3.1 also provides an assessment on safety arrangements required for each gate. Normal and specific safety arrangements are identified.

A normal classification indicates that the gate location can be traversed safely providing standard safety precautions are taken.

A specific classification means that the conditions surrounding the gate are such that specific safety arrangements will need to operate to ensure safe passage through the gate and its surrounds. Gates that have been received a specific classified will be subject to a risk assessment and suitable operating procedures and rules will be developed prior to site access.

Apex will instruct all contractors and employees in the procedures for passing through the gates safely.

4. NORMAL SAFETY ARRANGEMENTS

All proposed access points will be subject to normal safety arrangements. Specific traffic management plans will be developed in consultation with the RTA for each access point to ensure their requirements are met. Normal safety arrangements will include:

- Appropriately placed signs either side of the access point alerting road users to the access point. These may need to be reflective, flashing or appropriately highlighted during night time.
- Employee/Contractor will receive appropriate education and training alerting them to safety issues and responsibilities whilst using the access points.
- There will be no stopping on the public road or parking illegally or dangerously during passage through the access point.
- Vegetation clearing may be required to improve lines of site.

Apex are currently progressing the project through a Risk Assessment process. This process will include traffic and road access matters and may result in further typical and specific safety arrangements.

All access points currently exist and in use. No new access points are required for the project. SCA and private landholders currently use all the access points and Apex will liaise with them to obtain their current access arrangements and to identify problematic access points that may not be obvious.

Table 3.1 - Conditions at Access to Public Roads

Gate ID (Refer Figure 1)	Boreholes Accessed	Road Intersection	Road and Traffic Comments
1	AI10, AI14, AI16 and AI18.I	Appin Road.	Gate located 26m from road edge. Approximately 100m to west speed control changes from 100kph to 80kph. Two lanes from west and single lane from east. Extensive off-road parallel parking available. Site distances at least 170m to west and 180m to east. **Normal safety arrangements required.** Refer photographs 1 to 3.
2	AI17	Princes Highway	Gate located 10m from edge of road. Speed control 100kph. Parallel parking available along road edge. Site distance at least 140m to south and 350m+ to north. **Specific safety arrangements required for heavy vehicles to access this gate.** Refer photographs 4 to 6.
3	AI15	Princes Highway	Gate located 13m from edge of road. Speed control 100kph. Parallel parking available along road edge. Site distance at least 250m to south and 120m to north. **Specific safety arrangements required for heavy vehicles to access this gate**. Refer photographs 7 to 9.
4	AI11, AI12B and AI13.	Princes Highway	Gate located 45m from edge of road. Speed control 100kph. Parallel parking not available along road edge. Site distance at least 130m to south and 180m to north. **Specific safety arrangements required for heavy vehicles to access this gate.** Refer photographs 10 to 12.
5	AI04B, AI07, AI08 and AI09.	Princes Highway	Gate located 18m from edge of road. Speed control 100kph. School Zone restrictions applicable. Deceleration lane available from north. Some parallel parking available. Site distances at least 210m to north and 250m to south. **Normal safety arrangements required**. Refer photographs 13 to 15.
6	AI03	Princes Highway	Gate located 29m from edge of road. Speed control 100kph. Limited parallel parking available to south of gate. Site distances 100m to south and 350m to north. **Specific safety arrangements required for vehicles to access this gate.** Refer photographs 16 to 18.

7	AI01	Princes Highway	Gate located 33m from edge of road. Speed control 100kph. Parallel parking available. Site distances at least 200m to south and 190m to north. **Normal safety arrangements required.** Refer photographs 19 to 21.
8	AI02	Princes Highway	Gate located 25m from edge of road. Speed control 70kph and bending road alignment. No parallel parking available. Site distances at least 80m to south and 130m to north. **Specific safety arrangements required for vehicles to access this gate**. Refer photographs 22 to 24.
9	AI05	Darkes Forest Road	Gate located 25m from road edge. Rural bitumen two lanes wide. Site distances at least 90m to west where a very sharp corner exists and 140m to the east. **Specific safety arrangements required for heavy vehicles to access this gate.** Refer photographs 25 to 27.
10	AI06	Darkes Forest Road	Gate located 17m from road edge. Rural bitumen two lanes wide. Parallel parking available. Site distances at least 250m to west and 90m to the east, where a very sharp corner exists. **Normal safety arrangements required for vehicles to access this gate.** Refer photographs 28 to 30.

5. SPECIFIC TRAFFIC ARRANGEMENTS

Table 3.1 identifies a number of gated access points that require specific traffic arrangements to ensure safe utilisation.

In addition to the normal safety arrangements described in 3.1, these access points will be subject to the additional arrangements and procedures outlined in this section.

