Olsen Consulting Group Pty Ltd

REPORT

ENVIRONMENTAL ASSESSMENT

Illawarra Coal Seam Gas Exploration Drilling
&
Gas Monitoring Program

APEX Energy NL

March 2009

INFORMATION STATEMENT

David Olsen, Director of Olsen Environmental Consulting Pty Limited and contractor for Olsen Consulting Group Pty Ltd, prepared this Environmental Assessment. David holds a Bachelors Degree in Agricultural Science with Honours.

This Environmental Assessment is based on information provided by Apex Energy NL and various reports prepared by specialist consultants. Olsen Consulting Group Pty Ltd has relied on this information in preparing this Environmental Assessment.

CERTIFICATION

I certify that I have prepared this Environmental Assessment for the Apex Energy NL, Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Program, and to the best of my knowledge, it is true in all material particulars and does not, by its presentation or omission of information, materially mislead.

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1 EXECUTIVE SUMMARY AND CONCLUSION

This document is an Environmental Assessment of the Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Program to be undertaken by Apex Energy NL (Apex). It has been prepared to meet the requirements of Part 3A of the ***Environmental Planning and Assessment Act,*** **1979**.

The EA is set out in a logical format as described in the following paragraphs.

Section 2 introduces the main aspects of the Program, which will be located at various sites throughout the Mining Tenements Petroleum Exploration Licence No. 442 (PEL 442) and Petroleum Exploration Licence No. 444 (PEL 444). The locations of these Mining Tenements is shown on **Figure 2.1**.

Within the above tenements, the Program will determine gas potential in all seams of the Illawarra Coal Measures, as well as goaf gas that has collected in abandoned Bulli Seam workings.

Determination of gas potential will require ongoing measurement of gas quality and quantity from some of the boreholes.

Defining the gas reserves will enable planning of developments to use the resource, such as greenhouse friendly, peak/intermediate combined cycle gas turbine (CCGT) power stations and liquid natural gas (LNG) pipelines for export. These gas sources have environmental benefits over traditional energy sources and would provide medium to long-term benefits to the community.

Section 3 describes the Program and its justification. The Program will improve the understanding of available methane resources in the district. This will enable Apex to plan and assess the viability of future power generation projects or reticulation for industrial and household use.

The Program involves a typical drilling operation commonly used in coal exploration and ventilation of underground mines throughout the State. Drilling activity will be followed by a period in which borehole gas flows will be measured. Measuring gas flows will involve venting and flaring depending on gas volumes.

It is planned that approximately 15 boreholes will be drilled from the surface down to various levels within and to the base of the Illawarra Coal Measures. Apex intended to drill approximately 18 boreholes and the investigative reports included in **Appendices I** to **VI** reflect that original intention. Subsequent considerations have reduced the number of boreholes to the 15 referred to in the following sections of this Environmental Assessment. The boreholes referenced in the investigative reports, but not included in this Environmental Assessment, are AI01, AI02 and AI03. The boreholes referenced in this report which are subject to this application are AI04B, AI05, AI06, AI07, AI08, AI09, AI10, AI11, AI12B, AI13, AI14, AI15, AI16, AI17 and AI18.

Some of the boreholes will provide access to old mine workings and these will enable determination of goaf gas quantities and quality. The remaining boreholes will intersect coal and will enable in situ coal gas quantities and quality to be defined. All boreholes will enable gas extraction rates to be measured. Boreholes that intersect coal will enable a series of horizontal radial boreholes to be drilled parallel to the Measures from the vertical borehole. This drilling would be undertaken at some time in the future and is not part of the current

Project Application. Additional approval would be sought at that time. The number of horizontal radial boreholes drilled will depend on the measurable gas reserves.
Access to the drilling sites will be via existing tracks. Apex has selected the proposed borehole sites to minimise surface disturbance and to facilitate environmental management of the drilling and gas measuring activities. Many of the sites have been selectively located on previously disturbed areas such as quarries, access tracks and power line easements. Where a previously disturbed area was not available, undisturbed sites were selected to minimise the disturbance of significant surface features. These are all located adjacent to existing tracks.

Should this proposed exploration program identify potential gas reserves Apex intend to seek additional approval to develop the reserve. Some of the boreholes currently proposed would be developed into gas production wells. Any future development of the gas reserves would require a pipe-based gas collection system. Apex has not identified any obvious environmental constraints that would preclude any of the currently proposed boreholes and gas collection system routes from this future development. Any future development would be subject of another approval application and does not form part of this Project Application.

Exploration data collection requires boreholes to be located at specific sites to ensure that they intersect the required strata and/or remnant underground mining feature. However, there is sufficient flexibility to move the proposed sites in order to avoid significant surface features. Apex has undertaken detailed surface inspections together with specialist flora and fauna, archaeology, and water consultants in order to select appropriate borehole and ongoing gas monitoring sites. The nominated sites can be relocated should other significant surface features be identified prior to commencing borehole drilling.

Various individuals and Government organisations own the land on which the drilling and subsequent gas flow monitoring will take place. Apex will negotiate access arrangements with all landowners.

Up to 6 people will be on site during drilling operations and it will take approximately 4 to 6 weeks to drill each borehole. Once built, the facility should generally be self-operating and will require approximately one inspection per week for monitoring and maintenance purposes. The time required for gas flow monitoring is dependent on the levels of gas flow experienced. It is anticipated that gas flow monitoring will be conducted over a 1 week period for each borehole tested.

Section 3 also details the Environmental Planning background for the Program. The Program is being assessed by the Minister for Planning under Part 3A of the ***Environmental Planning and Assessment Act* 1979**.

All drilling is located in the Wollongong City Local Government Area (LGA). Wollongong Local Environmental Plan 1990 (LEP) controls development in the LGA and zones the land in accordance with development guidelines. The land on which drilling and monitoring is proposed is zoned 7a Environmental Protection Conservation, 7b Environmental Protection Special and 7d Environmental Protection Hacking River. The proposed Program is permissible on the land pursuant to the LEP.

Section 3 also outlines the approvals required from other government agencies. Mining tenements for the drilling and gas monitoring have been obtained from the Department of Primary Industries Mineral Resources in accordance with provisions of the ***Mining Act* 1992**. This Section also outlines the responses to the Program of various relevant groups, including government agencies and the community. The general response has been one of conditional support. Consultation with the community is ongoing.

Section 4 details the environmental impact assessment of the Program. The various issues addressed in this Section are summarised in the following paragraphs.

Dust

Any dust generated during the drilling and the gas monitoring phases of the program will be insignificant.

Surface Water Quality

Sediment controls built in accordance with the Landcom publication, ***"Soils and Construction" Volume 1, 4th Edition, March 2004***. will be implemented to control surface water quality. A Site Water Management Plan will be developed and implemented.

Soils

Topsoils will be stored for use in rehabilitation.

Acoustics

All sites are isolated from residential areas. Noise levels emitted during the drilling should meet all DECC criteria at 13 of the 15 proposed boreholes. Two boreholes (AI05 and AI06) would exceed the criteria unless amelioration measures are implemented. These include management practices, acoustic screening and negotiating agreements with the two landholders involved. Noise monitoring will be undertaken during operations. Should these measures not resolve potential noise matters, Apex would limit drilling to hours when criteria could be achieved. During drilling operations all equipment will be checked and maintained to ensure acceptable noise characteristics. Any residents living nearby will be advised prior to the drilling.

Flora and Fauna

The proposal will involve limited clearing affecting approximately 4.2 ha of existing native vegetation and 4.8 ha of disturbed areas that support a mix of native and exotic species. A Species Impact Statement under the ***Threatened Species Conservation Act* 1995** (TSCA) or a Referral for Matters of National Significance under the TSCA and the ***Environment Protection and Biodiversity Conservation Act* 1999** (EPBC) were not necessary for any threatened flora or fauna within the area of the proposed activities. The proposed works are unlikely to have a significant impact on any threatened species, endangered ecological communities or populations. However, commitments are made to minimise any disturbance on the ecological values of the area.

Traffic

Due to the small number of employees and the limited construction time, significant traffic impacts are not expected. Traffic safety rules and procedures would need to be developed to ensure public and employee safety during all operational stages of the program.

Waste Management

All waste will be disposed of at appropriately licensed facilities off site. Recycling will be encouraged.

Archaeology, History and Heritage

The proposal is not predicted to significantly impact archaeological or cultural heritage values within the proposed borehole locations.

Visual Effects

Due to the isolated location and access restrictions, it is unlikely that the proposed drilling and gas monitoring operations would be greatly noticeable or offensive to a general member of the public when viewed from the surrounding area.
Section 5 describes the Environmental Management System that Apex will implement to ensure appropriate environmental management of the Program.

Section 6 is a draft Statement of Commitments, which indicates the measures Apex will undertake to minimise impacts on the environment if the Program is approved.

Section 7 provides a summary of the Director General's Requirements together with information on where these requirements are addressed in this Environmental Assessment.

Appendices I to VI contain all the supporting specialist consultant reports. **Appendix VII** contains the Major Project Application and **Appendix VIII** contains the Director General's Requirements for this Environmental Assessment. The appendices are attached as two additional volumes.

The borehole sites have been selected by Apex to be suitable for the proposal and to minimise disturbance of significant surface features. Specialist consultants were commissioned to assess potential environmental impact and to recommend amelioration measures to eliminate or minimise any potential impacts. The sites are located to ensure the Program objectives can be achieved and that future development of the boreholes as gas production wells and establishment of a pipe-based gas collection system can be installed without significant environmental impact. Benefits will flow to both the proponent and the local and state community through increased knowledge of available gas reserves.

In conclusion, this Environmental Assessment does not identify any environmental issues that would preclude conditional approval of the Program.

2 INTRODUCTION

2.1 The Current Major Project Application

Apex Energy NL (Apex) is involved in coal seam gas exploration and developments in various parts of the Sydney Basin.

Apex holds Petroleum Exploration Licences (PEL) 442 and 444 in the Illawarra region of the southern Sydney Basin. **Figure 2.1** shows the location of PEL 442 and PEL 444.

Apex proposes to undertake an exploration program consisting of the drilling of approximately 15 exploratory boreholes at various locations throughout PEL 442 and PEL 444. 18 borehole were initially selected for investigative purposes. Following receipt of specialist reports (**Appendices I** to **VI**) Apex propose to drill only 15 boreholes. These boreholes are identified in this report as AI04B, AI05, AI06, AI07, AI08, AI09, AI10, AI11, AI12B, AI13, AI14, AI15, AI16, AI17 and AI18.

The boreholes would be drilled to variable depths up to 50 m below the base of the Illawarra Coal Measures. The exploration program 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 workings being predominantly in the Bulli Seam. **Figure 2.2** shows a typical stratigraphic cross-section of the southern coalfield.

The exploration and gas monitoring program will define potential gas quality, volumes and flow rates within the area. Definition of the gas reserves and flow rates will enable planning of future developments capable of utilising the gas resource. Precise details of these future developments cannot be defined until the gas potential is known more accurately. It is an objective of this Program to generate these essential details.

Lonestar Lateral International, which is part of the Apex Star Systems Group of Companies, have developed a range of complementary technologies in the USA over the last decade including zero radius lateral drilling from standard production holes horizontally into coal seams. These lateral drill holes will boost flow rates, particularly in the case of NSW's interbedded coals thereby allowing the NSW Coal Seam Methane (CSM) industry to match the success of the Queensland CSM industry. Apex also has access to biological technology that utilises methanogenic bacteria, which occur naturally in the coal seams, to improve gas yields, gas quality and flow rates.

Apex expect that the proposed exploration program will prove up sufficient gas reserves to supply a 15 MW ($65M), greenhouse friendly, peak/intermediate combined cycle gas turbine (CCGT) power station in 2011 located near Sydney. This power station would be able to meet NSW's growing need for peak/intermediate electricity.

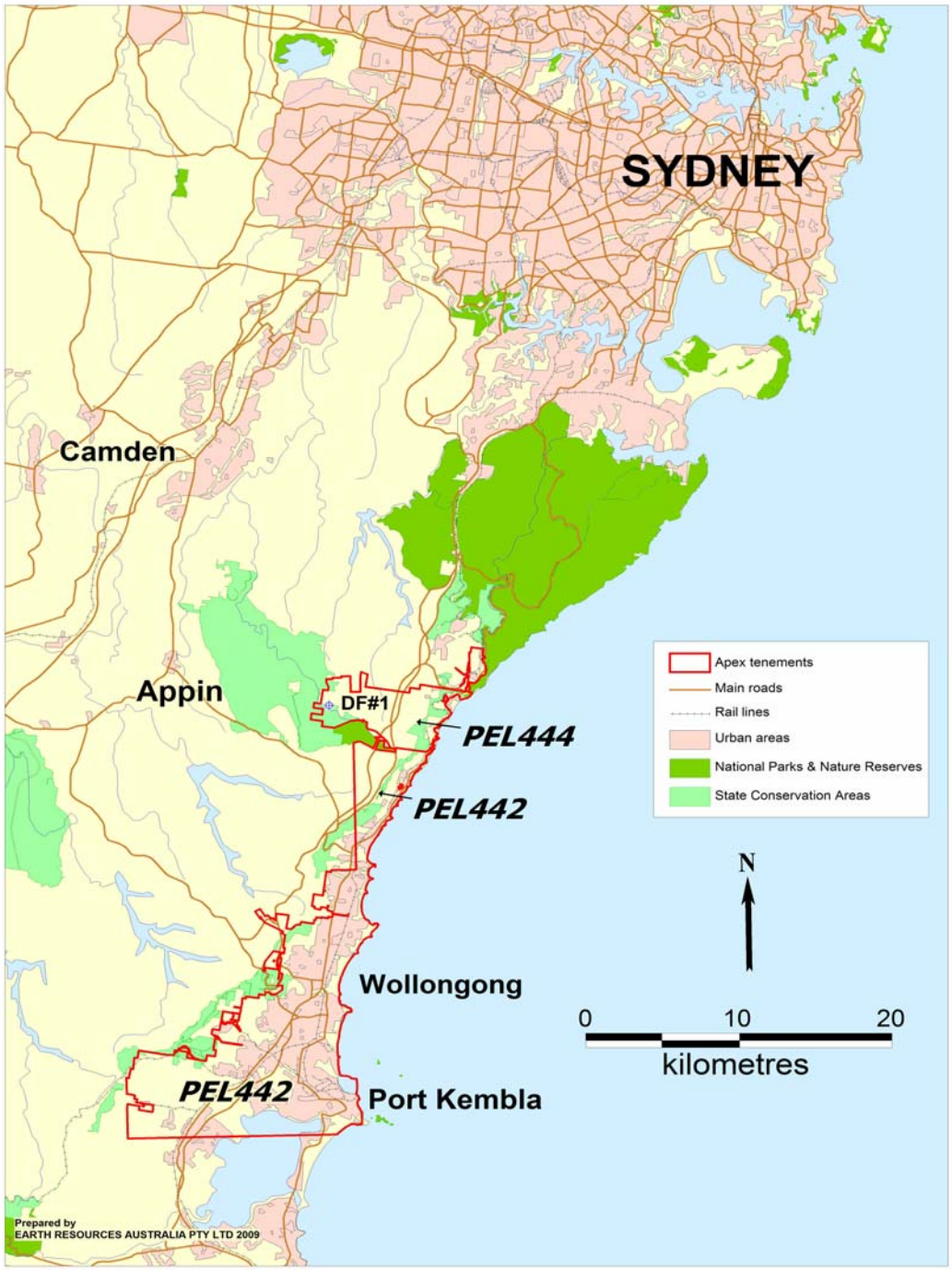

Figure 2.1 – Apex Mining Tenements

Source: Earth Resources Australia Pty Limited

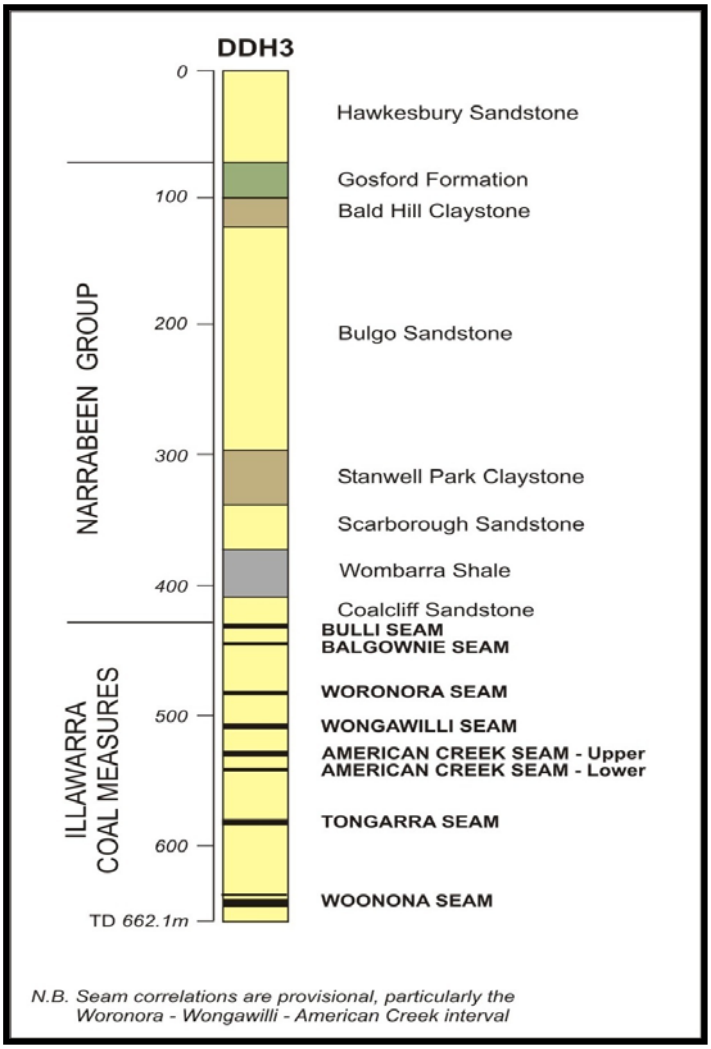

Figure 2.2 – Typical Stratigraphic Cross Section Southern Coalfield

Source: Earth Resources Australia Pty Limited

Any additional future gas utilisation developments would depend on the outcomes of this Program.

Access to reliable deep coal seam gas and goaf gas makes the use of variable coal-mine waste gas economic. This gas use would help to significantly reduce the environmental impact of NSW coal mining. The use of coal mine waste methane gas will have positive Greenhouse benefits through reduction in burning of coal for power generation and the conversion of waste coal mine methane to carbon dioxide. Carbon dioxide has a Greenhouse potential at least 21 times less than that for methane.

Potential future developments which could flow from the Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Program will also provide a global demonstration site of the new drilling and biological gas extraction technologies. Field demonstration of these new technologies will be subject to another approval application. It is anticipated that these technologies will enable Apex to demonstrate an ability to produce more and cheaper gas from NSW inter-bedded coals (and other similar coals) than has been possible with previous technologies.

Successful demonstration of the new gas exploration and extraction technologies in a full scale operation could enable a NSW-based company to be established to provide the technology throughout Asia. This would enhance NSW's position as a leading technical and commercial centre for the region and contribute to employment in NSW.

In 2004, Apex demonstrated potentially commercial gas from a borehole identified as Darkes Forest No 1 (DF#1), which intersected abandoned mine workings of the Coal Cliff Colliery. This borehole, which was the first well drilled specifically to target goaf gas in NSW, flowed in excess of 1 million cubic feet per day of gas, which consisted of approximately 80% methane. The success of this borehole has generated this current exploration program. The location of this borehole is shown on **Figure 2.1** and **Figure 3.1A**.

Recent flows have been very encouraging, defining reserves of about 1 billion cubic feet. Should similar flows and quality be confirmed in the proposed exploration program, Apex would seek to develop energy production developments based on this resource.

Also in 2004, Apex developed two core holes to the base of the Illawarra Coal Measures. Coal testing indicated potentially commercial levels of gas of high quality in the lower seams. This previous exploration work has been undertaken in cooperation with the landowners and with no significant negative environmental impacts.

The proposed Program constitutes a Major Project under the ***State Environmental Planning Policy (Major Project)* 2005**. Consequently, the exploration proposal has to be assessed in accordance with Part 3A of the ***Environmental Planning and Assessment Act,* 1979** (EP&A Act).

In July 2007, Apex lodged a Major Project Application with the Department of Planning **(Appendix VII)**. A Preliminary Environmental Assessment supported the Major Project Application. The Preliminary Environmental Assessment was prepared in accordance with existing Department of Planning Guidelines and requirements.

The Department of Planning reviewed the Major Project Application and Preliminary Environmental Assessment and provided the Director General's environmental assessment requirements (DGRs) for the Program **(Appendix VIII)**. The DGRs nominate the requirements for the Environmental Assessment, key issues to be addressed, the level of assessment required in relation to these issues and any other requirements the Director General determines as being relevant.

The DGRs were prepared by the Department of Planning having regard to any relevant existing guidelines, in addition to the information included in the Major Project Application and Preliminary Environmental Assessment. The DGRs are included in **Appendix VIII** of this Environmental Assessment. **Section 7** summarises the DGRs and indicates the sections in this Environmental Assessment in which they have been addressed.

This Environmental Assessment of the Program has been prepared to address the issues identified in the DGRs.

2.2 Context and Potential Future Major Project Applications

The information in this section is provided to enable the current exploration and monitoring program to be understood in the context of potential future development. Any proposals described in this section would be the subject of a separate Project Application and Environmental Assessment.

The purpose of the Illawarra Coal Seam Gas Drilling and Gas Monitoring Program is to further define the presence and viability of Coal Mine Gas (CMG) and Coal Seam Gas (CSG) in Apex tenements. The information obtained from the Program will build on existing information obtained from the drilling of the Darkes Forest Number 1 well in 2004 and subsequently tested in 2004, 2005 and 2007. This well revealed a high probability that a gas extraction and utilisation project in the area would be commercially viable.

The drilling of the 15 proposed boreholes will allow Apex to carry out a detailed assessment of the viability of the abandoned coal mines and coal seams in the area. However, Apex has determined that there is a high probability of commercial success from a gas extraction and utilisation program in the area. Due to the expected success of the 15-borehole program, each site has been selected in order to easily facilitate the subsequent establishment of a gas reticulation system. Each proposed well site is adjacent to existing roads, tracks and easements and Apex intends to utilise these existing corridors for the establishment of a gas reticulation system. It is not the intention of Apex to create additional tracks or roads as part of this project. Apex proposes to utilise the verges of the following for the subterranean installation of a pipe system:

- Darkes Forest Road,
- Princes Highway,
- SCA tracks and fire trails,
- Sada Services tracks (Coalcliff Colliery surface).

Apex is carrying out feasibility studies involving options for gas utilisation. These include:

- Placing gas into the Eastern Gas Pipeline,
- Delivering Gas to the Talawarra Power station,
- Small scale liquid natural gas (LNG) unit,
- Installation of small scale combined cycle power station (circa 10 – 15 MW).

To date Apex has held discussions with various organisations regarding commercial arrangements for the utilisation of gas including Tru Energy, AGL/Sydney Gas and Integral Energy. Apex is also in discussion with the Department of Lands regarding the potential access to Crown Land adjacent to the Darkes Forest Sub Station. This site is being considered as a potential small power station site (circa 10 – 15 MW). **Figure 2.3** shows the site and its proximity to the existing substation. This substation would be utilised to distribute the electricity generated by the plant. The substation is operated by Integral Energy and Apex has had discussions with Integral Energy regarding the project.

This site demonstrates the ease by which Apex can establish gas reticulation lines. The site's proximity to the Princes Highway, Darkes Forest Road and the Sada Services area (old Coalcliff/Darkes Forest mine site) can be clearly seen in **Figure 2.3**.

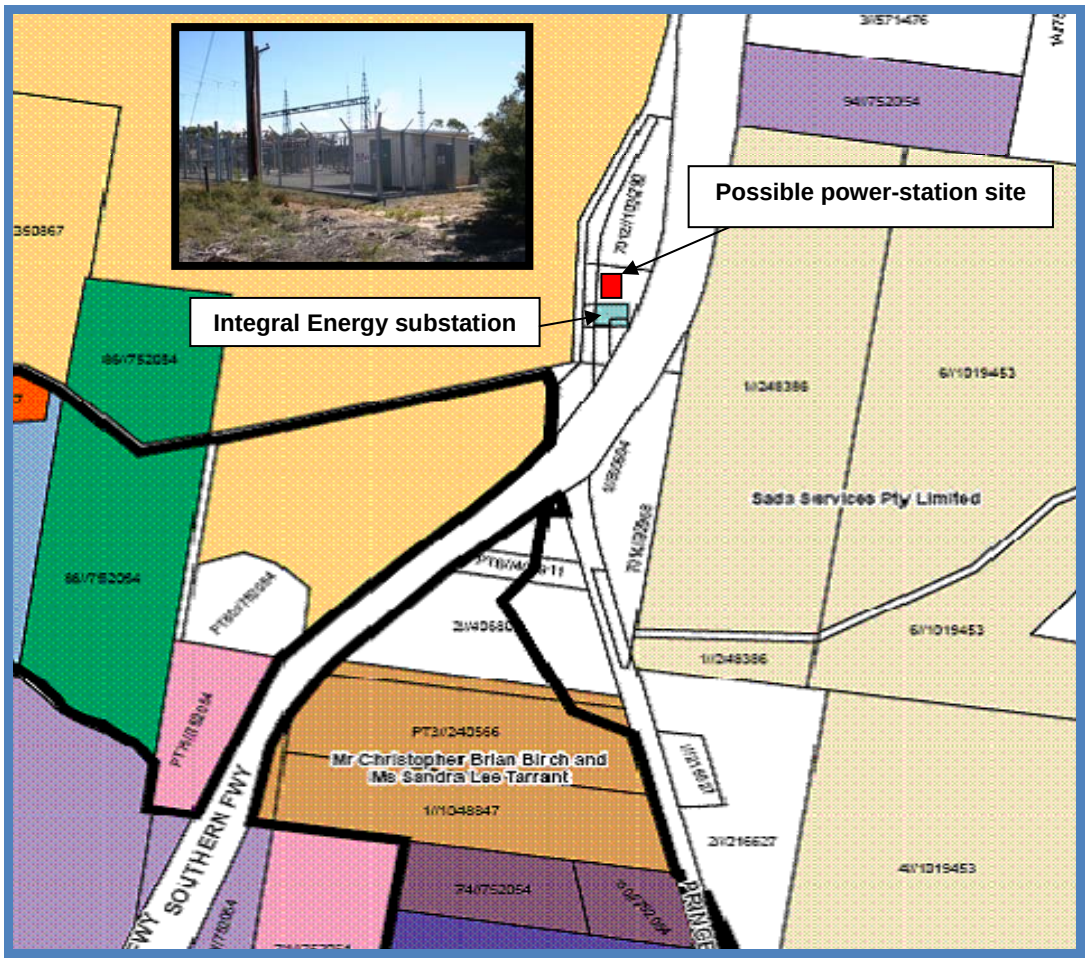

Figure 2.3 – Location of Potential Future Power Generation Facility

2.3 Project Duration

The Gas Exploration Drilling and Gas Monitoring Program is the initial stage of a potential gas utilisation project in the Southern Coalfield. Defining the exact duration or lifetime of each individual site is problematic and depends on the outcome of the exploration and monitoring. It is also dependent on the type of borehole. For example, a successful borehole accessing goaf gas would generally have a shorter timeframe than a successful one accessing the full seam sequence.

Successful exploration boreholes are highly likely to be converted to future gas production wells.

This initial drilling program is not by itself a gas utilisation program but will define the volumes and quality of gas available for future use. In this initial stage, gas will be extracted purely for data collection and it is planned that this data collection would be obtained over a period of approximately one week per well. This one week period may occur immediately after drilling or it may be delayed depending on the availability of monitoring equipment, site gas flow/flaring equipment, personnel or for geological reasons.

This initial stage of the Program involves installing 15 boreholes to obtain essential data. They will be retained as secured boreholes while data analysis and review determines whether they would be required for future gas monitoring, utilisation or for other operational purposes.

Table 2.1 shows a typical drilling schedule for the project. This schedule and timing of drilling may be affected by a number of factors not readily identifiable that will only become evident as drilling proceeds.

The typical schedule and timing is also affected by the fact that drilling of boreholes into goafs (Type 1) represents a separate purpose to Types 2 and 3. The latter involve taking of core samples throughout the coal measures. The drilling of Type 1 boreholes and the drilling of Types 2 and 3 have different objectives and outcomes. Type 1 are used for Goaf gas production evaluation, while Types 2 and 3 are used to determine gas levels in the entire coal sequence with potential to use for production at some later time.

Drilling the different Types of boreholes involve the use of different drill rigs due to the different technical aspects required.

Gas exploration drill rigs having the necessary safety requirements are difficult to secure at present within Australia. It is hoped that a rig with the capability to drill the Type 1 boreholes will be available in June or July 2009. It is unclear at present (March 2009) when a core rig will become available to drill the Types 2 and 3 boreholes. In addition, the rig that will be deployed to drill the Type 1 boreholes will also be required to drill the first section of the Type 2 borehole. Therefore scheduling the rigs is difficult and rigs may be able to be secured on an opportunistic basis.

Apex plans to drill the 5 “Type 1” boreholes as a priority with 1 “Type 3” and 1 “Type 2” following on. This will give Apex valuable information on which to base further exploration work. These boreholes will be evaluated prior to decisions being made for further drilling and commitment to capital.

Because the drilling of Type 1 and the core boreholes are technically quite different activities, it may be possible to secure a rig for each activity simultaneously. However, for assessment purposes it has been assumed that 5 x Type 1 boreholes will be drilled first, followed by a single Type 3 borehole and then another single Type 2 borehole. The schedule for the remaining boreholes will then be reviewed based on the results achieved.

Therefore, although the typical schedule gives an insight into field activity, Apex will most likely vary the typical drilling schedule to take advantage of drill rig availability, field experience and resource knowledge gained as the program proceeds.

Table 2.1 provides information on the 15-borehole drilling program. The table includes an indicative priority for the wells in the left hand column.

Due to constraints of equipment availability and professional personnel to manage and operate the gas monitoring stage, there will only be one borehole being monitored at any one time.

Figure 2.4 presents a typical timeframe for the drilling of the 15 boreholes.

Once the exploration results have been determined and analysed Apex will be able to define detailed future use options. Apex plan to lodge a future Major Project Application based on the outcome of this initial gas exploration and monitoring stage. This future Application will better define the long term life expectancy of each borehole.

Depending on the degree of this initial stage, Apex anticipates lodging a Major Project Application for gas utilisation with the Department of Planning. If approved, the Major Project Approval for the future Application will detail expected borehole timeframes including decommissioning and rehabilitation details. It would replace the Approval for the initial stage of the Program.

Decommissioning and rehabilitation would be undertaken in accordance with DPI-MR requirements. Once Apex knows that a borehole is no longer required, it will be sealed in accordance with the requirements of the DPI-MR.

Consequently, the timeframes anticipated for this initial stage are widely variable and would range from 6 months for an unsuccessful borehole, through to 5 to 10 years for a successful goaf gas drainage hole and up to 25 years for a successful full seam borehole. A Future Major Project Application will more accurately define the timeframes.

Table 2.1 – Typical Drilling Schedule

Priority	Borehole Identifier	Well Type	Top Coal Depth (m)	Total Depth (m)
1	AI05	1	457	687
2	AI09	1	395	625
3	AI14	1	373	608
4	AI18	1	335	565
5	AI17	1	325	555
6	AI16	3	335	565
7	AI04B	2	371	601
8	AI06	2	460	690
9	AI15	2	345	575
10	AI07	1	432	662
11	AI08	1	405	635
12	AI12B	1	395	625
13	AI13	1	385	615
14	AI10	1	450	680
15	AI11	1	400	630

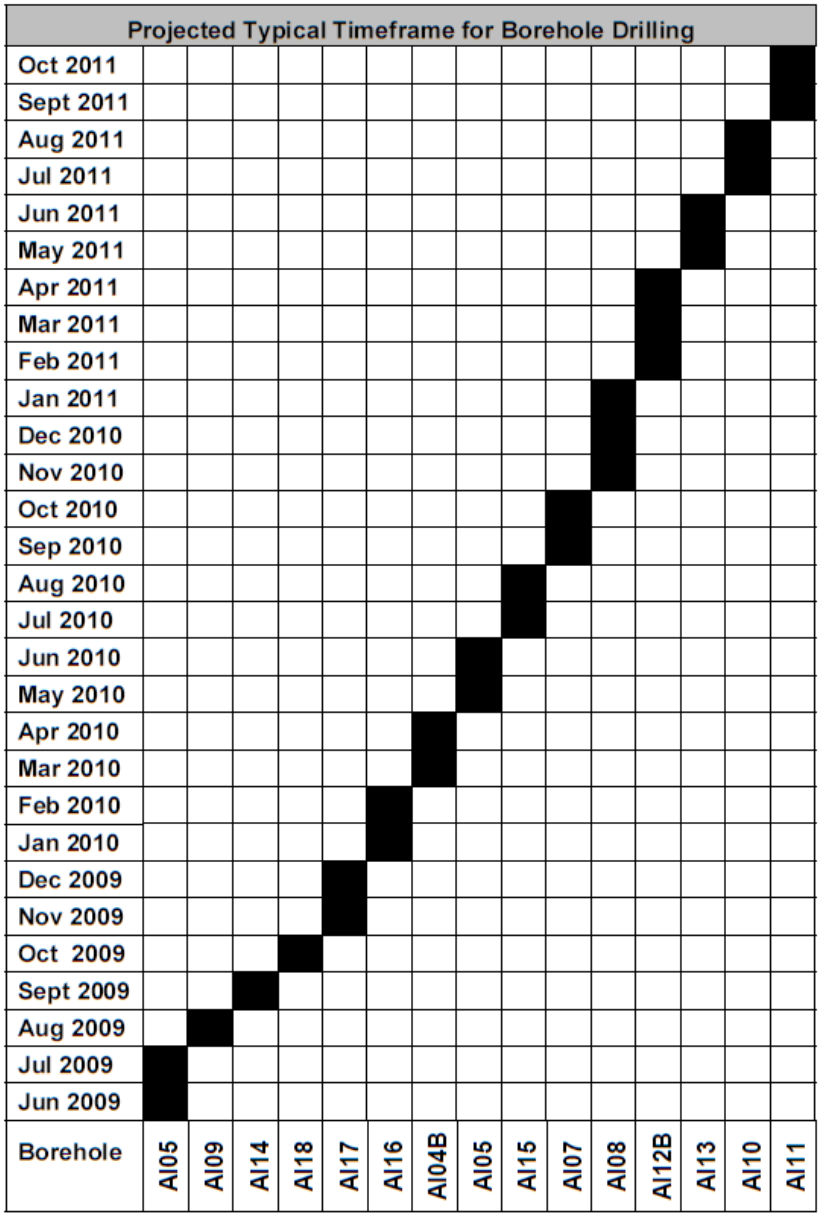

Figure 2.4 – Projected Typical Timeframe for Borehole Drilling

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3 PROGRAM DESCRIPTION, JUSTIFICATION & PLANNING BACKGROUND

3.1 Description and Justification

The proposed exploration program will involve the sinking of approximately 15 boreholes at the locations shown on **Figure 3.1A**. Some of the boreholes will be extended to the base of the Illawarra Coal Measures and as well as defining the regional gas potential will also provide more detail of the regional geology.

The boreholes will be configured to enable ongoing gas monitoring. This monitoring will assess gas quality, quantity and flow rates. This is essential data for planning future gas energy projects.

The proposed program of each borehole involves both core drilling for initial data gathering and exploration drilling for reserve testing. 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 borehole is shown on **Figure 3.1A**.

In **Figure 3.1B** aerial photographs, taken using Google Earth (2008) satellite imagery software, of the 15 borehole locations are presented, and identify the individual borehole locations in the context of the surrounding environment. Further descriptions of the borehole locations are presented in **Appendix I**. In that report the Map Grid of Australia (MGA) coordinates (zone 56), along with a brief description of each site including the surrounding surface natural and man-made features are discussed in detail.

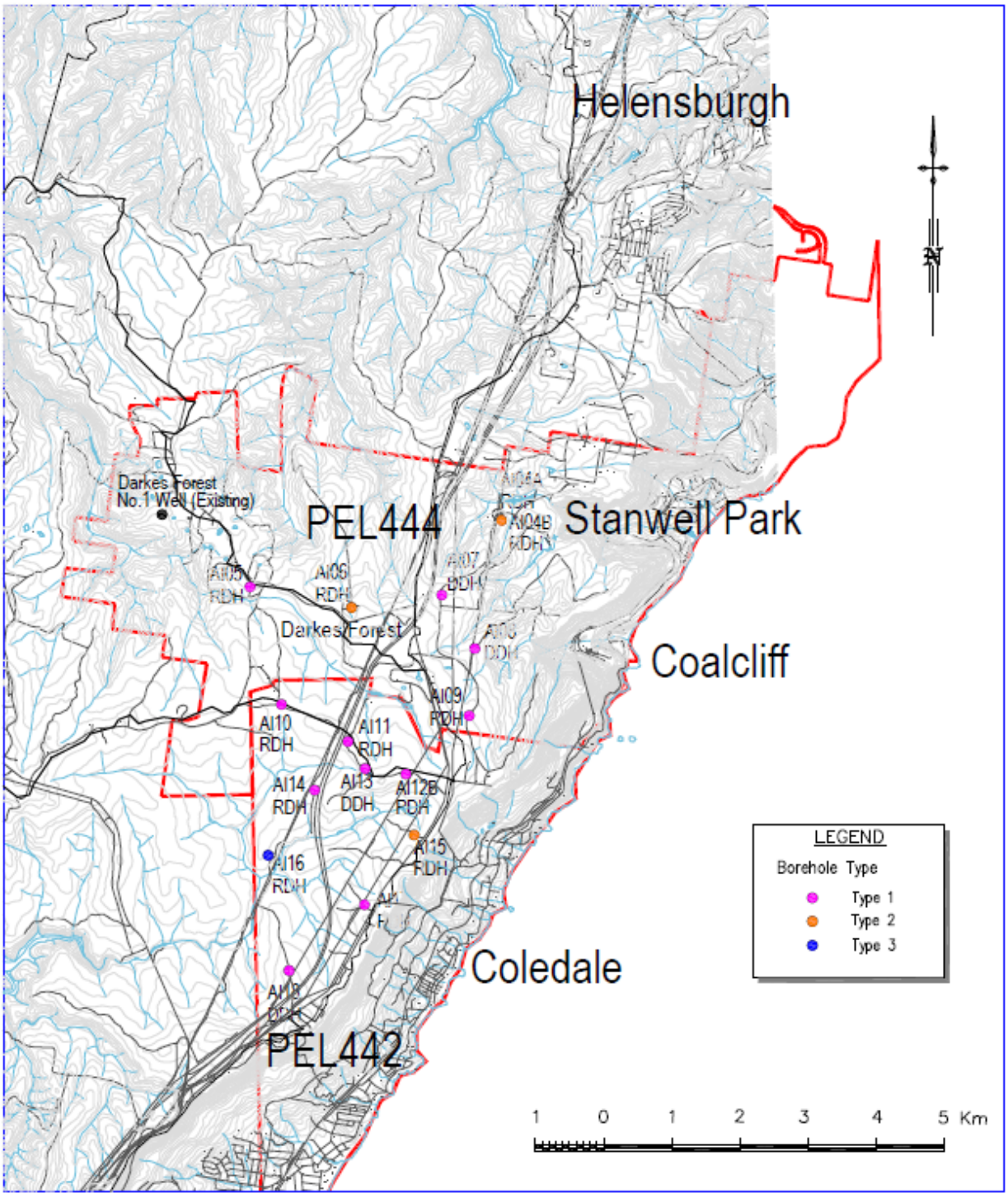

Figure 3.1A – Borehole Locations

Figure 3.1B – Aerial Photographs of Borehole Locations in Context of Surrounding Environments

Source: Google Earth 2008 and Ecoengineers Pty Ltd.