Particular attention needs to be placed on drilling rigs and trucks as these have the potential to obstruct the public road if the access point is not negotiated appropriately.

Specific traffic management plans will be developed in consultation with the RTA for each access point to ensure their requirements are met. Specific traffic arrangements will include:

- Appropriately placed signs either side of the access point alerting road users to the access point. These may need to be flashing or highlighted during night time.

- Employee/Contractor will receive appropriate education and training alerting them to safety issues and responsibilities whilst using the access points.

- There will be no stopping on the public road or parking illegally or dangerously during passage through the access point.

- All gates will be unlocked prior to the arrival of a heavy vehicle or truck at the access point. Before arriving at the access point either for access or egress, the heavy vehicle or truck driver will make contact with the gate controller to ensure ready access is available and that the access point can be negotiated without obstructing

traffic flow. The driver will not proceed to the access point until they have received confirmation from the access point controller that it is appropriate to do so.

- In addition to appropriately placed signs, the access point and abutting section of road will be controlled by two “lolly-pop” people who are appropriately trained and competent.

- All personnel on foot outside of vehicles will wear the appropriate personal protective equipment including reflector clothing.

- Vegetation clearing may be required to improve lines of site.

6. CONCLUSIONS

Traffic safety rules and procedures would need to be developed to ensure public and employee safety during all operational stages of the program.

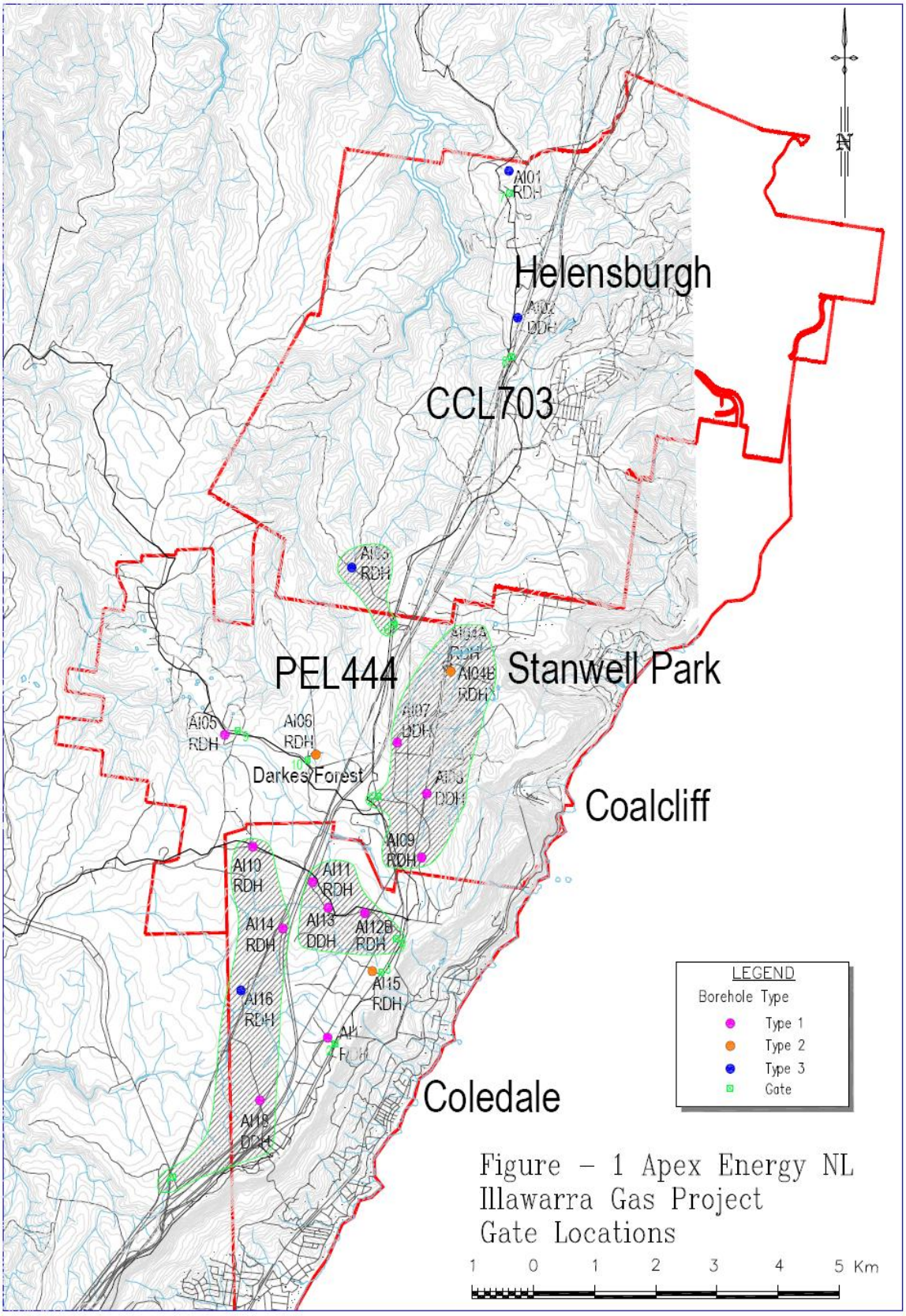


Figure 1 – Borehole Locations for Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Program