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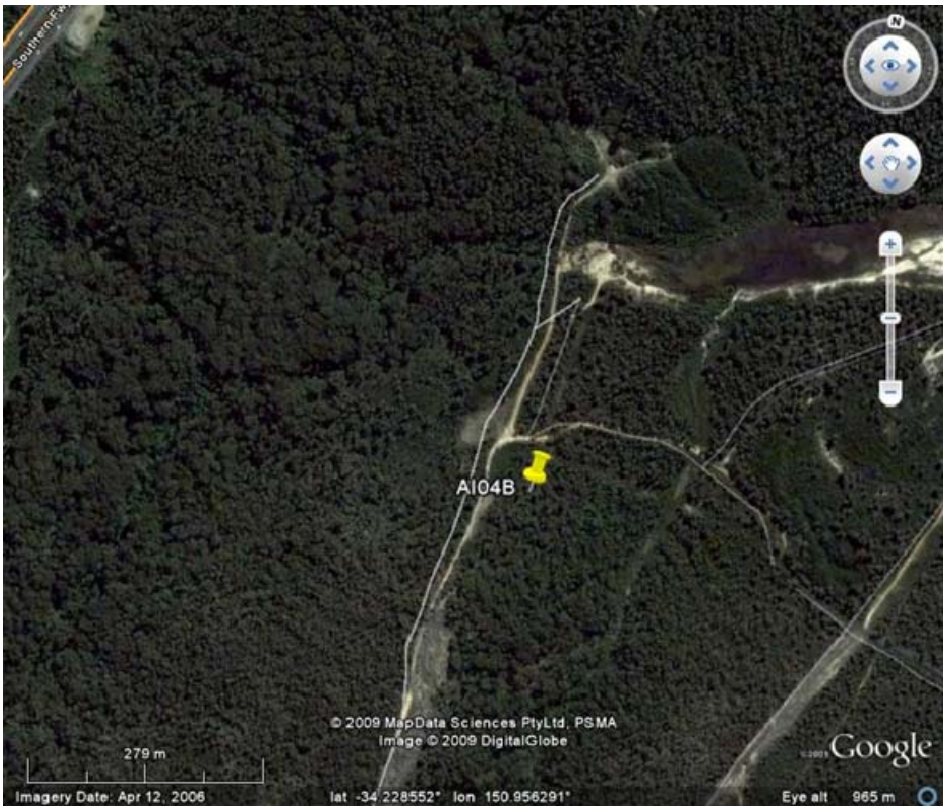
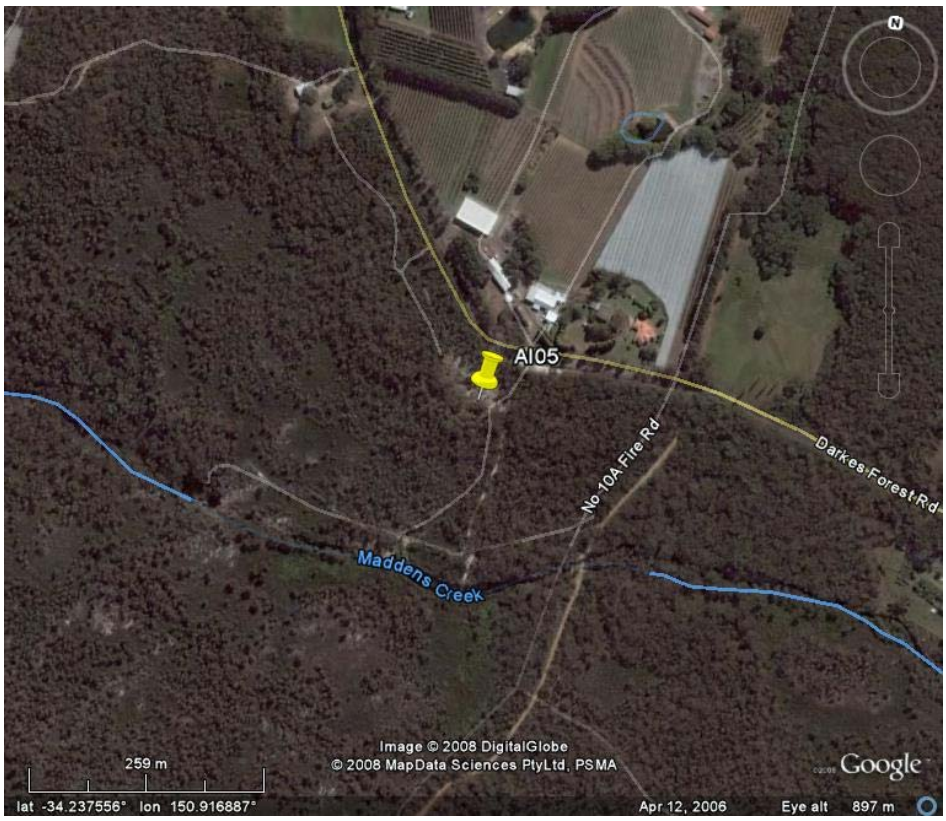
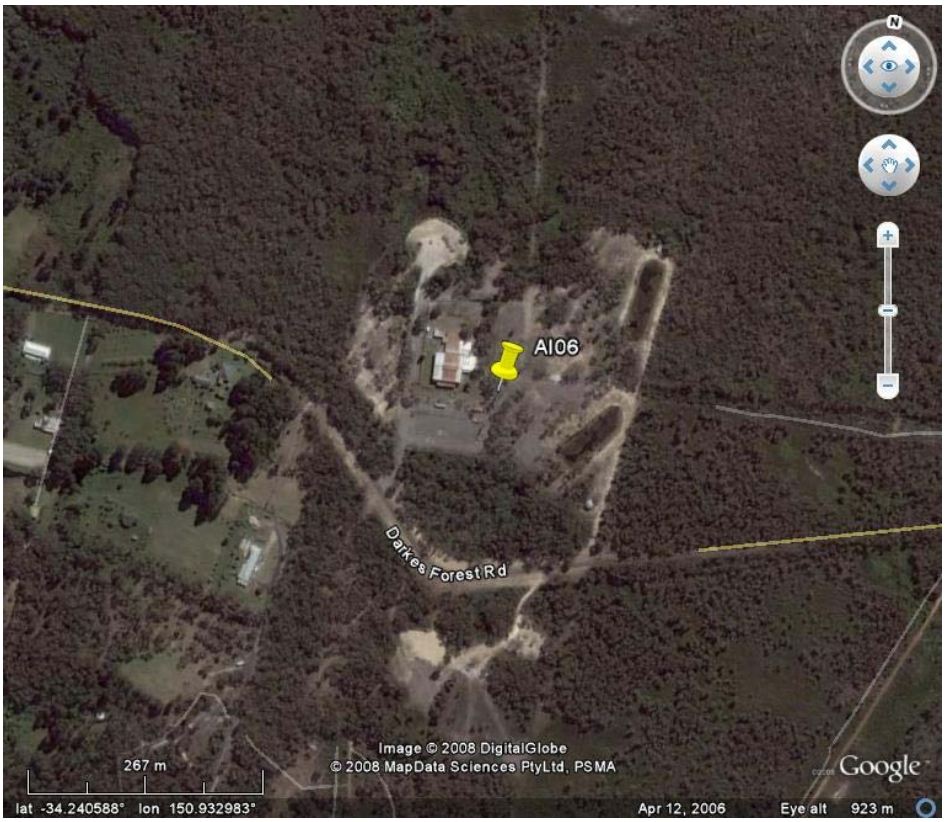


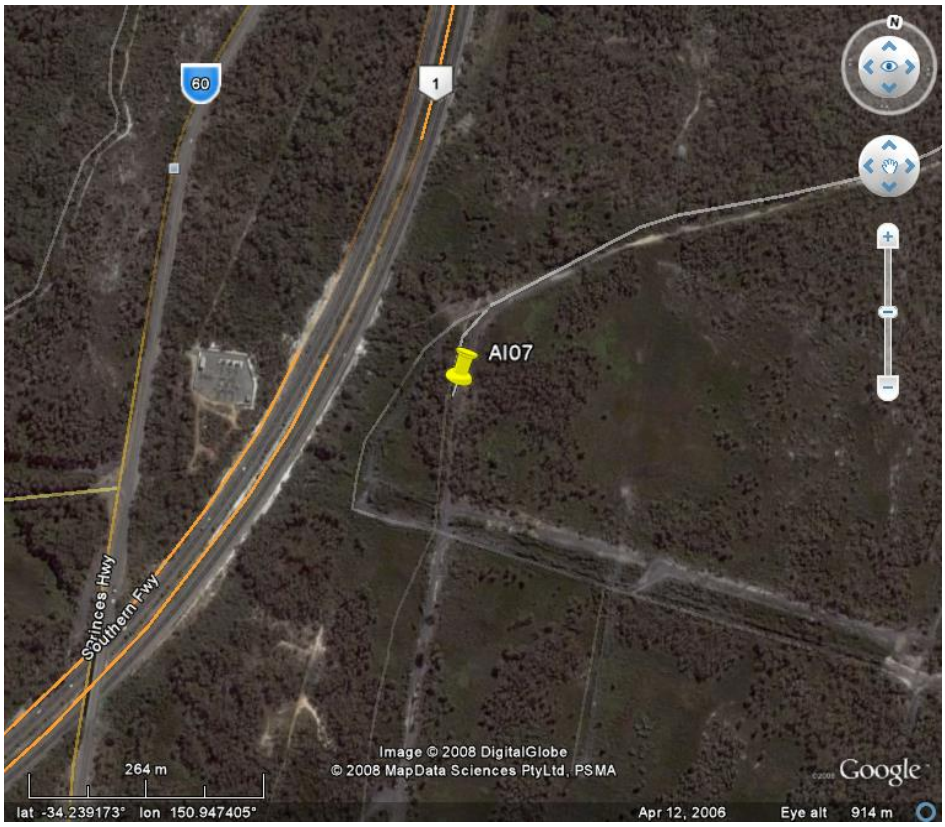
Borehole AI04B



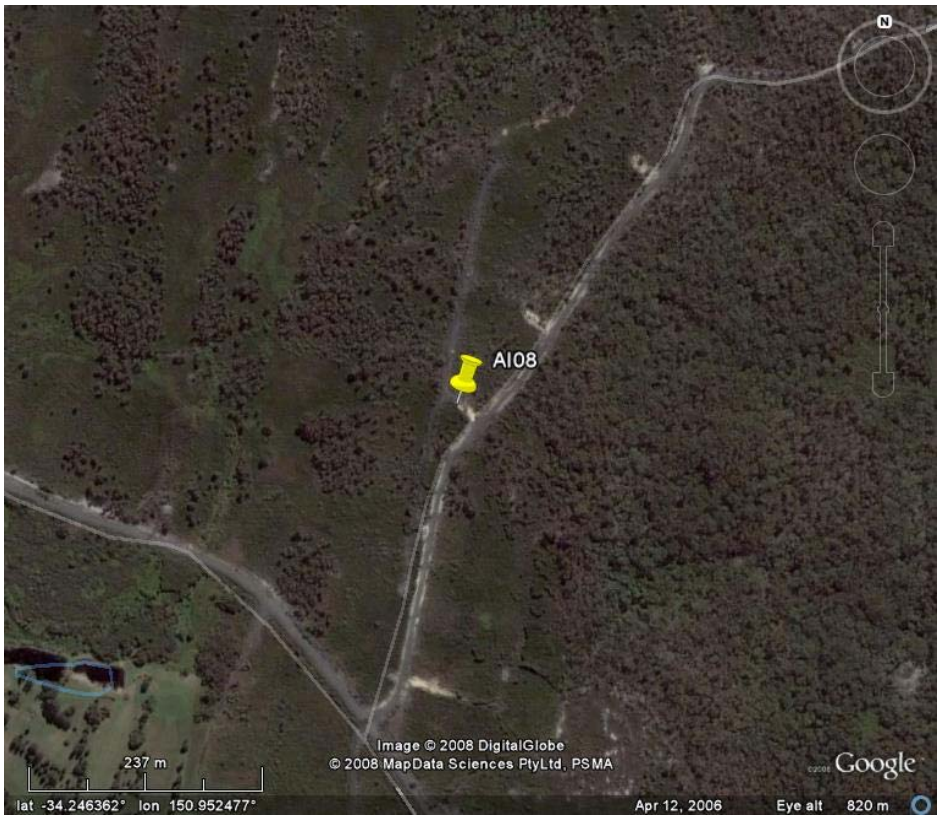
Borehole AI05



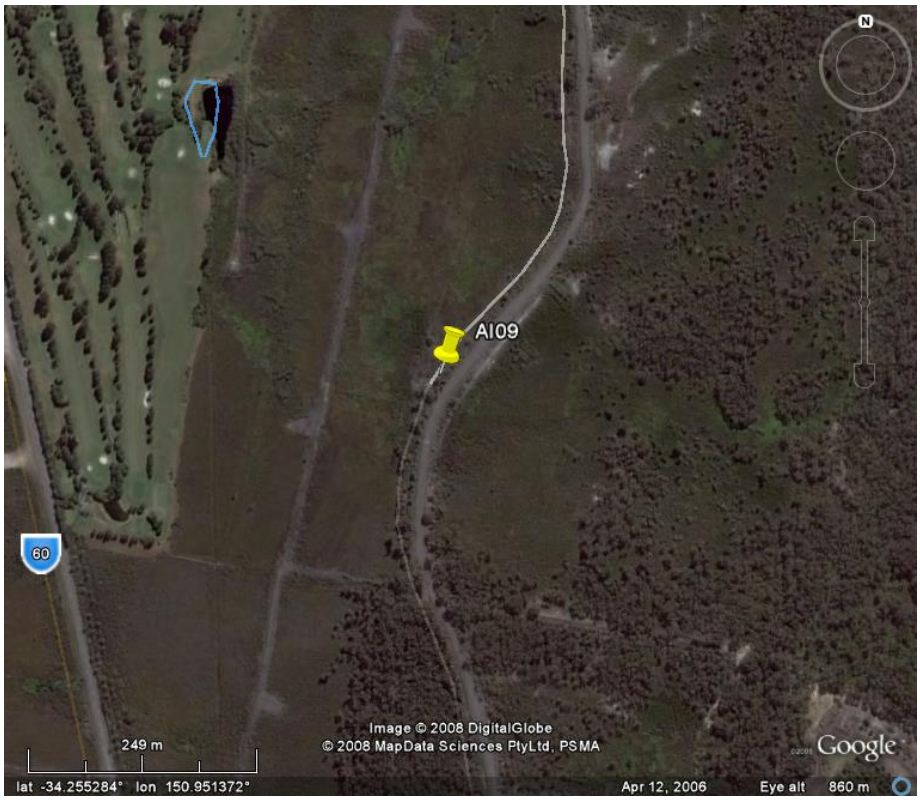
Borehole AI06



Borehole AI07

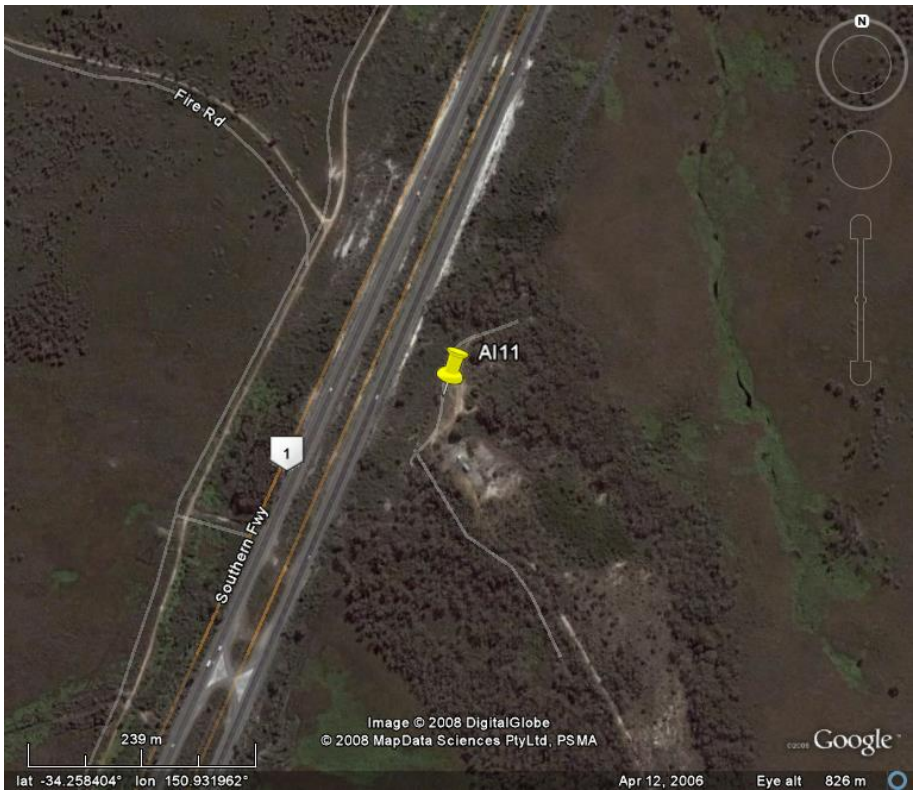


Borehole AI08



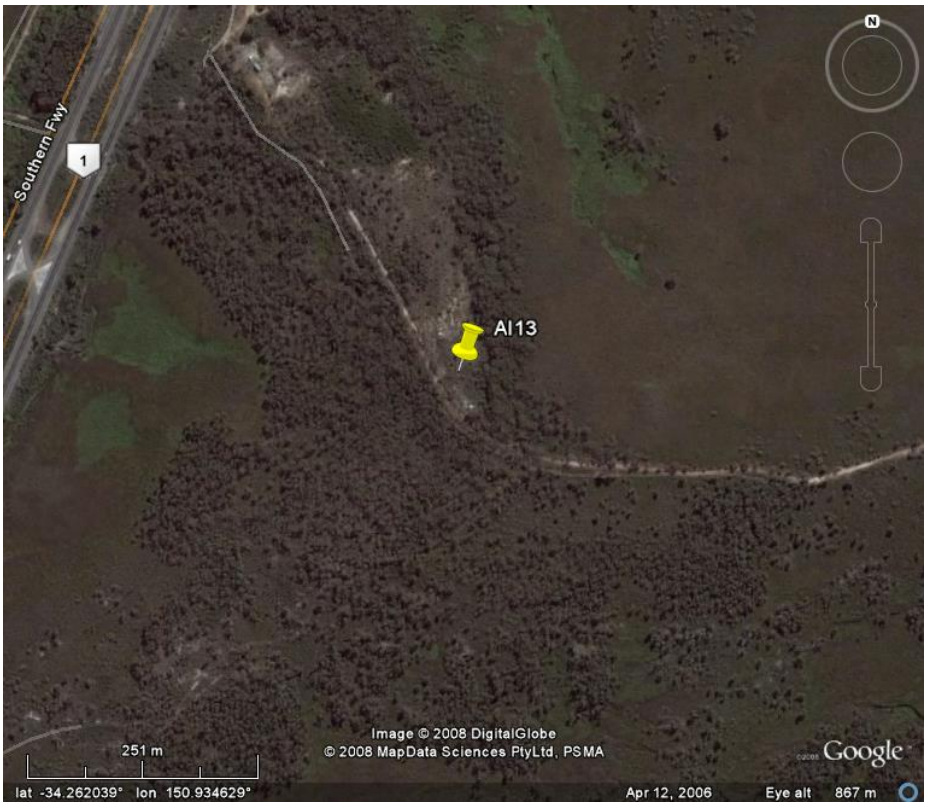
Borehole AI09

Borehole AI10



Borehole AI11

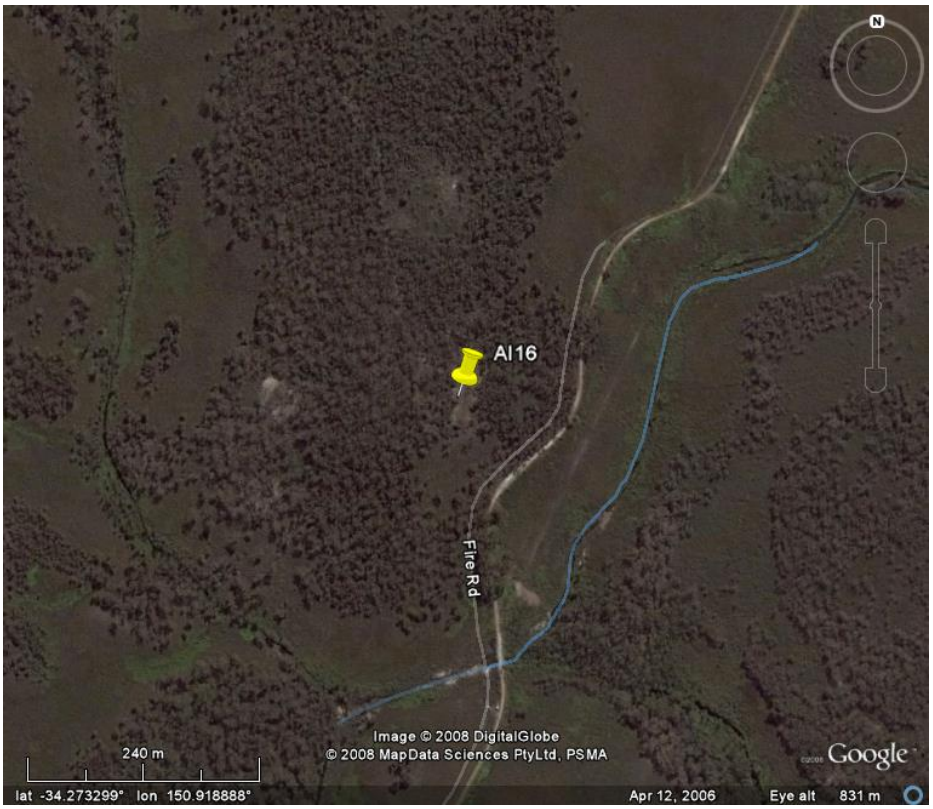
Borehole AI12B



Borehole AI13

Borehole AI14

Borehole AI15



Borehole AI16

Borehole AI17

Borehole AI18

The three different types of boreholes are shown diagrammatically on **Figure 3.2**.

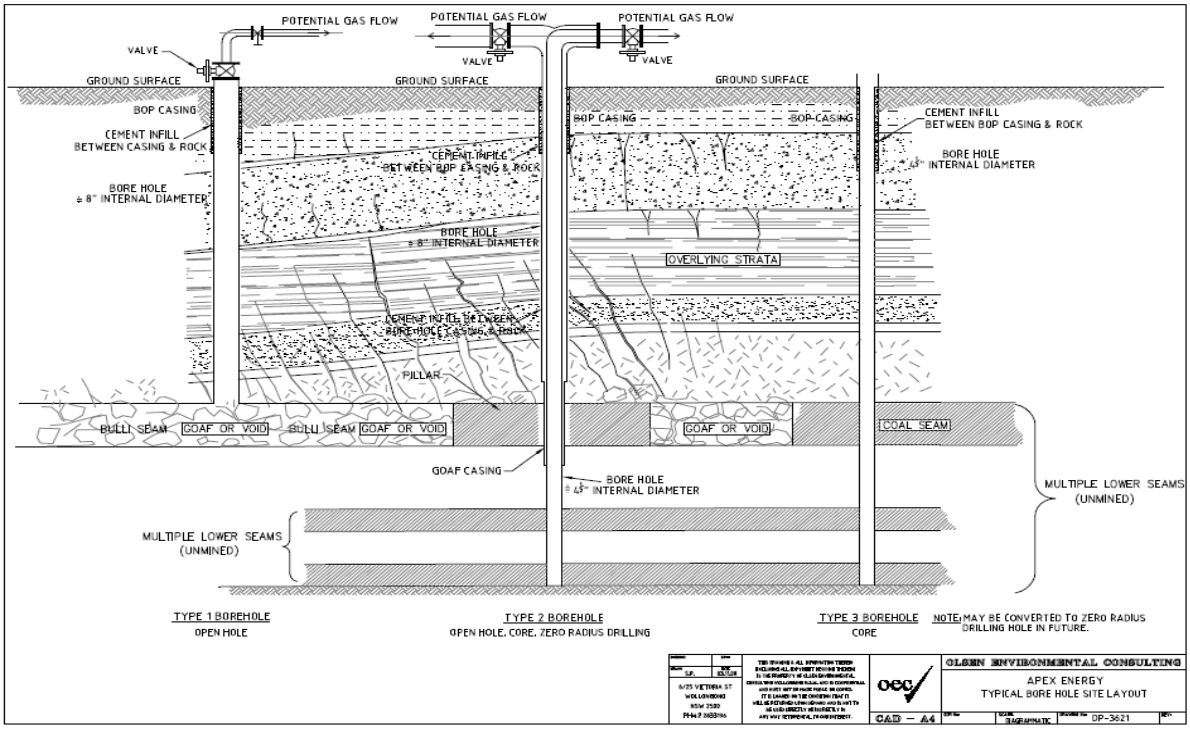


Figure 3.2 – Program Borehole Types

Type 1

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, AI05, AI07, AI08, AI09, AI10, AI11, AI12B, AI13, AI14, AI17 and AI18 are of this type.

Type 2

This type of borehole is transitional between Types 1 and 3. They 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 using the zero radius drilling technology. They will be used to determine goaf gas characteristics in underlying old Bulli Seam workings. The gas will be accessed through fractures in the remnant pillars and surrounding strata. Additional drilling will then be undertaken 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 AI04B, AI06 and AI15 are of this type.

Type 3

This is a cored hole of approximately 100 mm diameter, drilled over un-worked areas. This hole 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 hole AI16 is of this type.

Table 3.1 identifies type of each of the proposed boreholes at Apex based on the above description of Types 1, 2 or 3.

Table 3.1 – Borehole Type

Borehole Identifier	Type 1, 2 or 3
AI 04B	2
AI 05	1
AI 06	2
AI 07	1
AI 08	1
AI 09	1
AI 10	1
AI 11	1
AI 12B	1
AI 13	1
AI 14	1
AI 15	2
AI 16	3
AI 17	1
AI 18	1

During drilling operations actions will be undertaken to protect aquifers from any operational impacts. Circulating drilling mud seals the original borehole and stops aquifer contamination or drainage during the drilling operation.

Immediately after the hole is drilled, steel casing is inserted in the borehole. Concrete is pumped down the inside of the casing and is extruded through the open end of the casing. The extruded concrete subsequently fills the gap between the casing and the borehole. This results in the entire length of the hole being encased in steel and concrete, which prevents any uncontrolled movement of material into or out of the borehole.

Core sampling will further define the distribution and gas content of the coal seams within the Illawarra Coal Measures. The test wells will indicate the areas of best gas potential and define the gas resources and likely gas and water flows. They also help determine the viability of production proposals and help to define and prioritise future gas production areas.

If results warranted, some of the core holes could be reamed out into exploration wells, subject to DPI-MR Inspectorate approvals. Use of any of the boreholes for future gas production is dependent on exploration outcome and appropriate prior approvals.

Holes will require a blow-out prevention (BOP) device on the wellhead which is secured to steel casing cemented in to a depth of at least 10% of the estimated final hole depth, or as required under the ***Petroleum Act* 1991.**

Apart from the BOP casing requirement, cored holes over areas with no workings will have a diameter of 100 mm and will be identical to many coal exploration boreholes drilled in the region.

When cored holes are drilled over areas of abandoned workings it may be necessary to ensure that the abandoned workings are sealed off. This requires drilling of a hole to just above the workings depth, which is known from mine survey data. That hole will be cased and cemented. The hole will then be drilled across the workings and into the underlying formation. The presence and significance of gas in the workings can be assessed at this stage, and this effectively constitutes a goaf gas exploration well. A further string of removable liner casing,

cemented in place across the abandoned workings, will enable coring to progress in the underlying seams.

Assuming that core testing indicates the seams to have potentially commercial gas content and composition, drilling of exploration wells will then be undertaken. Some proposed exploration wells require drilling through old workings, and drilling procedures to the stage of casing-off the goaf are the same as indicated above. Drilling to the lower seams is preferably with air and the hole completed with fibreglass casing.

It is proposed to undertake the drilling program on a continuous basis operating the drilling rig 24 hours per day and seven days per week. The following sections outline the reasons for this approach.

Safety

If operations are carried out only in daylight hours, the contractor would have to trip in and out of the holes (pull the drill rods out and then re-establish them) on many more occasions as compared with a continuous operation. Because the tripping in and out and associated handling of rods is labour intensive, drillers are exposed to increased risk of injury due to manual handling and exposure to energy during rod handling. Rod handling is one of the most hazardous aspects of drilling and has historically been a major source of injury of both a short term and long term nature. Drilling companies implement employee training and operating procedures to reduce the manual handling component of drilling activity.

Continuity

Undertaking drilling as a continuous in a 24/7 operation, results in a reduced propensity for safety and production issues to arise as a result of human error.

Time on Site

When drilling 24/7 the time at each particular site and therefore the impact on the environment is much lower than for a daytime only operation.

Machinery

When drill rigs are operated continuously they are less prone to component and system failure. These means that a 24/7 drilling operation reduces the need for failure maintenance and therefore reduces the exposure to the hazards associated with such failures such as high pressure injection and manual handling hazards.

Rig Availability

Access to drill rigs and crews of the required capability to complete the projects both safely and productively is limited. Drill rig availability for wells of such magnitude has become increasingly problematic not only for operators of leases but also for the contractors. There are few contract companies in Australia capable of completing these wells safely. Therefore by drilling 24/7 Apex is more likely to be able to secure a competent contractor with appropriate fit for purpose equipment. In addition, drilling 24/7 would assist other local companies to maintain viability. The rigs used by Apex would most likely be engaged on other local projects to reduce underground gas levels at collieries in the region. Increasing rig availability by drilling 24/7 also assists other organisations and may assist them to improve safety.

Commercial

Drilling 24/7 would reduce the cost of operations significantly and increase the viability of the project. An operator must pay for a rig and crew during their engagement on a project whether they are drilling or not.

Although not proposed in this Project Application, future development that would include gas utilisation would involve a work-over rig drilling 50 mm diameter lateral holes from the main vertical exploration hole into each coal layer of each coal seam. This Zero Radius Lateral technique was developed by Lonestar Lateral International (LTI) in the US, and involves drilling a radial pattern of lateral holes up to 100 m long to promote water and gas flow. LTI are part of the Apex Star Systems Group of Companies and as a result, Apex has access to this unique and innovative drilling technology. This technology enables the boreholes established in this initial drilling program to be used to enable access for a radial drilling tool. This tool would enable multiple radial boreholes to be drilled in the unmined coal seams, greatly increasing the area of coal gas available to each borehole. It also enables drilling into individual layers in the multi-layered coal seams typically encountered in the Illawarra Coal Measures.

Should this future proposal be approved and installed, it will be the first instance of this patented technique being utilised for coal seam gas anywhere in the world, with this Apex Project being the global demonstration site.

The lateral holes will enable inherent moisture in the coal seams to be removed to the surface. This inherent moisture inhibits gas flows and its volume must be reduced in the seam before gas will flow from the seam.

The moisture will be collected in the drilling pit on the surface and will be removed by tanker as required. In the unlikely event of the water tanker being unable to cope with the pit water, Apex propose a contingency of a purpose-drilled borehole that would enable excess water from the surface to be directed to abandoned goaf areas underground.

Rigs and ancillary equipment and drill site operations must comply with all safety and environmental requirements of the ***Petroleum Act*** **1991** and associated legislation administered by DPI-MR. Drill site layouts are shown in **Figure 3.3, Figure 3.4 and Figure 3.5.** Actual site layout will contain the components identified in these figures, but may be varied to be suitable for each individual site. This will enable flexibility to avoid unnecessary disturbance of significant surface features. Site layout will be confirmed depending on surface topography, environmental constraints and in consultation with stakeholders.

Wells will be sealed in accordance with DPI-MR requirements supervised by their Inspectorate Branch.

Each drill site will be designed in accordance with the specific site requirements. The design will incorporate risk management techniques and will involve input from relevant stakeholders in order to ensure their requirements are met. The pre-establishment liaison and planning will result in a site specific Management Plan that will ensure the site is managed appropriately.

Figure 3.6 shows a typical layout of a borehole at the completion of drilling. In order to provide a firebreak and to enable ongoing site access, the area initially cleared during drilling will remain cleared. The wellhead gas control equipment and piping arrangements together with the monitoring equipment will be covered with an all-weather cover. A man-proof fence will enclose the area and a locked gate will provide access. The area inside the fence will be covered in gravel.

The drilling sump will be retained for water drainage from the borehole. The sump will be lined with a plastic membrane and will collect water extracted from the gas during gas flow testing.

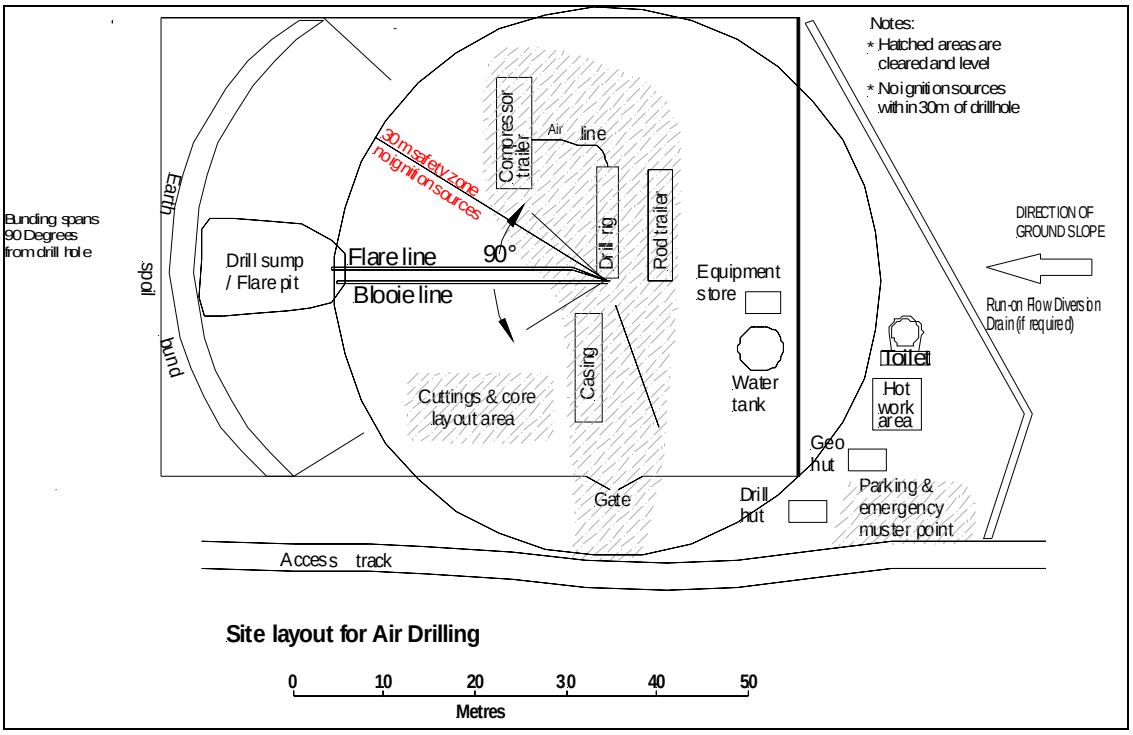


Figure 3.3 – Site Layout for Air Drilling

Source: Earth Resources Australia Pty Limited and Ecoengineers Pty Ltd.

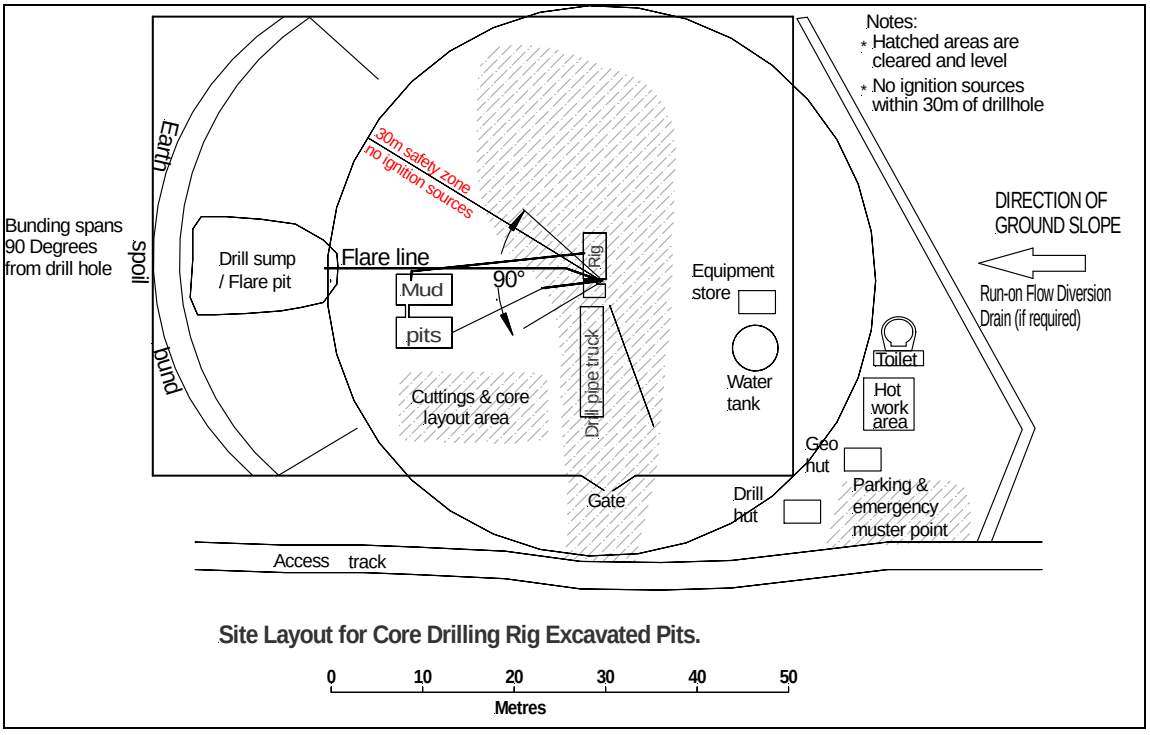


Figure 3.4 – Site Layout for Core Drilling Using In-Ground Fluid Pits

Source: Earth Resources Australia Pty Limited and Ecoengineers Pty Ltd.