Photographs for Table 3.1

Photograph 1: Gate 1

Photograph 2: Gate 1 - Site Distance to West

Photograph 7: Gate 3

Photograph 8: Gate 3 - Site Distance to South

Photograph 9: Gate 3 - Site Distance to North

Photograph 10: Gate 4

Photograph 11: Gate 4 - Site Distance to North

Photograph 12: Gate 4 - Site Distance to South

Photograph 13: Gate 5

Photograph 14: Gate 5 - Site Distance to South

Photograph 15: Gate 5 - Site Distance to North

Photograph 16: Gate 6

Photograph 17: Gate 6 - Site Distance to North

Photograph 18: Gate 6 - Site Distance to South

Photograph 19: Gate 7

Photograph 20: Gate 7 - Site Distance to North.

Photograph 21: Gate 7 - Site Distance to South

Photograph 22: Gate 8

Photograph 23: Gate 8 - Site Distance to South

Photograph 24: Gate 8 - Site Distance to North

Photograph 25: Gate 9

Photograph 26: Gate 9 - Site Distance to West

Photograph 27: Gate 9 - Site Distance to East

Photograph 28: Gate 10

Photograph 29: Gate 10 - Site Distance to East

Photograph 30: Gate 10 - Site Distance to West

APPENDIX VII

(No. of pages excluding this page = 10)

Director General's Requirements

NSW GOVERNMENT
Department of Planning

Mining & Extractive Industries
Major Development Assessment
Phone: (02) 9228 6495
Fax: (02) 9228 6466
Email: rebecca.ward@planning.nsw.gov.au
Level 4 Western Gallery
23-33 Bridge Street
GPO Box 39
SYDNEY NSW 2001

John Carmody
Chief Executive Officer
Apex Energy
Suite 14/44 Bridge Street
SYDNEY NSW 2000

Our ref: 9042505

Dear Mr Carmody

Director-General's Requirements
Apex Energy Exploration Drilling Project
Project Application No: 07_0103

The Department has received your application for the Apex Energy Illawarra Coal Seam Gas Exploration Drilling Project in the Wollongong local government area.

I have attached a copy of the Director-General's requirements (DGRs) for the project. These requirements have been prepared in consultation with the relevant Government authorities, and are based on the information you have provided to date. I have also attached a copy of the Government authorities' comments for your information.

Please note that under section 75F(3) of the *Environmental Planning and Assessment Act 1979*, the Director-General may alter these requirements at any time.

If your proposal is likely to have a significant impact on matters of National Environmental Significance, it will require an additional approval under the Commonwealth *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act). This approval is in addition to any approvals required under NSW legislation. It is your responsibility to contact the Department of Environment and Water Resources in Canberra (6274 1111 or http://www.environment.gov.au) to determine if the proposal is likely to have a significant impact on matters of National Environmental Significance, and would require an approval under the EPBC Act. The Commonwealth Government has accredited the NSW environmental assessment process for assessing any impacts on matters of National Environmental Significance. As a result, if it is determined that an approval is required under the EPBC Act, please contact me immediately as supplementary Director-General's requirements will need to be issued.

I would appreciate it if you would contact the Department at least two weeks before you propose to submit your Environmental Assessment for the project to determine:

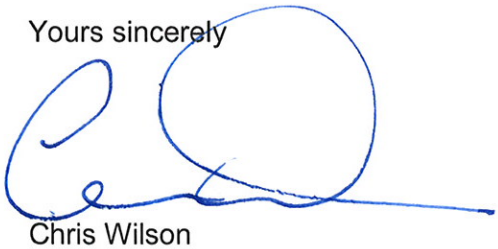
- whether the proposal requires an assessment under the EPBC Act and any assessment obligations under that Act;
- the consultation and public exhibition arrangements that will apply; and
- the number of copies (hard-copy or CD-ROM) of the Environmental Assessment that will be required for exhibition purposes.

As you may know, the Department will review the Environmental Assessment in consultation with the relevant authorities to determine if it adequately addresses the Director-General's requirements. If the Director-General considers the Environmental Assessment to be inadequate, you will be required to revise it prior to public exhibition.