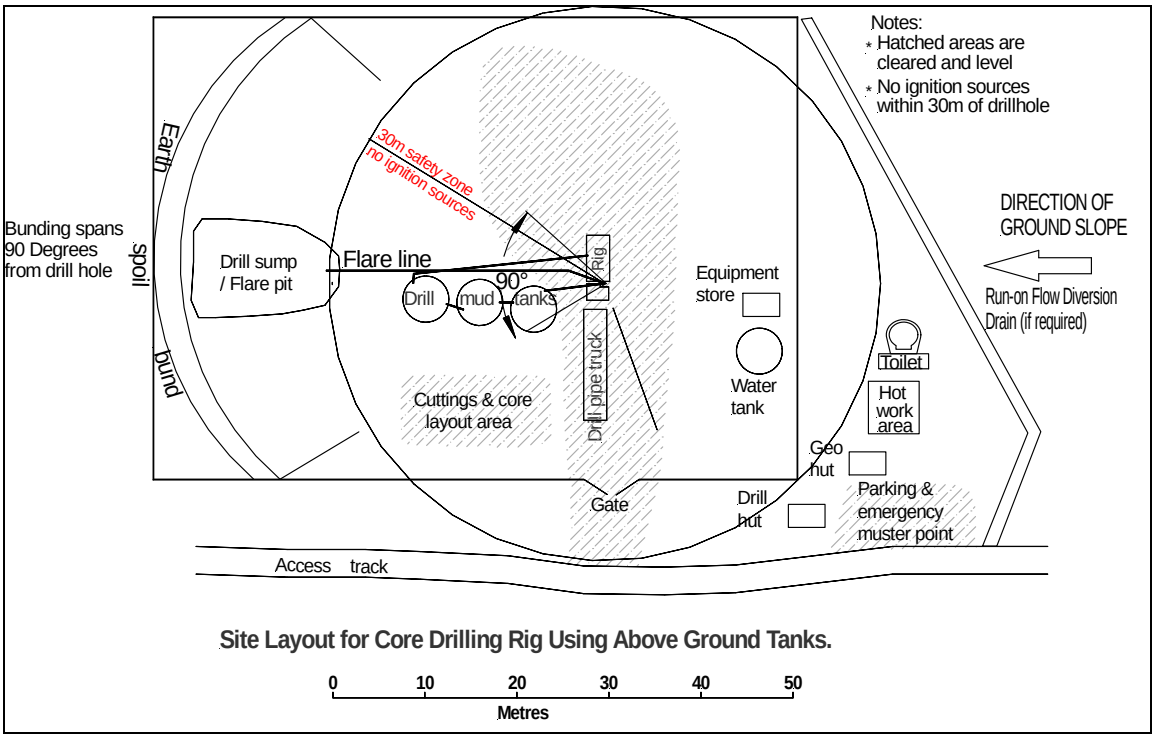


Figure 3.5 – Site Layout for Core Drilling Using Above Ground Tanks

Source: Earth Resources Australia Pty Limited and Ecoengineers Pty Ltd.

Previous coal exploration boreholes in this area have demonstrated that they are relatively dry. The proposed sumps would be sized to accommodate expected volumes of water consisting of recirculating drilling water and additional groundwater make. A tanker will empty the sumps as required. The sumps will be enclosed in a man-proof fence and a locked gate will provide access.

During the one-week gas monitoring period, a gas flaring chamber will be located at least 30 m from the wellhead and outside the fenced pit area as shown on **Figure 3.6**.

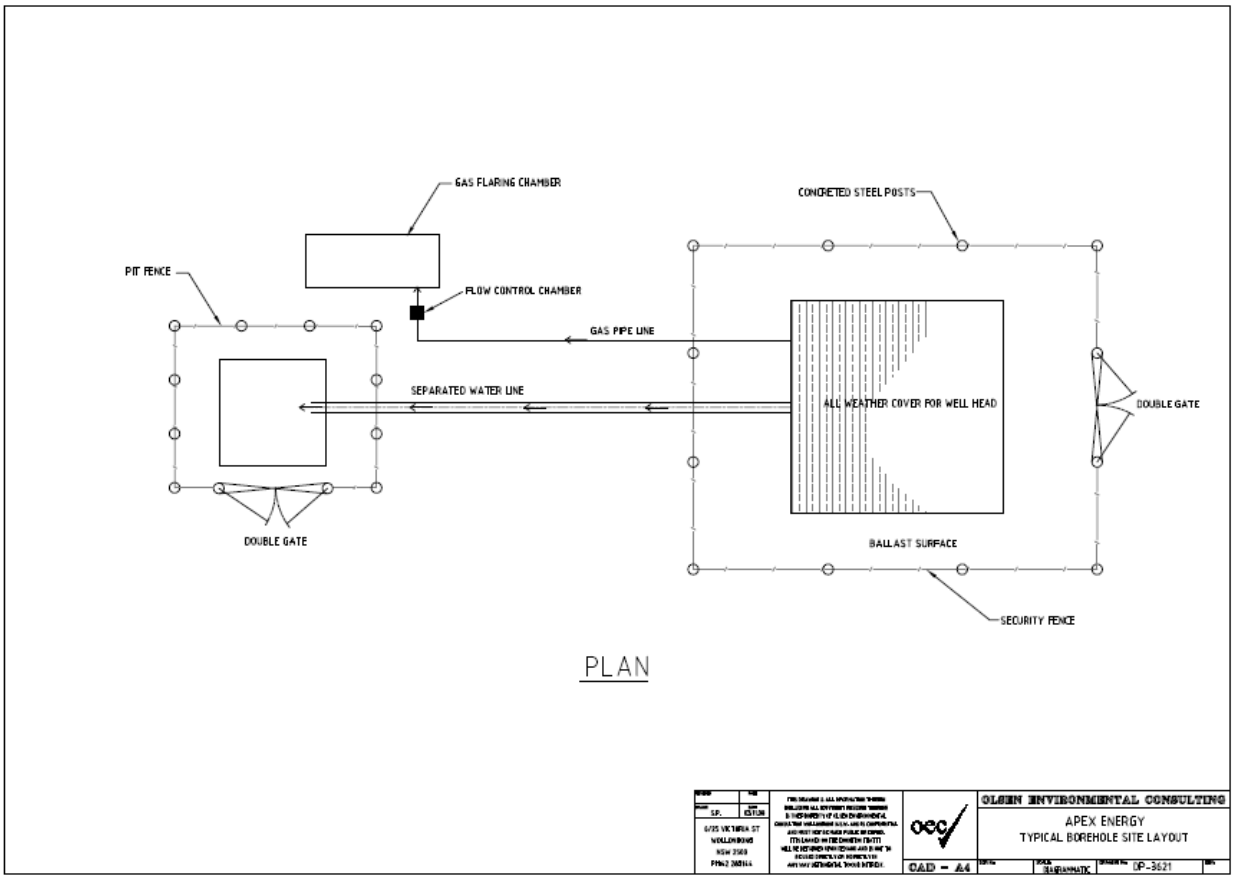


Figure 3.6 – Typical Borehole Layout at the Completion of Drilling

Figure 3.7 provides detail of the wellhead arrangement. Gas flows will be controlled initially by a ball valve located immediately above the bore casing flange near the surface.

A pressure gauge will be located in line and immediately after the ball valve. This gauge will be connected to an automatic shut-off valve that is able to stop gas flows during unplanned events. The pressure gauge and automatic shut-off valve will be connected by a fire susceptible hose that will cause an automatic shut down of gas flow should a fire occur.

During normal gas flows, gas would flow through these components and enter a baffled water separator. This unit would separate the water entrained within the gas, collect that water and direct it to the fenced pit (**Figure 3.6**).

De-moisturised gas would then pass out of the water separator and be piped past a flow meter which would measure gas flow parameters. The meter would be connected by cable to a data logger. The gas would then continue and pass through a manual shut-off valve and then a non-return valve. Depending on the rate and duration of flow, the gas would either be vented to atmosphere or directed to a gas flaring chamber (**Figure 3.10**). It is planned to flare most gas emissions, but on occasions relatively small volumes of gas will be vented to atmosphere. The data logger would be downloaded periodically and the data transferred to a central location via the site telecommunications aerial. A solar panel will supply power to the monitoring site.

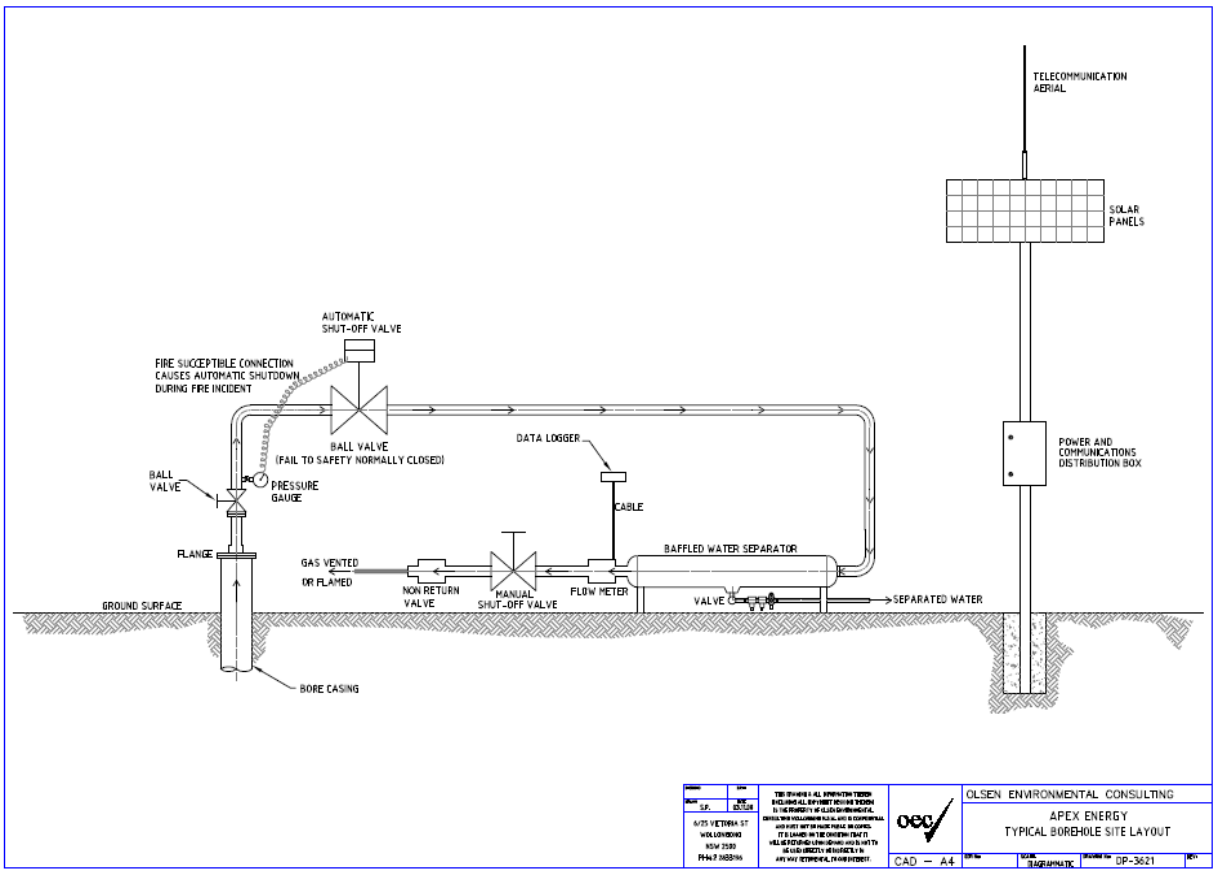


Figure 3.7 – Typical Wellhead Arrangement Details

A photograph of the actual site layout during establishment drilling of Darkes Forest No. 1 Well is shown in **Figure 3.8**. **Figure 3.9** is a photograph of an actual gas production well in the Southern Coalfield and gives a clear indication of the scale of a monitoring wellhead.

Figure 3.8 – Drilling Darkes Forest No 1 Well

Figure 3.9 – Gas Production Wellhead in Southern Coalfield

Figure 3.10 – Gas Flaring Chamber

3.2 Gas Monitoring and Testing

3.2.1 Data Collection

Gas monitoring and testing form an integral component of this program. Results of gas monitoring and testing will enable future potential activities to be assessed, and will provide essential data on:

- Gas quality,
- Production rates,
- Volumes of gas in place,
- Gas reserves,
- Deliverability.

Gas Quality

Gas analysis will determine the quality of the gas that would be extracted should full-scale production eventuate.

Type 1 boreholes will access directly into gas filled goaf areas and bag samples of typical gas will be collected for laboratory analysis. The gas is expected to be predominantly methane. Apex has tested the quality of gas from the previously drilled Darkes Forest No 1 Well. The

composition of gas extracted from the Darkes Forest well was typically 80% methane, 15% carbon dioxide and 5% nitrogen. Apex expects similar gas qualities will be observed during the gas monitoring stage of this Program.

Type 2 and Type 3 boreholes will enable core samples of coal to be obtained. The cores will be forwarded to a laboratory where gas content of the core sample will be determined. These samples will enable coal gas quality to be ascertained and will also give an indication of likely quantities of gas available for extraction.

Production Rates

Gas production rates will be determined by measuring flow rates on the surface. This will result in gas being either emitted to atmosphere or being flared in a mobile gas flare chamber.

Gas in Place

This is a measure of the total amount of gas in the area around the borehole or well. It is affected by a number of parameters including leakage of gas from other workings, bacterial action, desorption from unworked coal pillars or seams and from underlying coal seams through fractures of the mine floor. Gas in Place is calculated from a range of measurements taken during the monitoring and testing phase.

Reserves

Gas reserves represent the amount of gas that is available for extraction. For a range of reasons, it is not possible to extract all Gas in Place. Calculation of Reserves takes into account this range of factors and provides a measure of the gas that is available for extraction and subsequent utilisation.

Deliverability

Deliverability provides a measure of the longevity of gas flow from a borehole or gas well. The variety of borehole types proposed will enable the derivation of these gas quality and quantity parameters, which are essential for planning and assessing future gas utilisation projects.

3.2.2 Borehole Testing and Flaring Management Plan

Gas flows will occur in accordance with a Borehole-testing and Flaring Management Plan that will be created using a standard risk management approach including consultation with Government and industry experts. The Well-testing and Flaring Management Plan will be authorised by DPI-MR prior to any release of gas.

3.2.3 Gas Flaring

During gas flow testing, gas will be emitted from the boreholes. This gas will be approximately 80% methane and flaring will be undertaken to reduce the greenhouse gas effect of the emissions.

Flaring will be undertaken in a purpose built mobile gas flaring chamber. It is essentially a shipping container-size unit, with thermal and acoustic lining. The top and bottom are open for ventilation and a series of gas burners are fitted in the bottom section of the unit. During flaring operations, this design significantly reduces noise and lighting impacts. **Figure 3.10** is a photograph of a chamber similar to the one that Apex will use.

3.3 Future Exploration Activities

The works planned in this proposal will provide essential basic gas quality and quantity data. Apex proposes to undertake additional exploration and gas data acquisition at some time in the near future. This future activity will be dependent on the initial results and involves a technology which promotes methanogenic bacteriological activity. It will be subject to further approval in a separate application and assessment process.

Coal seams universally contain natural methanogenic bacteria, which generate methane and higher order hydrocarbons as a metabolic by-product. It is possible to isolate these bacteria and increase their number in a laboratory environment. The bacteria are then re-introduced into the coal seam, where their biological activity results in generation of increased methane and higher order hydrocarbons. Additionally, the bacterial activity results in greater permeability of the coal seam, enhancing the rate of gas flow

3.4 Borehole Location

The proposed location of each hole and type shown on **Figure 3.1A** 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. The final location of each borehole will be confirmed by an on-site environmental appraisal at the time of site selection. The flexibility of borehole location is such that, in most cases, relocation to avoid unacceptable impact can occur without jeopardising the success of the exploration program.

3.5 Borehole Establishment

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

Coring Rigs

Coring rigs are usually smaller truck-mounted or jack-up rigs with a gross vehicle weight under 20 t. In-ground pits or above ground tanks are required to enable recirculation of drilling fluid.

Open-hole Drilling Rigs

Open-hole drilling rigs are usually truck-mounted, but are larger and heavier than coring rigs and are around 35 t gross weight. Drilling an exploration hole requires a larger operations area than a coring rig site and better access for delivery of casing, which is 12 m long.

Workover Rigs

Workover rigs are smaller than a coring rig and will undertake zero radius lateral drilling. The proposed zero-radius drilling will involve using a Work-over rig over boreholes of Type 2 and 3 as described in **Section 3.1**. It will only occur during future activities that will be subject to a new Project Application and Environmental Assessment.

It is a standard safety requirement for all holes drilled under the ***Petroleum (Onshore) Act* 1991** that provision is made for venting of gas through a flare line to a point 30 m distant from the wellhead. Similarly, no sources of ignition are allowed within 30 m radius of the well. Other equipment on site will include a drill-pipe truck (or racked pipe), air compressor (may be 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 drill-pipe, 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.

3.6 Environmental Precautions

To provide suitable environmental management of the proposal Apex will implement a number of actions that are discussed in this section.

Boreholes have been sited to minimise vegetation clearing and soil disturbance and compaction. Any cleared vegetation and topsoil will be stockpiled and respread over the site on completion of operations. Wherever possible, sites have been selected on previously disturbed level locations and adjacent to existing tracks. Where possible, level areas have been selected so as to avoid the need for cut and fill earthworks and to minimise the potential for subsequent erosion. The rig and immediate areas must however be level for safe and efficient drilling operations. Vehicle access will be restricted to defined parking and unloading areas.

Exploration hole drilling will require excavation of a sump to collect cuttings and expelled water. Following completion of drilling, the sump will be allowed to settle. The sump would be backfilled with material originally excavated from it and the disturbed area covered with topsoil and any remnant vegetation.

Following completion of operations all excavations will be backfilled and the site rehabilitated. Any excavations will be backfilled with the original spoil and compacted in layers. Topsoil will be re-spread over the site. The site will be left slightly proud to allow for settling. Cleared vegetation will be spread over the disturbed area to promote revegetation and to provide erosion protection.

Silt fences will be erected where appropriate and maintained until a suitable level of rehabilitation has been achieved.

On-site storage of fuel and lubricants will be kept to a minimum and safely stored on site in bunded pallets. Hydrocarbon spill kits will be available on site.

Where practicable, and if agreed by the landowner or Sydney Catchment Authority (SCA) where relevant, water requirements will be pumped to the site. Otherwise water will be brought in by tanker and stored in above ground tanks.

Drilling equipment will be required to be clean of soil and free of oil leaks prior to entering the site. Any oil leaks that develop will require immediate repair and drilling contractors will be required to have a supply of oil absorbent material on hand.

Apex does not intend to use additives in the drilling of cored holes. However, there may be a need to add some KCl to the drilling fluid to provide clay stability. Should KCl additions be necessary, Apex will ensure that the drilling fluids are removed from site at the completion of drilling and the water containing KCl disposed of in an appropriate manner.
All packaging, damaged or surplus equipment and drilling supplies will be removed from site prior to or at the completion of operations. Food wastes and similar, will be deposited in

secure capped bins and removed on a daily basis to maintain hygiene and minimise scavenging by wildlife.

A “portaloo” will be installed on site and maintained on a regular basis. Potable water will be available on site for personnel use.

Fire precautions will include spark arrestors on the drilling rig, and no smoking or sources of ignition within 30 m of the wellhead. There will be fire extinguishers on the drilling rig. Apex will provide cleared areas for hot work (grinding, cutting and welding) and a “butt bin” for smoking. All hot work will be done with an observer standing by and fire extinguishers on hand.

Where possible, the drilling activity will occur every day over 24 hours per day.

Within SCA areas, the site boundary will be marked by coloured tape suspended between steel droppers with warning signs. In open areas Apex will provide temporary security fencing and warning signs around the boundary of each site.

Exploration well testing may produce groundwater from the seams and it is not possible to predict the volume and quality of this water. It is proposed that such water be stored in the ground sumps or in above ground tanks and removed off-site by tanker or temporary above ground poly-pipe. Local experience with coal exploration boreholes confirm minimal groundwater make up. Ultimate disposal will comply with DECC requirements. The exploration program will provide details of water quality and quantity to assist planning of any future activities.

Some sites are within SCA Special Areas and require prior approval from SCA to enter and conduct operations. Apex agrees to adhere to all safety and environmental requirements set out in any SCA Access Standard Conditions to which they are a party.

Wireline geophysical operations require the use of small radioactive sources. These are under the control of the contracted logging engineer who must comply with all legislative requirements as to their use.

Apex is not expecting any subsidence to occur as a result of the Coal Seam Gas Exploration and Gas Monitoring Program. Very minor amounts of gas are planned to be extracted. Should the Program identify commercial gas quality and quantity, Apex would lodge an additional application for Major Project Approval. This would address subsidence issues if there is any likelihood of potential occurrence. Apex does not expect subsidence to occur in the Southern Coalfields as a result of seam and goaf gas extraction.