The Director-General's requirements will be placed on the Department's website along with other relevant information which becomes available during the assessment of the project. As a result, I would appreciate it if the documents submitted to the Department are in a suitable format for the web, and if you would arrange for an electronic version of the Environmental Assessment for the project to be hosted on a suitable website with a link to the Department's website.

If you have any enquiries about these requirements, please contact Rebecca Ward of the Department's Mining & Extractive Industries team (02 9228 6495).

Yours sincerely



18.9.07

Chris Wilson
Executive Director
Major Project Assessments
As delegate for the Director-General

Director-General's Requirements

Section 75F of the *Environmental Planning and Assessment Act 1979*

Application number	07_0103
Project	Drilling of approximately 20 exploratory wells to test "goaf gas" from abandoned mine workings and to determine the gas potential in un-mined coal seams in the Illawarra region
Location	Within Petroleum Exploration Licences 442 and 444 and Metropolitan Collieries' Consolidated Coal Lease 703 in the Illawarra region
Proponent	Apex Energy NL
Date of Issue	18 September 2007
Date of Expiration	18 September 2009
General Requirements	The Environmental Assessment must include • an executive summary; • a detailed description of the project including the: - need for the project; - alternatives considered; - various components and stages of the project; and - the likely inter-relationship between the proposed works and the existing or approved mining operations in the region; • consideration of any relevant statutory provisions; • a general overview of the environmental impacts of the project, identifying the key issues for further assessment, and taking into consideration the issues raised during consultation; • a detailed assessment of the key issues specified below, and any other significant issues identified in the general overview of environmental impacts of the project (see above), which includes: - a description of the existing environment; - an assessment of the potential impacts of the project; - a description of the measures that would be implemented to avoid, minimise, mitigate, offset, manage and/or monitor the impacts of the project, and how the environmental monitoring and management programs/plans will be reported; • a Statement of Commitments, outlining environmental management, mitigation and monitoring measures; • a conclusion justifying the project, taking into consideration the environmental impacts of the project, the suitability of the sites, and the benefits of the project; and • a signed statement from the author of the Environmental Assessment certifying that the information contained in the report is neither false nor misleading.
Key Issues	• **Soil and Water** - particularly sediment and surface water control during and following construction, soil disturbance and compaction, and groundwater quantity and quality; • **Flora and Fauna** – including impacts on native vegetation through clearing and disturbance, and the requirement for offsetting; • **Noise and Vibration;** • **Greenhouse Gases;** • **Aboriginal Heritage;** and • **Rehabilitation.**
References	The Environmental Assessment must take into account relevant State Government technical and policy guidelines. While not exhaustive, guidelines which may be relevant to the project are included in the attached list.
Consultation	During the preparation of the Environmental Assessment, you should consult with the relevant local, State or Commonwealth government authorities, service

	providers, community groups or affected landowners. The consultation process and the issues raised must be described in the Environmental Assessment. In particular you should consult with: • Department of Environment and Climate Change; • Department of Primary Industries; • Department of Water and Energy; and • Wollongong City Council. The consultation process and the issues raised must be described in the Environmental Assessment.
Deemed refusal period	60 days

State and Commonwealth Government Technical and Policy Guidelines - For Reference

Aspect	Policy / Methodology
Soil and Waters	
Erosion & Sediment Control	Managing Urban Stormwater: Soils & Construction (Landcom)
Groundwater	NSW State Groundwater Policy Framework Document (DLWC)
	NSW State Groundwater Quality Protection Policy (DLWC)
	NSW State Groundwater Quantity Management Policy (DLWC) Draft
Water Quality	Approved Methods for the Sampling and Analysis of Water Pollutants in NSW (DEC)
	Using the ANZECC Guideline and Water Quality Objectives in NSW (DEC)
Flora and Fauna	
	Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities. Working Draft (DEC)
	Draft Guidelines for Threatened Species Assessment under Part 3A of the *Environmental Planning and Assessment Act 1979* (DEC)
	Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 - Guide to implementation in NSW (DoP)
Noise and Vibration	
	NSW Industrial Noise Policy (DECC)
	Environmental Noise Control Manual (DECC)
Greenhouse Gas	
	AGO Factors and Methods Workbook (AGO)
Heritage	
Aboriginal	Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC)
	Aboriginal Cultural Heritage Standards and Guidelines Kit (NSW EPA)

22-8-07.

Our reference : FIL07/13227:DOC07/31470:KH
Contact : Kate Hopkins, (02) 4224 4100

Department of Planning
(Attention: Rebecca Ward)
GPO Box 39
SYDNEY NSW 2001

Dear Madam

ENVIRONMENTAL ASSESSMENT REQUIREMENTS
APEX ENERGY NL ILLAWARRA COAL SEAM GAS EXPLORATION DRILLING

We refer to your request for the Department of Environment and Climate Change (DECC) to identify key requirements for the Environmental Assessment (EA) in regards to the above proposal for the development of information to seek a Project Approval.

Based on the presented information, there are a number of environmental issues that warrant close investigation as part of the EA process. These have been identified in Attachment A. However, the following are considered some of the key environmental issues based on the limited information presented on the project at this point of time and relate only to coal seam gas exploration proposed in various parts of the greater Metropolitan area:

- Water quantity and quality
- Threatened species
- Aboriginal cultural heritage

Based on advice from the Department of Planning, DECC understand that there will be no coal seam gas exploration and associated boreholes located on DECC estate.

Should you require any further information please contact the officer listed above.

Yours sincerely

William Dove 22/08/2007

WILLIAM DOVE
Acting Manager Illawarra
Climate Change and Environment Protection Group

Att: A and B

(N:\EPRD\KH\2007\ PART 3A\APEX EA'S\.DOC)

The Department of Environment and Conservation NSW is now known as the Department of Environment and Climate Change NSW

PO Box 513, Wollongong NSW 2520
Level 3, 84 Crown Street, Wollongong NSW
Tel: (02) 4224 4100 Fax: (02) 4224 4110
ABN 30 841 387 271
www.environment.nsw.gov.au

Department of Environment and Conservation

Attachment A

The following are Department of Environment and Climate Change's (DECC) key environmental requirements to be addressed in the development of an Environmental Assessment (EA) for the proposed development.

Environmental Impacts of the Project

1. The following environmental impacts of the project need to be assessed, quantified and reported on:
   - Water quantity and quality
   - Threatened species
   - Aboriginal cultural heritage
   - Greenhouse gas emissions
   - Noise and vibration
   - Air quality
   - Waste

2. These should be assessed in accordance with the relevant guidelines listed in Attachment B.

3. Details are required on the location of the proposed development including the affected environment to place the proposal in its local and regional environmental context including surrounding landuses, planning zonings, potential sensitive receptors, surface and sub-surface area/ features of conservation significance and environmental sensitivity. These should include areas containing natural and cultural heritage values.

4. Describe mitigation and management options that will be used to prevent, control, abate or mitigate identified environmental impacts associated with the project and to reduce risks to human health and prevent the degradation of the environment. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

5. The EA should determine if any potential impacts may occur directly or indirectly on DECC Estate.

Impacts on Water Quantity and Quality

The goal of the project should ensure:

- there is no pollution of waters (including surface and groundwater)
- polluted water (including process waters, wash down waters, polluted stormwater or sewage) is captured on the site and directed to reticulated sewer where available or else collected, treated and beneficially reused, where this is safe and practicable to do so
- there is consistency with any relevant Statement of Joint Intent established by the Healthy Rivers Commission
- it contributes to the protection or achievement over time of River Flow Objectives and Water Quality Objectives.

An assessment needs to be provided in the EA demonstrating how the above objectives will be achieved. The proponent should confirm in the EA, the catchment that the development occurs in to determine the requirements that should apply. The EA should clearly identify any sensitive areas nearby and provide details on any potential impact this proposal may have on these areas including any associated mitigation measures. Consultation with the Sydney Catchment Authority is also suggested and should be documented in the EA. The EA should also address erosion and sediment controls applicable to construction of the site.

DECC considers that an assessment should be undertaken to assess whether there are any potential environmental impacts associated with subsidence due to gas extraction and any potential groundwater contamination. For your information, DECC has recently been involved in

en investigation where surface water pollution was possibly a result of gas extraction activities in the Menangle area. While investigations are continuing, the matter has raised the issue on whether gas extraction activities do impact upon groundwaters and thereby cause groundwater and surface water pollution.

In addition, DECC has identified overseas examples, such as in the Netherlands, where subsidence has occurred as a result of gas extraction activities. In these examples, subsidence has caused impacts on the environment by altering local streams by changing slopes and altering flow velocities and surface patterns.

Subsidence may also impact groundwater resources by fracturing aquifers and interacting with surface water by providing alternative pathways for groundwater accession or discharges. In particular, water-dependant ecosystems can potentially be seriously impacted as a result of subsidence and groundwater contamination.

The EA should include an assessment of the potential for subsidence and groundwater contamination as a result of the proposal including the identification of any mitigation measures to address any such impacts.

Hanging swamps of regional significance occur in the Illawarra Escarpment area. Hanging swamps are extremely sensitive ecosystems which are dependant on a particular hydrology. The EA needs to identify any boreholes which are proposed in this area and address any potential impacts on these sensitive areas due to borehole location and changes in hydrology.