3.7 Data Collection

The proposed drill holes are designed to collect data necessary for the establishment of the potential for gas production in the project area. Two modes of occurrence for the gas are being investigated:

- Gas held in abandoned mines and generally known as goaf gas,
- Gas held in unmined coal seams and known as coal seam gas or coal seam methane.

Cored Boreholes

Cored holes allow collection of data on depths, thickness and character of unmined coal seams and the overall geological sequence. Specific testing is conducted on coal core to determine gas content and composition and the degree of gas saturation of the coal. Coal seam permeability, which is an indication of how readily the gas may be extracted from the seam, is determined by down-hole testing.

Goaf Gas Boreholes

Goaf gas boreholes function to allow measurement of the composition and potential production rate of gas held in old mine workings. Allowing the gas to flow from the borehole under controlled conditions and measuring the variations in bore-head pressure will enable the potential production to be measured. Such data can be used to indicate the volume of gas in the goaf. Samples of gas for composition analysis are taken during the flow testing.

Exploration Boreholes

Exploration boreholes are designed to allow pump testing of intersected seams to ascertain likely gas and water production volumes. A proportion of coal seam gas can be held in unmined seams by the hydrostatic head (water pressure) in the seam. In these situations, pumping of water from the seam is usually required to reduce this pressure and allow the gas to flow. The required level of reduction in water pressure is related to gas saturation, which will be determined from core tests. Illawarra coals tend to be dry and water disposal is anticipated to be minimal. This has been the experience of Sydney Gas operations in the Camden area.

An initial indication of the rate of water production can be achieved by air-lift testing for several hours at the completion of drilling. This can indicate the size of down-hole pump required for more sustained production testing, and the likely requirements for management of produced water. Water samples will be collected during air-lift testing to determine water quality including pH, salinity, major ions and suspended solids.

All drill holes will be logged by wire-line geophysics to provide data used for borehole correlation and seam characterisation.

The proposed testing methods for cored and exploration boreholes are routinely used and are the accepted method to achieve this data. The testing proposed for goaf gas boreholes is similar to that carried out successfully on the Apex Darkes Forest No 1 Well.

3.8 Site Security and Safety

The borehole sites associated with the project are remote and conspicuous. This means that the exposure to theft and vandalism is potentially high. For this reason Apex has considered measures to reduce this risk. Many of the areas for the proposed boreholes have traditionally been subject to theft and vandalism and as such security must be carefully managed.

3.8.1 Theft

The borehole sites would not be manned continuously after completion and steps would be taken to reduce the risk of theft. These measures would include:

- High perimeter fencing around well heads and pits/poly water tanks,
- Locked gate,
- Substantial fasteners to deter theft of instruments and solar panels,

- Regular inspections,
- Deterrent signage,
- Keeping valuable equipment to a minimum.

3.8.2 Vandalism

Vandalism has been a local issue in many of the proposed borehole sites and measures to deter vandalism would include:

- Regular inspections of each site at random times,
- Deterrent signage,
- High perimeter fencing around well heads and pits/poly water tanks,
- Locked gates.

3.8.3 Safety

Due to the nature of the boreholes it is vital that each site be subjected to a detailed risk management process in order to reduce safety risk. Measures would include:

- Fire fighting facilities (**Section 3.8.4**) i.e.
    - Fire extinguishers
    - Water supply for fire fighting (from a tank)
    - Reduced fuel source management
    - Heat screens
- High perimeter fencing around well heads and pits/poly water tanks,
- Locked gates,
- Fit for purpose equipment,
- Gas flow and pressure monitoring,
- Regular inspections,
- Lockable valves to prevent adverse tampering,
- Safety devises that are consistent with good oil field practice:
    - Non-return valves
    - Steel pipes for reticulation
    - Protection from the elements for well head equipment

- Automatic shut-off system in order to ensure that gas feed is eliminated during a threatening fire situation
- Safety signage i.e.
  - Access for authorised persons
  - Contact phone details (Apex, Rural Fire Service, SCA etc)
  - No smoking within 30 m radius of fence
  - Valve purpose
  - Schematic diagrams for well head equipment
  - Reticulation pipes below ground where possible.

3.8.4 Fire Management

Apex will implement risk management procedures to Australian Standards and individual Site Management Plans (SMP). Operations will be carried out in accordance with the ***Petroleum (Onshore) Act* 1991**, the ***Petroleum (Onshore) Regulation* 2007** and the Schedule of Onshore Petroleum Exploration and Production Safety Requirements (the Schedule). As such full cooperation with the various regulatory authorities and local services such as the Rural Fire Service (RFS) will be developed and maintained. Each well site will form part of Emergency Response Procedures (ERP) detailed in clause 210 of the Schedule. These safety measures will be developed using proper risk management protocols and procedures in full consultation with all stakeholders including the RFS.

Table 3.2 details some measure that would be considered during the development of an Emergency Response Procedure and site management plans.

Table 3.2 – Potential Fire Prevention and Protection Measures

Point	Issue	Comments
1	Fire caused during well construction and/or subsequent operations on site	Drilling operations for each borehole site will be in accordance with a Site Management Plan (SMP) developed using proper risk management techniques in cooperation and consultation with all necessary stakeholders (Apex, RFS, contractor, land owner etc). The SMP will detail fire prevention and protection methods required during such operations. Operation will include drilling, maintenance, monitoring and flaring.
2	Bush fires	Measures as per SMP and ERP including: • Fuel reduction • Fire breaks • Heat shielding • Fit for purpose equipment • Fire fighting measures within the perimeter fence o Fire extinguishers o Water hose (supplied from a tank) • No vegetation within fence (gravel base) • Safety signage including contact telephone numbers
3	Fires caused by vandalism	Vandalism has been a local issue in many of the proposed borehole site areas and measures to deter vandalism would include: • Regular inspections of each well site (times varied) • Deterrent signage (prosecutions etc) • High perimeter fencing around well heads and pits/poly water tanks • Locked gates
4	Fire caused by well head equipment	All equipment will be designed and installed as per good oilfield practice, be fit for purpose and maintained to a standard.

3.9 Alternatives

The borehole drilling and ongoing gas monitoring is required for the determination of the coal seam methane resource. Without these boreholes it is not possible to determine the properties of this resource.

There are no practical alternatives (other than that proposed) to define the coal seam methane gas potential. Drilling has to occur to enable coal and gas samples to be obtained and to determine the long term gas flow rates.

The proposed Program is the only alternative that can measure available gas potential to enable longer-term development of the gas for sustainable power generation or for reticulation for industrial and household use.

3.9.1 Alternative 1 – Do Nothing

If the proposed Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Program does not proceed the Coal Seam Methane resource in the exploration area remains undefined.

This precludes the examination, design and assessment of potential environmentally commendable energy projects in close proximity to Sydney.

3.9.2 Alternative 2 – Exploration Geophysics

Exploration geophysics uses surface methods to probe or detect properties of the sub surface. Exploration geophysics includes techniques such as:

- Reflection seismology,
- Ground penetrating radar.

Geophysical methods are unsuitable for this Program as they will only provide information on geological structures but will not provide information on gas content, gas quality, or borehole flow rates. These are essential data for assessing future energy projects.

3.9.3 Alternative 3 – Coal Seam Gas Exploration Drilling Program (Preferred Alternative)

This alternative is the proposed Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Program. The Program will monitor gas flows and compositions to determine the magnitude and quality of the resource.

3.10 Environmental Planning Background

3.10.1 Wollongong City Council

All activity will be undertaken within the Wollongong City Local Government Area. The area is subject to the provisions of the Wollongong Local Environmental Plan 1990 (LEP 1990). The zoning is 7(a) Special Environmental Protection Zone, 7(b) Environmental Protection Conservation Zone and 7(d) Environmental Protection Hacking River Zone. In these zonings, mining is permitted with development consent. Because the proposal is being assessed in accordance with the provisions of Part 3A of the *Environmental* ***Planning and Assessment Act,*** **1979**, the Minister for Planning will be the determining Authority.

3.10.2 Sydney Catchment Authority

The proposed activity will be undertaken on both Sydney Catchment Authority (SCA) land and private land located within a number of Sydney's water supply catchment areas. There will be a number of boreholes located off water supply catchment on land with an eastern fall directly towards the Pacific Ocean.

The activities on SCA land will be located within the Woronora, Cataract and O'Hares Catchments. SCA have quite detailed conditions controlling access and activity to these Special Areas. Apex would liaise with SCA to obtain agreement with a series of requirements to enable the activities to proceed.

3.10.3 Department of Primary Industries – Mineral Resources

The Department of Primary Industries – Mineral Resources (DPI-MR) administer the ***Petroleum Act,*** **1991** under which the Apex Petroleum Exploration Licences Nos 442 and 444 have been granted. DPI-MR supervision of the activity will address area associated with resource utilisation, safety, and environmental protection.

3.10.4 Department of Environment and Climate Change

The Department of Environment and Climate Change (DECC) have been consulted in relation to fauna, flora and archaeological matters. Biosis Research Pty Ltd has prepared the assessment reports to predict likely impact on these matters. The reports were prepared in accordance with specific DECC requirements.

The level of ongoing involvement of the DECC will be dependent upon the outcomes of the initial assessments.

Given the location and mining title covering this activity, an Environmental Protection Licence from DECC will not be required.

3.10.5 Roads and Traffic Authority

The proposed development will not create new intersections onto public roads and will generate very small additional traffic flows through existing intersections. Consequently, the Roads and Traffic Authority (RTA) will not be required to approve any components of the proposal.

Section 3.11 provides an assessment of likely traffic impacts.

All vehicles involved in the project will be roadworthy, registered and operated in accordance with RTA requirements.

3.10.6 Department of Water and Energy

The Department of Water and Energy (DWE) administer the ***Water Act* 1912** and the ***Water Management Act* 2000**. These acts regulate and control water extraction and use in NSW. Any activity resulting in water extraction or aquifer interference requires a licence. The proposed program will intercept groundwaters and may require licences under these Acts. Apex acknowledges its statutory obligation to obtain all necessary licences under these Acts.

3.10.7 State Environmental Planning Policies

There are a number of State Environmental Planning Policies (SEPP) relevant to this project. They are discussed in the following paragraphs.

State Environmental Planning Policy (Major Projects)

This SEPP is relevant to the Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Program in that it identifies development to which the assessment and approval process under Part 3A of the ***Environmental Planning and Assessment Act* 1979** applies. The Project is being assessed in accordance with Part 3A of the Act.

State Environmental Planning Policy for Mining

The State Environmental Planning Policy (Mining, Petroleum Production and Extractive Industries) 2007 (Minerals SEPP) was gazetted on 16 February 2007.

The SEPP outlines where various minerals activities are permissible both with and without development consent. This specifies that the proposed exploration and gas monitoring can be carried out on any land with development consent.

The SEPP prohibits development specified in Schedule 1. The only development specified at the time of gazettal was open-cut mining within the local government area of Lake Macquarie and identified on a map included in the SEPP.

State Environmental Planning Policy No. 44 (SEPP 44) – Koala Habitat Protection

The Wollongong City Local Government Area (LGA) is listed in Schedule 1 of this SEPP as an area that could provide habitat for Koalas. The SEPP requires an investigation be carried out to determine if core or potential Koala habitat is present on the areas of the Project Site likely to be disturbed. Core Koala habitat comprises land with a resident population of Koalas, whereas potential Koala habitat comprises land with native vegetation with known Koala feed trees constituting at least 15% of the total number of trees present on a site.

3.10.8 Project Approval and Licences

The following approvals are required from the Minster for Planning and a range of government agencies in order for the proposed exploration and monitoring program to proceed.

- **Project Approval – Minister for Planning:** Project approval is required in accordance with Part 3A of the ***Environmental Planning and Assessment Act*** **1979** for all activities associated with the development and operation of the mine.

- **Environment Protection Licence – Department of Environment and Conservation:** An Environment Protection Licence will not be required under Section 47 of the ***Protection of the Environment Operations Act*** **1997** to explore for and monitor the gas.

- **Roads and Traffic Authority:** Roadwork must not be undertaken on a classified State road that involves the deviation or alteration of the road, or the construction of a bridge, tunnel or level crossing unless the plans and specifications of the proposed work have been approved by the RTA. No such work is proposed and an approval under Section 75 of the ***Roads Act*** **1993** would not be required from the RTA. However, appropriate Traffic Management Plans will be developed in consultation with the RTA to ensure safe entry and exit from roads under their control.

- **Water Licence - Department of Water and Energy:** A licence is required under Section 116 of the ***Water Act*** **1912** to permit the extraction of groundwater during drilling activities.

- **Entry Approval - Sydney Catchment Authority:** Permission to enter and undertake activity within a Special Area will be required from the Sydney Catchment Authority.

The gas is owned by the Crown, and all petroleum exploration approvals required by Apex have been obtained from the DPI-MR. Further leases would be required before gas extraction and utilisation could be undertaken.

3.11 Consultation

During the preparation of the Environmental Assessment, Apex and its various consultants have consulted with the relevant local, State and Commonwealth Government authorities. This has ranged from one–on–one meetings through to phone calls. The level of consultation reflected the degree of involvement of each stakeholder.

Apex will continue the consultation activities throughout the processing of the Major Project Application. Should the Program define gas of commercial quantities and quality, Apex would

anticipate submitting further Major Project Applications to develop the defined gas resource. This would involve further consultation and Apex has acted to ensure that ongoing consultation will occur.

During compilation of the Environmental Assessment Apex have met with representatives of the Department of Planning, Department of Water and Energy, Department of Environment and Climate Change (including NSW National Parks and Wildlife Service), Department of Primary Industry - Mineral Resources Division, Sydney Catchment Authority, Wollongong City Council and the Crown Lands Office. In order for the Environmental Assessment to be assessed for adequacy for public review it was forwarded to these groups (apart from the Crown Lands Office).

The majority of the boreholes are located on Sydney Catchment Authority land or on privately owned land within catchment areas. Most boreholes are isolated from public view and access. Of the 15 proposed to be drilled, only 2 (AI05 and AI06) are predicted to have potential impact on individual residents. The landowners likely to be affected have been contacted and ongoing consultation is underway with them.

Consultation with Government authorities and private individuals has not identified any additional matters or concerns than those already identified in the DGRs and addressed in this Environmental Assessment. All matters raised during consultation have been addressed in this Environmental Assessment.

4 ENVIRONMENTAL IMPACT ASSESSMENT

4.1 Introduction

This section addresses the environmental issues, predicted in the Preliminary Environmental Assessment dated July 2007 and summarised in **Table 4.1**, and those issues required to be assessed by the Director General's requirements (DGRs).

Apex intended to drill approximately 18 boreholes and the investigative reports included in **Appendices I** to **VI** reflect that original intention. Subsequent considerations have reduced the number of boreholes to the 15 identified in the preceding sections in this Environmental Assessment. These boreholes, denoted as AI04B, AI05, AI06, AI07, AI08, AI09, AI10, AI11, AI12B, AI13, AI14, AI15, AI16, AI17 and AI18, are discussed further in the following sections. Note the boreholes referenced in the investigative reports, but not included in this section are AI01, AI02 and AI03.

Table 4.1 – Summary of the Issues and the Level of Assessment

What are the key issues? Extent of the impacts? Nature of the impacts? Environmental sensitivity of the site?	**What is the extent of the studies required to determine the level of risk?**	**What is the extent of the studies required to avoid, minimise or manage the impacts so the risks are acceptable?**
1. Surface Water Quality Management	Comparison with similar activities.	Identify and commit to implementing standard operating control measures. Preparation of Water Management Plan. Determine neutral or beneficial effect.
2. Flora and Fauna Impacts	Undertake flora and fauna study in accordance with standard procedures. Minimise area cleared and implement selective clearing as required.	Undertake flora and fauna study in accordance with standard procedures. Minimise area cleared and implement selective clearing as required.
3. Archaeological, Historical and Heritage Implications	Undertake archaeological and heritage study in accordance with appropriate requirements and incorporate findings into project design.	Undertake archaeological and heritage study in accordance with appropriate requirements and incorporate findings into project design.
4. Dust and Air Quality	Comparison with similar activities.	Identify and commit to implementing standard operating control measures.
5. Noise and Vibration	Comparison with similar activities.	Identify and commit to implementing standard operating control measures.
6. Waste	Determine waste streams and volumes and identify appropriate management response.	Determine waste streams and volumes and identify appropriate management response. Develop Waste Management Plan.
7. Soil Management	Comparison with similar activities.	Identify and commit to implementing standard operating control measures.
8. Greenhouse Gases	Comparison of predicted emissions with national and international emissions.	Identify and commit to implementing standard operating control measures to minimise greenhouse emissions.
9. Rehabilitation	Comparison with similar activities.	Identify and commit to implementing standard operating control measures.

4.2 Water Quality

4.2.1 Introduction

Ecoengineers Pty Ltd (Ecoengineers) was commissioned to provide an assessment of potential water related impacts associated with the proposed Coal Seam Gas Exploration Drilling and Gas Monitoring Program. A complete copy of their report, ***"Assessment and Management of Water-related Impacts – Illawarra Coal Seam Gas Exploration Program, September 2008"*** is included in this Environmental Assessment in **Appendix I**. The report investigates the 18 boreholes originally proposed. Apex has decided to install only 15 out of the 18 boreholes investigated at this time. The following discussions on water quality reflect the lower number of boreholes.

Each proposed borehole site was inspected in the field and site specific recommendations to avoid and/or minimise water impacts were developed.

At the time of installation, each borehole site will be assessed for the potential for run on water. A sedimentation fence will be constructed immediately down slope of the drill sites.

The sedimentation fences will be installed in accordance with requirements as described in ***"Soils and Construction", 1st Edition, March 2004***.

Should any surface drains and/or sedimentation basins be required during construction, they will be constructed in accordance with the Landcom publication, ***"Soils and Construction" Volume 1, 4th Edition, March 2004"***.

Sedimentation controls will be installed along the access roads. These would include such things as sedimentation fences, water diversion structures and establishment of a vegetative cover.

The construction contractor will prepare a Site Environmental Management Plan that will address site water management details.

4.2.2 Potential Water-Related Impacts

The National Water Quality Guidelines (NWQ Guidelines) classifies the receiving waters in the area in which the exploration program will be undertaken as 'upland rivers and streams'.

Expected groundwater qualities, and associated potential impacts for such produced water are assessed with reference to the NWQ Guidelines in the following sections.

4.2.2.1 Stormwater Runoff

There is a potential for significant topsoil erosion due to site run-off during and immediately following the clearing of each site, and prior to the commencement of drilling. At some of the drill sites there is also potential for erosion to be caused by run-on from upslope areas.

Given the small size of the drilling sites, loss of significant sediment off-site, however, would be unlikely if there were adequate stormwater detention volume provided and, in the case of one site (AI04B) with slope exceeding approximately 5%, adequate diversion of run-on from upslope areas.

4.2.2.2 Drilling Fluids

In terms of water used for drilling, the only additive that may possibly be used is potassium chloride (KCl) solution, which may be needed to provide clay stability. Should KCl be used, it is standard practice in the Southern Coalfield to use a 5% weight:volume ratio KCl concentration in the drilling fluid.

All drilling sites are located on the Woronora Plateau, an area characterized by extremely low soil salinities. Any impact related to the loss of KCl solutions into the surrounding environment would relate primarily to the high salinity of the water, which would have an electrical conductivity of approximately 6800 µS/cm.

This salinity greatly exceeds the default trigger value for the protection of 95% of all freshwater species in upland rivers, as set out in the NWQ Guidelines. If such solutions were to be lost offsite, negative effects would likely be seen on any native vegetation receiving these waters, and potentially also in any nearby non-ephemeral receiving water.

4.2.2.3 Groundwater

During the drilling and gas testing activities, it is anticipated that groundwater will be brought to the surface. It is likely that, should any groundwater produced be lost off-site there would be a potential for significant off site phyto- and ecotoxic effects.