Impacts of the Project on Threatened Species and their Habitat
A field survey of the site should be conducted and documented in accordance with the draft 'Guideline for Threatened Species Assessment'.

Likely impacts on threatened species and their habitat need to be assessed, evaluated and reported on. The assessment should specifically report on the considerations listed in Step 3 of the draft guideline. The EA should include consideration of impacts due to changes in hydrology and introduction of weeds to the site.

The EA must describe the actions that will be taken to avoid or mitigate impacts or compensate to *prevent unavoidable impacts of the project, including the placement of the boreholes and access* roads on threatened species and their habitat. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

The EA needs to clearly state whether it meets each of the key thresholds set out in Step 5 of the draft guideline.

The project proposes to access old mine workings. Old mines have previously been known to form habitat for numerous bat species including threatened bats. The EA should carefully consider this as threatened bat species have been identified in past mine workings at the Elouera Mine site. Many threatened species and endangered ecological communities occur near the borehole sites and should also be taken into consideration.

Impacts of the Project on Aboriginal Cultural Heritage Values
The EA should address and document the information requirements set out in the draft "*Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation*" involving surveys and consultation with the Aboriginal community.

Identify the nature and extent of impacts on Aboriginal cultural heritage values across the project area.

Describe the actions that will be taken to avoid or mitigate impacts or compensate to prevent unavoidable impacts of the project on Aboriginal cultural heritage values. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.

The EA needs to clearly demonstrate that effective community consultation with Aboriginal communities has been undertaken in determining and assessing impacts, developing options and making final recommendations.

Greenhouse Gas Emissions

The *NSW Greenhouse Plan* (2005) commits the NSW Government to pursuing greenhouse gas emission reductions in NSW. The greenhouse impacts of new development is therefore a key consideration in the development of an EA.

It is unclear in the preliminary information provided how much if any gas will be allowed to escape during the exploration process. The EA should address this issue including measures to minimise the release of greenhouse gases into the atmosphere. Emissions should be estimated using an appropriate methodology, in accordance with the Department of Planning's Draft "*Guidelines: Energy and Greenhouse in EIA*" (2002) and the Australian Greenhouse Office's "*Factors and Methods Workbook*" (2006).

Impacts of Noise and Vibration

The development should be designed in accordance with the NSW Government's *Industrial Noise Policy* with the identification and assessment of all potential noise sources associated with the development. This assessment should include but is not limited to: the location of sensitive receptors; assessment of the background noise; project specific noise limits; the potential impact of any transport noise and the proposed hours of operation.

Impacts on Air Quality

The environmental outcome for the project in relation to air quality is to ensure sensitive receptors are protected from any adverse impacts from dust and odour. Dust is the primary concern with potential emissions including, but not necessarily limited to, construction of drill pads, water storage ponds and access roads as well as vehicular movements. In addition, the development should ensure:

- emissions should not cause adverse impact upon human health or the environment, and there must be no offensive odour beyond the boundary of the premises
- National Environment Protection Measures (NEPM) ambient air quality goals should not be compromised
- visible dust emissions from material handling, storage, processing, haul roads, transport and material transfer systems are minimised and
- vehicular kilometres travelled are minimised.

Waste

The goal of the development should ensure:

- it is in accordance with the principles of the waste hierarchy and cleaner production;
- the handling, processing and storage of all materials used at the premises does not have negative environmental or amenity impacts
- the beneficial reuse of all wastes generated at the premises are maximised where it is safe and practical to do so; and
- no waste disposal occurs on site except in accordance with an EPA licence.

ATTACHMENT B

Guidance Material

Water Quality

- National Water Quality Management Strategy: Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000)
- NWQMS Australian Guidelines for Water Quality Monitoring and Reporting (ANZECC 2000)
- NSW Government Interim Water Quality and River Flow Environmental Objectives See http://www.environment.nsw.gov.au/ieo/
- State Environmental Planning Policy No 58 - Protecting Sydney's Water Supply and other relevant Government policies
- Sustaining the Catchment Regional Plan, REP
- The relevant targets within the State Water Management Outcomes Plan
- EPA technical guidelines *'Bunding and Spill Management'*.

Wastewater

- National Water Quality Management Strategy: Guidelines for Sewerage Systems - Effluent Management (ARMCANZ/ANZECC 1997)
- National Water Quality Management Strategy: Guidelines for Sewerage Systems – Use of Reclaimed Water (ARMCANZ/ANZECC 2000)
- Environmental Guidelines for the ~~Utilisation~~ of Treated Effluent by Irrigation (NSW DEC 2004)
- Environment and Health Protection Guidelines: 'Onsite Sewage Management for Single Households', February 1998 (Silver Book).