Due to the possibility of there being significant concentrations of dissolved methane (CH_4) in some produced groundwater, any release off site, even if it this does not reach a receiving water, will likely cause a temporary growth of methanotrophic bacteria (which are ubiquitous) in the down slope drainage line.

It is known that there are metabolic products of such growth, including 4-methyphenol (para-cresol) and possibly hydrogen sulfide which exhibit phyto- and ecotoxic-effects. Should such water reach nearby receiving waters such compounds are also ecotoxic to aquatic species.

Some produced groundwaters would also have elevated salinity and concentrations of heavy metals, which may be phyto- and/or ecotoxic.

Expected groundwater qualities associated with the major strata are presented in **Table 4.2**. The values for the Hawkesbury and Bulgo Sandstones were drawn from a recent University of Wollongong Honours research study over Dendrobium Mine Area 2, whereas all other data were drawn from Ecoengineers' substantial resources of past studies for local coal mining companies.

The values shown for the water quality parameters pH, Electrical Conductivity (EC; a measure of salinity), sodium (Na), aluminium (Al), iron (Fe), manganese (Mn), nickel (Ni), zinc (Zn) and arsenic (As) are based on past experience and are presented as means with probable error limits at the ± one standard deviation level.

The default trigger values for the protection of 95% of all freshwater species in upland rivers, as set out in the NWQ Guidelines, are shown in the final row.

Table 4.2, shows that for each of the parameters where NWQ Guidelines default trigger values are available, at least one of the groundwaters tabulated has an exceeding mean value.

In addition to ecotoxic effects arising from possible exceedance of NWQ Guidelines default trigger values, there are potentially deleterious effects on dissolved oxygen (DO) in receiving waters resulting from the physical addition and mixing of anoxic groundwater with them.

High concentrations of dissolved iron (Fe), despite having no trigger value and manganese (Mn), are sometimes present in these groundwaters. This is particularly so with those groundwaters associated with Bulgo Sandstone which can have substantial water storativity in some areas. High concentrations of Fe and Mn can also reduce DO concentrations, as both metals consume DO when being oxidized to form insoluble oxyhydroxides. This effect also lowers the pH of the water (i.e. makes it more acidic).

Table 4.2 – Typical Groundwater Qualities Associated with Major Strata

Strata	pH	EC (µS/cm)	Na (mg/L)	Al (mg/L)	Fe (mg/L)	Mn (mg/L)	Ni (mg/L)	Zn (mg/L)	As (mg/L)
Hawkesbury Sandstone	5.19 ±0.48	92.3 ±40.2	9.2 ±2.8	0.071 ±0.065	0.457 ±0.748	0.132 ±0.180	0.073 ±0.046	0.374 ±0.537	
Bulgo Sandstone	5.88 ±0.71	281 ±272	14.3 ±3.4	0.02 ±0.01	1.012 ±0.819	0.307 ±0.167	0.497 ±0.298	4.477 ±3.450	
Scarborough Sandstone	8.07 ±0.28	844 ±89	176 ±32	0.009 ±0.01	0.561 ±0.632	0.028 ±0.030			0.002 ±0.001
Wombarra Shale	7.60 ±0.23	1741 ±61	405 ±19	0.007 ±0.005	0.029 ±0.012	0.017 ±0.002			0.038 ±0.009
Wongawilli Seam	7.98 ±0.20	6605 ±7	2030 ±269	0.015 ±0.014	1.56 ±2.17	0.023 ±0.003			
NWQ Guidelines	**6.5-7.5**	**30 - 350**	**n/a**	**0.055 (pH>6.5)**	**n/a**	**1.9**	**0.011**	**0.008**	**0.013**

4.2.2.4 Groundwater Interception

Apex has investigated the likelihood of their drilling program intersecting groundwater aquifers and creating the potential for excessive groundwater to be released at the surface. Apex concluded that the likelihood of this occurring is very remote. This conclusion is based on the known absence of recognised aquifers beneath the Eastern Woronora Plateau and hydrogeological experience obtained in the course of extensive coal exploration drilling and coal mining in the area. Apex has discussed this matter with experienced geologists and groundwater consultants who have extensive experience of the proposed drilling area.

There were no aquifers in this part of the Southern Coalfield recognised, assessed and classified as such by the former Department of Land and Water Conservation (DLWC) in any of their 5 guideline publications on recognised groundwater resources (exploited or otherwise) within NSW. The continuing absence of any viable farm bores in the proposed exploration area supports the DLWC's findings.

The principal reason why any groundwater encountered in the proposed drilling program will be of small volume and easily managed is that it has always been found in the Woronora Plateau Region that the vertical transmissivity in local strata is extremely low except where, due to undermining, goafing has occurred. Furthermore, in such undisturbed strata it has been found that:

- Horizontal transmissivity always far exceeds vertical transmissivity,
- Regionally horizontal transmissivities are invariably far lower than those typically found in an aquifer,
- Hydraulic gradients are also very low.

This means that any water bearing strata encountered is extremely unlikely to provide a significant make of groundwater into the borehole. The Department of Water and Energy (DWE) and other stakeholders have been copied over the years with major consultancy study reports which have invariably reached the above conclusions. This is also consistent with the prior position of the former DLWC. Some examples of these reports include the June 2004 GHD LongMac report for BHP Billiton Illawarra Coal on Dendrobium Area 1 Hydrogeology and their December 2007 report for BHP Billiton Illawarra Coal on Dendrobium Mine proposed Area 3 Hydrogeology. There is also a recent (February 2009) report by Dr. Noel Merrick on Dendrobium Area 2 Hydrogeology and another report by Dr Merrick on Metropolitan Colliery Lease Area Hydrogeology which also endorses this view.

In general terms there are 4 strata which, at various discrete places have been known to contain bodies of in situ water which may appear from time to time in such places as underground workings or in gas drainage boreholes. These potentially water-bearing strata are:

- Hawkesbury Sandstone
- Bulgo Sandstone
- Lower Scarborough Sandstone
- Eckersley Formation

Of these known potential minor water bodies, the Hawkesbury Sandstone groundwater is generally found close to the surface in hill slope aquifers. These will not be affected by the drilling program. There may be some Hawkesbury Sandstone waters at depth, but these have always been found to be very small and scattered and most unlikely to be intersected by drilling. There are also some perched water bodies that occur above the Hawkesbury Sandstone at its interface with the Wianamatta Shales. However, these only occur further to the west of the proposed drilling. The Wianamatta Shale has eroded from the drilling area and all holes will commence in Hawkesbury Sandstone.

The Bulgo Sandstone is known to contain some connate water, however, this has occurred in the Nepean Valley further to the west (down dip) of the proposed drilling. Bulgo Sandstone is expected to occur in all boreholes, however, it is most unlikely to contain any connate water in the proposed drilling area.

The Lower Scarborough Sandstone water, where it occurs, is known to enter the Bulli Seam underground workings. It is most unlikely to occur in the proposed drilling area. However, should it be intersected drilling operations would switch from air to mud to pressurise the borehole and stop inflow. If this action did not stop the inflow, the hole would be abandoned.

In mid 2008, Apex undertook a digital magnetotelluric (DMT) survey to assist in the design and planning of the exploration and monitoring project. The DMT survey provided structural geological data as well as identifying water in goafs and the presence of water bodies in strata.

The survey was undertaken at 30 representative sites across the proposed exploration area and the data was correlated with information from 7 previously established boreholes. Only one site returned a positive identification of water bodies. This was at the existing Darkes Forest Number 1 borehole site. Darkes Forest No 1 borehole already exists and does not result in groundwater accumulating on the surface.

This confirms that there is very little water in the strata that will be intersected during the proposed exploration activity. Historic drilling activity in the area together with experience of

people who have worked in the mines in this area strongly indicate that the area is dry and very little groundwater flowed into boreholes or underground mines.

In the unlikely event of significant water flows, the surface sump and bunded area would be capable of on-site storage until tankers transport the water off-site.

The drilling will be undertaken from the elevated sandstone plateau west of the Illawarra Escarpment. Consequently, the potential for artesian flows in any boreholes is negligible. The only production of water during drilling will be if air drilling is used where water is lifted from the hole by the pressure of the drilling air. Should excessive flows be encountered that cannot be adequately contained at surface, water make can be stopped by conversion to water based drilling. Once blow-out-prevention equipment (which will be required for drilling through the coal measures) is installed at the wellhead, this will provide an additional control on any upward flow.

Other factors which should minimise any effect on aquifers or aquifer dependent ecosystems include:

- The proposed boreholes are located away from known faults which may be zones of enhanced permeability and hydraulic connectivity.

- In respect of boreholes drilled over mined areas, any groundwater within rock intersected by goaf fractures eg Scarborough Sandstone, will have drained down into the goaf. Subsequent drilling will encounter pre-drained rock.

- Proposed boreholes are not located adjacent to incised drainage hence any slight drawdown adjacent to the hole is unlikely to have an effect on baseflow to surface streams.

- Casing installed as an anchor for blow out prevention equipment will protect any shallow aquifers in the Hawkesbury Sandstone which may feed upland swamp areas.

4.2.2.5 Groundwater Contamination

The previous section describes the low likelihood of occurrence of significant water bodies in the proposed drilling area. This significantly reduces the likelihood of any cross contamination of water bodies as a result of drilling. However, drilling actions are implemented to minimise the likelihood of any cross contamination.

The degree of potential for cross flow of water between water bodies will depend on the type of borehole. This potential is discussed in the following paragraphs.

Section 3.1 describes the borehole construction methodology that will be implemented to avoid aquifer contamination or drainage during drilling.

Goaf Hole to Bulli Seam Only: These are large diameter boreholes that only intersect the strata sequence above the Bulli Seam. During their drilling, there is a short exposure of any water bodies to an open borehole before casing and cementing of the borehole. This casing and cementing ensures that there is no potential for aquifer impact apart from some localised cement incursion. The only interval that will not be cased will be that immediately overlying the Bulli Seam goaf. While drilling with air, there may be some water production, but this will be a small volume that will be accommodated in the sumps on the surface. If the drilling is being undertaken with water-based mud, the in-hole mud pressure will usually be greater than the hydrostatic pressure in the water body. This may result in minor penetration of drilling water into the local water body. Should that penetration become significant it would be immediately

apparent in reduced return flow to the surface sump. If this were to occur, suitable materials such as sawdust or chaff based plug material would be added to minimise the observed penetration. These are typical of the materials commonly used in drilling in this area.

Cored Holes: These are small diameter (96 mm) open holes from which solid cores of the intersected rock and coal are removed. The drilling of these holes requires a longer duration on site to obtain the core samples. The upper part of the hole above the coal measures is however drilled more rapidly by open borehole methods. The smaller diameter minimises the area of interaction with any potential water bodies. During drilling activity, water pressure in the borehole will be greater than hydrostatic pressure as a result of the mud pump. When the borehole is not actively drilling, the borehole pressure will be determined by the level of clays in the water and any drilling additives. It is usual for the borehole pressure to be just slightly higher than hydrostatic pressure minimising the potential for water bodies to flow into the borehole.

At the completion of use (both exploration and gas production) all boreholes will be completely sealed from top to bottom using cement grout. This will eliminate the potential for future water body mixing or contamination.

There are also boreholes that will be a combination of these two described above. The likely impacts and management of these types of holes will be a combination of what has already been described.

Drilling operations will incorporate a number of actions to manage potential water contamination. Drainage arrangements will be installed to prevent infiltration or seepage into the boreholes from the surface. Accidental entry by fauna will also be controlled. Measures will be implemented to control the amount of oil and grease on drilling equipment. The site will be secured to minimise vandalism potential. Any drilling additives will be screened to ensure they are appropriate for use on site and do not create water contamination.

4.2.3 Surface Water and Sediment Control

4.2.3.1 Site Management

Conceptual site layouts showing the general site requirements for Air (open) and Core drilling using both in-ground mud pits and above ground tanks are shown in **Figures 3.3**, **3.4** and **3.5** respectively. These conceptual layouts contain minor modifications to those previously presented in the Preliminary Environmental Assessment.

The modifications include the widening of the arc made by the earth spoil bund so that the angle drawn from the drill hole is a minimum of 90^o, i.e. 45^o on either side of the site's drainage line. Additionally, run-on diversion drains have been added to the layouts, as these are required for some sites to divert clean surface water into existing drainage lines and away from the drill site.

The main components of the dirty water containment system are:

- Excavated drill sump(s),
- Earth spoil bund.

For air drilling, excavated sumps would be approximately 10 m x 7 m, and 2 m deep, i.e. having a total capacity of approximately 140 m^3. For core drilling, should excavated pits be used for the recirculation of drilling fluids, two sumps would be required, each approximately 3 m x 4 m and 2 m deep, i.e. a volume of approximately 25 m^3.

Silt-stop fencing will be installed on the downslope extremes of the sites to control sediment prior to and during the clearing of the site.

The bund would be constructed immediately following the site clearing. This construction is critical, as from this point on the risk of erosion during high rainfall events is high.
The down-slope bund wall is required for:

- Safe containment to site of any bore cuttings,
- Safe containment to site of any excess drilling fluid confined to the drill sump or onsite tanks,
- Disturbed site stormwater runoff containment and sediment settlement prior to off–site release.

On-site storage of fuel, lubricants, potassium chloride and any other chemicals would be kept to a minimum and these items would be stored in bunded pallets, as the earthen bund will only be suitable for water and drilling fluid containment.

4.2.3.2 Site-Specific Water Detention Requirements

In their document, ***"Bunding and Spill Management 2008",*** DECC specifies that the net capacity of a bund must be at least 100% of the net capacity of the largest site storage tank. Also, it is recommended that an additional allowance be made so that the bund has sufficient capacity to cope with a significant storm.

Water onsite is most likely to be brought in by tanker. Generally such water tanks will have a net capacity of approximately 20 m^3, a volume which will be easily captured by the site's bunding system.

The ability of the recommended bunding system to capture run-off following significant rainfall events is discussed in the following paragraphs. The calculations have been based on the volume contained by the bund wall and does not include that of excavated drill sump(s).

Assuming an average slope of 5% for the majority of near-level sites, the required minimum bund wall height is 660 mm, and this is recommended as a minimum height for all but one site (AI04B).

This bund wall height means that the detention volume is approximately 19 m^3, allowing for capture of a 20-year, 6 hour rainfall event of total rainfall approximately 42 mm.

The steeper site at AI04B has an estimated slope of about 10%. This slope will require a bund wall of a minimum height of 1320 mm, giving a detention volume of approximately 380 m^3. This detention volume allows for the capture of a 20 year, 10 hour storm event of total rainfall approximately 84 mm.

Following the completion of operations at each site, water contained in site sumps and behind the bund wall will be allowed to settle. The ultimate disposal of water collected in the sump will depend on its final quantity and quality, and will comply with DECC requirements. It is proposed that waste drilling fluid will be removed off site by tanker in all cases. **Table 4.3** identifies the direction or location of the required down-slope bund, the arc through which the bund should extend, the recommended minimum bund wall height and in the case of AI17 identifies where an upslope run-on diversion drain is also required.

Table 4.3 – Surface Water and Sediment Control Requirements for Each Drilling Site

Drilling Site	Centre Point of Down-slope Bund	Bund Arc Recommended	Minimum Bund Wall Height Required (mm)	Additional Surface Water Control Measures
AI04B	NE	N to E	1320	
AI05	S	SE to SW	660	
AI06	W	SW to NW	660	
AI07	NNE	NNW to ENE	660	
AI08	N	NW to NE	660	
AI09	Bunding is required on the eastern side of the access road (hole is on western side)	N to E, with the northern edge of bund wall meeting the pre-existing drainage channel.	660	
AI10	ESE	NNE to ESE	660	
AI11	N	NW to NE	660	
AI12B	E	NE to SE	660	
AI13	NW	W to N	660	
AI14	W	SE to NW. Northern end of bund to meet the access road.	660	
AI15	NE. On southern side of the road.	N to E	660	
AI16	NE	N to E	660	
AI17	NW of the hole.	W to N	660	Run-on diversion drain required to divert water from existing concreted drainage line away from site.
AI18	NW	N to W, with the edge of the bund meeting the access road.	660	

4.2.4 Conclusions and Recommendations

The default upper limit for salinity (EC) in local receiving waters is 350 µS/cm (***ANZECC/ARMCANZ, 2000***). Consequently, immediate or eventual exceedances in local receiving waters would be likely if any significant volume of drilling fluid containing 5% KCl, or most produced natural groundwaters greater than say 10 m^3 were to be discharged off-site.

Additionally, some groundwaters encountered during air-lift testing would likely also show potentially ecotoxic levels of trace metals, such as aluminium (Al), arsenic (As), manganese (Mn), nickel (Ni) and zinc (Zn).

Considering the likely detrimental environmental effects of drilling fluid and produced groundwaters should they not be successfully contained on-site, Ecoengineers considered the bunding requirements described in **Section 4.2.3.2** to be of critical importance and would be implemented at all sites.

In the event of a spill of produced groundwater onsite which is not contained within site sumps or above ground tanks, a water quality sampling and testing service would be employed to ensure that any 'normal' stormwater runoff retained by the bund wall has not been contaminated and, if it has, that prompt removal by tanker would occur.

Appropriate procedures for eroded sediment and surface water control have been set out in **Section 4.2.3.1**.

Ecoengineers concluded that with the sediment and surface water controls implemented as specified, no off-site impacts of site stormwater runoff, drilling fluid, chemical or produced groundwaters would be expected.

Ecoengineers made a number of recommendations which would be implemented. These recommendations are designed to avoid or minimise water impacts and include:

- For core drilling sites, where excavated sumps are used for the circulation of drilling fluid rather than above ground tanks, Ecoengineers strongly recommended that in the event of an actual commenced or predicted very high rainfall event, if possible drilling fluid would be confined within the mud pits and temporarily covered with say a tarpaulin so that mixing with stormwater is prevented.

- Significant amounts of produced groundwaters which can be confined within on site tanks or pits would have pH and EC monitored prior to tankering away off–site.

- To assess requirements for management of excessive volumes of produced groundwaters i.e. volumes which have not been successfully confined within on site tanks or pits and are contained behind the site bund wall, water samples would be collected to determine water quality in the event of possible loss of containment. This would be done by measuring pH and EC onsite, and collection by an appropriately trained person of samples to be sent to a NATA-accredited laboratory for determination of key chemical analytes as identified in **Table 4.2.**

- On demand, water quality sampling and analysis would be conducted in the unlikely event that there is any uncontrolled release from the site water containment system.

4.3 Flora and Fauna

4.3.1 Introduction

Biosis Research Pty Ltd (Biosis) was commissioned to undertake an assessment of the Program's impact on flora and fauna. A complete version of their report, ***"Flora and Fauna Impact Assessment: Illawarra Coal Seam Gas Exploration Program, October 2008"*** is included as **Appendix II**. This report investigates the 18 boreholes originally proposed. Apex has decided to install only 15 out of the 18 boreholes investigated at this time. The following discussions on flora and fauna reflect the lower number of boreholes.

The assessment was carried out for approval under Part 3A of the NSW ***Environmental Planning and Assessment Act* 1979** (EP&A Act) with reference to threatened biota listed on the NSW ***Threatened Species Conservation Act* 1995** (TSC Act) and the Commonwealth ***Environment Protection and Biodiversity Conservation Act* 1999** (EPBC Act).

The study was designed to be a habitat assessment, and therefore did not include trapping, spotlighting, active searching, call playback techniques and vegetation quadrat sampling.

Some plant species that occur in the locality are annuals and are present only in the seed bank for much of the year. Other plant species are perennial but are inconspicuous unless flowering. However, as the assessment of impact is based on the presence or absence of suitable habitat for threatened flora and fauna, such species are taken into account during the assessment

even though they may not be conspicuous during the survey. This methodology meets the requirements of the EP&A Act.

The Study Area supports Coastal Sandstone Ridgetop Woodland, Coastal Sandstone Gully Forest, Coastal Upland Swamp and Cleared areas.