Stormwater

(Note: some of these documents will be revised in 2006)

- Managing Urban Stormwater: Soils and Construction (NSW Landcom, 2004)
- Managing Urban Stormwater: Source Control (EPA 1998)
- Managing Urban Stormwater: Treatment Techniques (EPA 1998).

Groundwater

- State Groundwater Policy Framework Document (DLWC 1997)
- The NSW State Groundwater Quality Protection Policy (DLWC 1998)
- (Draft) NSW State Groundwater Quantity Management Policy
- NSW State Groundwater Dependent Ecosystems Policy (DLWC, 2002)
- National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (ARMCANZ & ANZECC, 1995).

Threatened Species

- Draft Guidelines for Threatened Species Assessment July 2005
- Draft Threatened Species Survey and Assessment Guidelines for Developments and Activities (DEC 2004)

Information on these guidelines can be obtained found on the DECC website.

Aboriginal Cultural Heritage

- Draft Guidelines For Aboriginal Cultural Heritage Impact Assessment and Community Consultation - Available from Dept of Planning.
- Aboriginal Cultural Heritage Standards and Guidelines Kit http://www.nationalparks.nsw.gov.au/PDFs/aboriginal_heritage_guidelines_kit_final.pdf
- Interim Community Consultation Requirements for Applicants http://www3.environment.nsw.gov.au/npws.nsf/Content/Protecting+Aboriginal+objects+and+places

Greenhouse Gas Emissions

- ~~Guidelines for Energy and Greenhouse in EIA, NSW Department of Planning (2002)~~
- *Factors and Methods Workbook* Australian Greenhouse Office (2006).

Noise and Vibration

- NSW Industrial Noise Policy (EPA, 1999)
- NSW Environmental Criteria for Road Traffic Noise (EPA, 1999)
- Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC 1990)
- Environmental Noise Control Manual, (EPA, 1994)
  - Section 171 Construction Noise Guideline
  - Section 19.3 Sleep Arousal Criteria
- Assessing Vibration: A Technical Guideline (DEC, 2006)

Air Quality

- Legislative requirements under the Protection of the Environment Operations Act 1997 and its associated Regulation
- Approved Methods ~~and Guidance~~ for the Modelling and Assessment of Air Pollutants in New South Wales (August 2001)
- Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (July 2001).

Waste

- Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes.

Rebecca Ward - Proposed Apex Energy Exploratory Drilling Program (Project Application - P 07_0103)

From: <judith.egan@dpi.nsw.gov.au>
To: <rebecca.ward@planning.nsw.gov.au>
Date: 11/09/2007 12:26
Subject: Proposed Apex Energy Exploratory Drilling Program (Project Application - P 07_0103)

Rebecca

Below are the DPI environmental requirements for the Apex EA:

- Detailed information of sealing of wells,
- Proposed rehabilitation outcomes,
- Characterisation and identification of impacts on groundwater,
- Greenhouse gas mitigation options.

Additional matters:

- Safety management given the interactions with an operational mine,
- Title issues given the interaction with the coal mine leases.

Regards

Judith Egan
Team Leader, Environment
Environmental Sustainability Branch
Southern Region (Wollongong)
Department of Primary Industries

Phone: 02 4222 8310
Mobile: 0429 082 258

This message is intended for the addressee named and may contain confidential information. If you a

APPENDIX VIII

(No. of pages excluding this page = 4)

Major Project Application

Major Project application

NSW GOVERNMENT
Department of Planning

Date received: ____/____/____ Project Application No. _____

1. Before you lodge

This form is required to apply for the approval of the Minister to carry out a project to which Part 3A of the *Environmental Planning and Assessment Act 1979* (the Act) applies.

Before lodging this application, it is recommended that you first consult with the Department of Planning (the Department) concerning your project.

A Planning Focus Meeting (PFM) may need to be held for this project involving the Department, relevant agencies, council or other groups identified by the Department. If a PFM is held, the Department will issue the Director-General's requirements for the Environmental Assessment following the meeting.

All applications must be lodged with the Director-General, by courier or mail. An electronic copy should also be emailed to the assessment contact officer assigned to the project.

NSW Department of Planning
Ground floor, 23-33 Bridge Street, Sydney NSW 2000
GPO Box 39 Sydney NSW 2001
DX 10181 Sydney Stock Exchange
Phone 1300 305 695

2. Details of the proponent

Company/organisation/agency: Apex Energy

ABN: 40 097 997 914

☒ Mr ☐ Ms ☐ Mrs ☐ Dr ☐ Other

First name: John

Family name: Carmody

Position: Chief Executive Officer

STREET ADDRESS

Unit/street no.: Suite 14/44

Street name: Bridge Street

Suburb or town: SYDNEY

State: NSW

Postcode: 2000

POSTAL ADDRESS (or mark 'as above')

as above

Suburb or town:

State:

Postcode:

Daytime telephone: 02 9251 0410

Fax: 02 9251 0082

Mobile: 0417 274 212

Email: jcarmody@apexenergy.com.au

3. Identify the land you propose to develop

STREET ADDRESS (where relevant)

Unit/street no. | Street or property name

Suburb, town or locality | Postcode

Local government area(s) | State electorate(s)

REAL PROPERTY DESCRIPTION

Note: The real property description is found on a map of the land or on the title documents for the land. If you are unsure of the real property description, you should contact the Department of Lands.

Please ensure that you place a slash (/) to distinguish between the lot, section, DP and strata numbers. If the project applies to more than one piece of land, please use a comma to distinguish between each real property description.

OR detailed description of land attached. ☑

MAP: A map of the site and locality should also be submitted with this application.

4. Major Project description and other requirements

Provide a brief title for your project.

Illawarra Coal Seam Gas Exploration Drilling Programme

PROJECT APPROVAL

If you are applying for approval of a project, include in the project title, all significant components for which approval is being sought. If the application relates to part only of a project, the project title should reflect this.

Is the application for approval of a project? ☑ Yes ☐ No

Is the application related to part only of a project? ☐ Yes ☑ No

CONCEPT PLAN APPROVAL

If you are applying for approval of a concept plan, include in the project title, all components for which approval 'in concept' is being sought. If the application also relates to approval of a project, a description of this should also be included in the project title.

Is the application for approval of a Concept Plan? ☐ Yes ☑ No

Is a project application being made concurrently for all or part of the project? ☐ Yes ☑ No

You are also required to provide a Project Description and address any matters required by the Director-General in accordance with section 75E or section 75M of the Act. Failure to do so may lead to your application being rejected.

Is a Project Description attached? ☑ Yes ☐ No

Does the Project Description include any additional matters required by the Director-General under section 75E or section 75M of the Act? ☑ Yes ☐ No

Note: An electronic copy of the project description is also required as all applications must be provided on the Department's website. You should contact the Department on the correct electronic format.

ESTIMATED CAPITAL INVESTMENT VALUE

Please indicate the estimated capital investment value (CIV) of the project. The CIV includes all costs necessary to establish and operate the project, including the design and construction of buildings, structures, associated infrastructure and fixed or mobile plant and equipment (but excluding GST and land costs).

$ 7.445 Million

EQUIVALENT FULL-TIME JOBS

Please indicate the number of jobs created by the project. This should be expressed as a proportion of full time jobs over a full year.

Construction jobs (full-time equivalent)	Nil
Operational jobs (full-time equivalent)	8

5. Approvals from State agencies

Does the project require any of the following: (tick all that are appropriate)

- ☐ an aquaculture permit under section 144 of the *Fisheries Management Act 1994*
- ☐ an approval under section 15 of the *Mine Subsidence Compensation Act 1961*
- ☐ a mining lease under the *Mining Act 1992*
- ☐ a production lease under the *Petroleum (Onshore) Act 1991*
- ☐ an environment protection licence under Chapter 3 of the *Protection of the Environment Operations Act 1997* (for any of the purposes referred to in section 43 of that Act)
- ☐ a consent under section 138 of the *Roads Act 1993*
- ☐ a licence under the *Pipelines Act 1967*

6. Landowner's consent or notification

As the owner(s) of the above property, I/we consent to this application being made on our behalf by the proponent:

Land	Land
Not required	
Signature	Signature
Name	Name
Date	Date

Note: Under clause 8F of the *Environmental Planning and Assessment Regulation 2000* (the Regulation), certain applications for approval under Part 3A of the Act do not require the consent of the landowner, however, the proponent is required to give notice of the application:

- in the case of linear infrastructure projects, by notice in a newspaper circulating in the locality prior to the commencement of the public consultation period,
- in the case of mining or petroleum production projects, by notice in a newspaper circulating in the locality within 14 days of this application being made,
- in the case of critical infrastructure projects, to the owner of the land within 14 days of this application being made, and
- in other cases, to the owner of the land at any time before the application is made.

7. Proponent's signature

As the proponent(s) of the project and in signing below, I/we hereby:

- provide a description of the project and address all matters required by the Director-General pursuant to section 75E and/or section 75M of the Act, and
- apply, subject to satisfying clause 8D of the Environmental Planning and Assessment Regulation, for the Director-General's environmental assessment requirements pursuant to Part 3A of the Act, and
- declare that all information contained within this application is accurate at the time of signing.

Signature

John G. Carmody

Name

John Carmody

Date

23.7.07

In what capacity are you signing if you are not the proponent

Chief Executive Officer

Name, if you are not the proponent