The proposal would involve clearing or modifying approximately:

- 2.4 ha of Coastal Sandstone Ridgetop Woodland,
- 0.6 ha of Coastal Sandstone Gully Forest,
- 1.2 ha of Coastal Upland Swamp,
- 4.8 ha of disturbed areas supporting regenerating common native and exotic species.

No Endangered Ecological Communities (EEC) listed on the TSC Act or EPBC Act were recorded in the Study Area. No threatened plant species were recorded within the Study Area. However, potential habitat for eight threatened species (*Acacia bynoeana, Callistemon linearifolius, Cryptostylis hunteriana, Epacris purpurascens* var. *purpurascens, Persoonia acerosa, Persoonia hirsuta, Pomaderris adnata,* and *Pultenaea aristata*) occurs within the Study Area.

The proposal is likely to remove or modify potential habitat for fifteen threatened animal species listed on the TSC Act (Koala, Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Bent-wing Bat, Eastern Freetail-bat, Large-footed Myotis, Red-crowned Toadlet, Square-tailed Kite, Gang-gang Cockatoo, Glossy Black- cockatoo, Powerful Owl, Sooty Owl, Barking Owl, Masked Owl and Eastern Pygmy-possum) and eight threatened species listed on the EPBC Act (Grey-headed Flying Fox, Satin Fly catcher, Black-faced Monarch, Rainbow Bee-eater, Regent Honeyeater, Swift Parrot, Southern Brown Bandicoot and Large-eared Pied Bat).

Impact Assessments following the Part 3A Guidelines under the EP&A Act were carried out for the threatened biota listed on the TSC Act occurring or with potential habitat in the Study Area. These assessments concluded that the proposal would have a minor impact, given that a relatively small area of potential habitat would be impacted and none of the threatened species were recorded during surveys of the Study Area. Further, impact assessments following the EPBC Act Significant Impact Guidelines were prepared for threatened biota listed under the EPBC Act with potential habitat in the Study Area. Biosis concluded that the proposal would not have a significant impact on threatened biota.

Biosis did not consider it necessary to undertake a Referral for Matters of National Significance (EPBC Act) for any threatened biota within the Study Area.

Biosis recommended mitigation measures to minimise any disturbances of the proposal on the ecological values of the Study Area. These are included in **Section 4.3.6.2** and would be implemented by Apex.

4.3.2 Objectives and Methodology

The fauna and flora assessment consisted of the following stages:

- A literature review and database search for the locality,

- Targeted field surveys for habitat of threatened terrestrial flora and fauna species, populations or ecological communities that were listed on the TSC Act and the EPBC Act and were identified as potentially occurring in the locality,

- Assessment of the habitat values of the various sites,

- Undertake impact assessments for threatened biota listed on the TSC and/or EPBC Acts following the guidelines for threatened species assessment under Part 3A of the EP&A Act and the EPBC Act Significant Impact Guidelines,

- Provision of recommendations to minimise the environmental impacts of the proposal.

4.3.3 Potential Impacts

The disturbance footprint of each borehole site typically comprises a 50 m x 60 m compound with additional light vehicle parking for up to six vehicles. The shape of this typical area would be modified in response to specific site conditions. Additional construction of access tracks may be required. During field assessment, Biosis assumed that a total area of 80 m x 80 m for each disturbed area was adequate to consider all direct and indirect impacts associated with the proposal.

Potential direct impacts as a result of implementing the proposal that were considered in the Fauna and Flora assessment included:

- Vegetation clearance,

- The removal of potential habitat,

- The fragmentation of potential habitat.

Indirect impacts included:

- Erosion potential,

- Creation of a suitable seed bed for exotic weed invasion,

- Increased human activity within or adjacent to sensitive habitat areas.

Sections 4.3.6.1 and **4.3.6.2** discuss the specific impacts associated with the proposal and the proposed amelioration measures. Direct impacts are usually unavoidable while indirect impacts are usually mitigated through amelioration measures.

4.3.4 Existing Conditions

The area where the proposal will be undertaken generally supports intact native vegetation in good condition with high native species diversity. Some borehole locations had been previously disturbed by coal mining and quarry activities. These disturbed areas generally supported reduced species diversity and given the degree of topsoil disturbance, have a limited capacity to regenerate.

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. Areas located away from major water courses are typically gently undulating crests, ridges and plateau surfaces.

The region within which the project will be undertaken includes a number of waterbodies such as rivers, lakes, creeks and drainage lines. The main waterbodies include Warratah Rivulet, O'Hares Creek, Iluka Creek and Maddens Creek in the northwest and Lodden Creek in the south with a number of smaller tributaries and drainage lines.

Within the area around the Project there are two predominant soil landscapes, with minor occurrences of a third soil landscape. The Project will be undertaken on Hawkesbury Sandstone, with occasional occurrences of the Mittagong Formation when the Lucas Heights Soil landscape is encountered.

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. Sandstone rock outcrops are very common, and occur as boulders, benches and large blocks, often forming scarps up to 10 m high. This soil 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 Bundeena Soil landscape comprises exposed plateaux and coastal headlands within the Woronora Plateau. The soils consist mostly of siliceous and earthy sands, along with yellow earths and gleyed podzolic soils on the mid to lower slopes. Swamps are a common feature of this landscape.

The Lucas Heights Soil landscape consists of soils which are generally yellowed to lateritic podsolic. Within the area affected by the Project this soil type is confined to the ridge tops and gentle slopes.

4.3.5 Outcomes and Recommendations

4.3.5.1 Boreholes

Section 4.1 of the Biosis Report includes detailed descriptions of each borehole including likely flora and fauna occurrences together with impact assessment and specific recommendations for environmental impact minimisation at each borehole site. These recommendations are accepted and would be implemented, with the exception of those made for boreholes AI01, AI02, AI03 and AI04A.

Table 4.4 summarises the data in Section 4.1 of the Biosis report and lists their recommendations to reduce impacts at each proposed borehole site.

Table 4.4 – Boreholes Locations and Recommendations to Reduce Impacts

Description	Impacts	Recommendations
Borehole AI04B: Intact native vegetation. Clearing required for access (approximately 80m) off existing fire road	Vegetation clearing required for borehole location and access.	Large trees with hollows occur in vicinity of site, which will be retained. No drilling activities should occur within 2m of the outer drip line of trees to protect the root zone and prevent dieback. Rocky outcrops should be retained and protected. If required to be moved during construction, these habitat features should be replaced on completion of works. Sediment fencing required to protect downslope areas of native vegetation from indirect impacts. Borehole AI04A would be the preferred location for this borehole, given the impact of Borehole AI104B on intact habitats.
Borehole AI05: Former gravel pit within Dharawal State Conservation Area, with extensive disturbance to topsoil.	Minimal vegetation clearing required for borehole and access. A few trees may need to be lopped along access track.	Sediment fencing required along southern boundary of borehole site to prevent impacts to downslope native vegetation and Maddens Creek. Sediment fencing also required on western edge to protect the small dam.
Borehole AI06: Darkes Forest Shaft site, with vacant buildings and bitumen carpark. Coal wash established over topsoil.	Minimal clearing required.	Retain existing trees. No drilling activities should occur within 2m of the outer drip line of trees to protect the root zone and prevent dieback.
Borehole AI07: Cleared area, with coal wash established over topsoil.	Minimal clearing required. No large trees to be cleared.	Sediment and erosion controls required on northern side of borehole site to minimise impacts to downslope upland swamp.
Borehole AI08: Cleared area, with coal wash established over topsoil.	Minimal clearing required.	Sediment fencing required along north-western side of borehole site to minimise impacts to downslope swamp.
Borehole AI09: Cleared area, with coal wash established over topsoil. Borehole location within road, extending into adjoining vegetation.	Minimal clearing required. No impacts to threatened flora or potential habitats.	Sediment fencing required along west and east side of borehole site to minimise impacts to adjoining swamp.

Description	Impacts	Recommendations
Borehole AI10: Intact native vegetation adjoining fire road. Access via Fire Road 10Q, including two creek crossings.	Vegetation clearing required for borehole location. Creek crossings should remain on existing crossings only.	Retain existing trees. No drilling activities should occur within 2m of the outer drip line of trees to protect the root zone and prevent dieback.Minimise clearing area required, restrict development to existing cleared fire road as far as practicable. Sediment and erosion control measures fencing required along north, east and south of boundary of borehole site to minimise impacts to upland swamp. Caution should be taken to prevent sedimentation run off and minimise disturbance to the 2 creek crossings along Fire Road 10Q.
Borehole AI11: Disturbed area, previously cleared. Former gravel pit, with extensive disturbance to topsoil.	Clearing of common native shrub and groundcover species required. No trees required to be cleared.	Sediment fencing required along south-western and north-eastern boundary of borehole site to prevent impacts to drainage areas and waterbodies.
Borehole AI12B: Intact native vegetation.	Vegetation clearing required for borehole location.	Miminise clearing area required. No trees to be removed. Sediment and erosion control measures fencing required along south, east and west boundary of borehole site to minimise impacts to upland swamp and woodland.
Borehole AI13: Disturbed native vegetation.	No trees will need to be removed. Clearing of regrowth shrubs and small trees required.	Restrict clearing to area previously cleared, avoiding adjoining intact bushland. Sediment fencing required along south east boundary to minimise impacts to adjoining intact vegetation.
Borehole AI14: Intact native vegetation.	No trees will need to be removed. Clearing of dense shrubs and groundcover species required.	Minimise clearing area required. Sediment and erosion control measures fencing required along southern boundary of borehole site to minimise impacts to upland swamp and woodland.
Borehole AI15: Intact native vegetation.	No mature trees will need to be removed. Clearing of small trees, dense shrubs and groundcover species required.	Minimise clearing area required. Sediment and erosion control measures fencing required along south, east and northern boundaries of borehole site to minimise impacts to adjoining upland swamp and woodland.

Description	Impacts	Recommendations
Borehole AI16: Former gravel pit, cleared of native vegetation with disturbance to topsoil. Access along existing access track off Fire Road, including two creek crossings along Fire Road 10Q.	Clearing of common native shrub and groundcover species required. No trees required to be cleared. Some tree branches will be lopped along the Fire Road to facilitate access. Creek crossings should remain on existing crossings only.	Sediment fencing required along the south eastern boundary of the borehole site. Avoid impacts to adjoining intact native vegetation. Caution should be taken to prevent sedimentation run off and minimise disturbance to the 2 creek crossings along Fire Road 10Q.
Borehole AI17: Cleared area, with coal wash established over topsoil.	Minimal clearing required. No trees to be removed. Access to the borehole site will be via existing roads and tracks only.	Sediment fencing required along the north-western boundary of borehole site, to minimise impacts to upland swamp.
Borehole AI18: Intact native vegetation. Access along existing Fire Road. Two creek crossings along Fire Road 10Q.	Vegetation clearing required for borehole location. Some tree branch lopping may be required along Fire Road to facilitate access. Creek crossings should remain on existing crossings only.	Retain existing trees and Stag containing numerous small hollows. No drilling activities should occur within 2 m of the outer drip line of trees to protect the root zone and prevent dieback. No hollow bearing branches along access track to be lopped. Minimise clearing area required, restrict development to existing cleared fire road as far as practicable. Sediment and erosion control measures fencing required along north, east and south boundary of borehole site to minimise impacts to upland swamp.

4.3.5.2 Plant Communities

Four native plant communities have been mapped as occurring in the Study Area for the 15 boreholes. Figure 3 of the Biosis Report shows the location of the boreholes relative to the native plant communities occurring in the region. These communities are listed and described below.

Coastal Sandstone Ridgetop Woodland

Coastal Sandstone Ridgetop Woodland is a low eucalypt forest with a diverse shrub layer and open groundcover of sedges. It is distributed extensively on ridgetops and upper valley slopes of the Hornsby and Woronora Plateau and the lower Blue Mountains. About one quarter of its range has been cleared for urban development, but large areas are represented in conservation reserves.

Boreholes AI07, AI12B, AI14, AI15 and AI18 support Coastal Sandstone Ridgetop Woodland.

Coastal Sandstone Gully Forest

Coastal Sandstone Gully Forest is an open eucalypt forest with a diverse sclerophyll shrub stratum and an open groundcover dominated by sedges. It occurs on the lower slopes of sandstone gullies along the eastern portion of the Hornsby and Woronora Plateaux. About

one third of the distribution of this plant community has been cleared for urban development, but there are several examples represented in conservation reserves.

Borehole AI04B supports Coastal Sandstone Gully Forest.

Coastal Upland Swamp

Coastal Upland Swamp has an open to dense shrub canopy with dense groundcover of sedges and forbs. This plant community is restricted to swampy areas on humic sandy loams in headwater valleys and seepage zones on coastal sandstone plateaux.

Boreholes AI08, AI10, AI12A, AI12B and AI15 support Coastal Upland Swamp.

Sydney Shale Ironstone Cap Forest

Sydney Shale Ironstone Cap Forest has a low eucalypt forest, with a very diverse, mixed understorey of shrubs, forbs and grasses. This plant community is restricted to shale lenses and ironstone mantles on ridges. Much of this plant community has been cleared for orchards and small farms.

This plant community was not recorded in the Study Area. Boreholes AI05, AI06, AI13, had been mapped previously by others as supporting Sydney Shale Ironstone Cap Forest. However, these boreholes were found to be mostly cleared of native vegetation, with some regeneration of common native shrubs and groundcovers, but supporting reduced species diversity due to disturbance to the topsoil. These boreholes were considered not likely to regenerate to support this plant community.

Cleared

In order to reduce impacts on local flora and fauna, many of the borehole sites have been proposed within previously cleared and disturbed areas. These include old shaft sites, quarries and areas where coal wash has been introduced over the topsoil. The borehole locations in these disturbed areas did not support a native plant community and generally suffered a highly modified structure and reduced species diversity. These disturbed areas have a limited capacity to regenerate given the extensive topsoil disturbance.

Boreholes AI05, AI06, AI07, AI09, AI11, AI16 and AI17 are located within cleared or disturbed areas.

4.3.5.3 Endangered Ecological Communities

Sydney Shale Ironstone Cap Forest includes O'Hares Creek Shale Forest, which listed as an EEC on the TSC Act. This plant community was mapped previously by others as occurring in the Study Area. However, it was not recorded during the Biosis field surveys. Therefore, Biosis considered that this EEC does not occur in the Study Area.

4.3.5.4 Threatened Flora

A total of 119 plant species were recorded in the Study Area, including 109 (92%) native species and 10 (8%) exotic species. A list of plant species recorded in the Study Area is provided in Appendix 1 of the Biosis Report.

A total of 25 threatened flora species listed on the TSC Act and/or the EPBC Act have been either previously recorded or have potential habitat within the locality (Table 2 of the Biosis Report). Records from the Biosis Research Threatened Flora Database have also been included from previous work in the locality. The distribution of threatened plants derived from

DECC Atlas of NSW Wildlife and the Biosis Research Threatened Flora Database are illustrated in Figure 4 of the Biosis Report.

No threatened flora species were recorded within the Study Area. However, potential habitat exists within the Study Area for *Acacia bynoeana, Cryptostylis hunteriana, Callistemon linearifolius, Epacris purpurascens* var*. purpurascens, Persoonia acerosa, Persoonia hirsuta, Pomaderris adnata,* and *Pultenaea aristata.*

Rare or Threatened Australian Plants (ROTAP) lists species that are Presumed Extinct, Endangered, Vulnerable, Rare or Poorly Known at the national level. The ROTAP list has no legal status but is an important reference for the national status of threatened species, particularly for Rare or Poorly Known species which are not recognised by national and state threatened species legislations.

Darwinia grandiflora is listed as a ROTAP, with a conservation rating of 2RCi, indicating:

- 2 – The species has a geographic range of less than 100 km in Australia;
- R – The species is rare, but not currently considered to be endangered;
- C – The species is known to be represented within a conserved area,
- i – Less than 1,000 plants are known to occur within a conservation reserve(s).

This species (*Darwinia grandiflora)* was recorded at borehole AI10 within Coastal Upland Swamp. The exact location of this species will be flagged, so it can be adequately protected and avoided by the proposal during and after construction of the borehole. A suitably qualified ecologist will be on site during the initial borehole site set up, to ensure this species is not impacted by the proposal.

4.3.5.5 Fauna Habitats

The typical fauna habitat consists largely of Woodland and Upland Swamp habitat and broadly corresponds to the plant communities outlined in Section 4.3.5.2. Finer scale habitat features include rock outcrops, overhangs, tree hollows, leaf litter, and permanent and ephermeral waterbodies. Animal species may utilise some of these features wholly or partly, in conjunction with one another, or may depend entirely on one specific habitat type. These habitat features and species associations are discussed in further detail below.

Woodland

Woodlands provide a wide range of foraging and sheltering habitat for vertebrate fauna. Myrtaceaeous trees dominate the upper canopy in these areas and supply direct (foliage, nectar, exudates) and indirect food (arthropods) for a range of vertebrates. In particular, native trees such as *Eucalyptus punctata* and *Allocasuarina littoralis* are considered feed trees for threatened species including Koala and Glossy Black-cockatoo.

A number of small tree hollows (formed in stags, mature and/or senescent trees) were recorded, providing nesting and roosting habitat for a range of common birds and arboreal mammal species. Locally recorded threatened species requiring tree-hollows for mating and nesting include the Gang-gang Cockatoo, Glossy Black-cockatoo and hollow-dwelling microchiropteran bats (micro bats).

Understorey and shrub vegetation are relatively open and dominated by native species. The ground cover has a moderate layer of leaf litter and fallen branches and bark (scattered throughout forested areas), providing refuge and nesting habitat for a range of terrestrial

animals. Many invertebrates and amphibians rely on these 'moisture-retaining' microhabitats to over-winter or as refuge during periods of drought. Similarly, many reptiles rely on ground litter and debris for shelter and foraging. Larger hollow logs provide potential denning and nesting habitat for small to medium sized mammals including the Common Wombat.

Woodland habitat is considered to be in moderate to good condition, with the ground flora containing a high number of indigenous species; ground, log and litter layer intact; and a variety of habitat and resources for a range of native fauna available. Examples of threatened fauna that may utilise these habitats include Gang-gang Cockatoo, Glossy Black-cockatoo, Swift Parrot and Regent Honeyeater.

Rock Outcrops, Caves and Overhangs

Rock outcrops, overhangs and small crevices occur along Cataract River and tributaries. These habitats provide refuge for a range of reptile species including, Southern Leaf-tailed Gecko, Lesueur's Velvet Gecko, and possibly the threatened Broad-headed Snake.

Overhangs generally occur along the Cataract River below escarpment areas. These areas can provide roosting and nursery habitat for cave-dwelling micro-bats, including the threatened Large-eared Pied Bat, Eastern Bent-wing Bat and Eastern False Pipistrelle. Small caves and crevices may provide den habitat for the threatened Spotted-tailed Quoll.

Rocky outcrops, overhangs and small crevices were considered to be in good condition, providing a high number of foraging and breeding habitat resources for native fauna.

Cleared Areas

The majority of the impact sites within the Study Area are located in sections that have been previously cleared or disturbed for a range of uses including fire roads, shaft sites, quarries, coal wash placement, and powerline easements. Despite these activities some native species still occur within disturbed vegetation and microhabitat components of these areas. Generally these areas would provide few habitat opportunities for native fauna. Species more likely to inhabit these areas include introduced and domestic animals and natives tolerant of disturbance or favouring edge/ecotone habitat.

Cleared areas are considered to be in poor condition, with the ground flora containing a low number of indigenous species, fragmented vegetation communities, ground, log and litter layer highly disturbed and few resources available for native fauna.

Waterbodies (Rivers, Creeks and Drainage lines)

The Cataract River and tributaries (Cascade, Wallandoola, Lizard and an unnamed creek) provide habitat for a range of vertebrates (amphibian, reptile, bird and mammal) and invertebrate species.

4.3.5.6 Significant Fauna

A detailed fauna survey was not undertaken for the assessment. Incidental observations of fauna species utilising the study site are listed in Appendix 3 of the Biosis Report and include two amphibian species, 30 bird species, five mammal species and four reptile species.

A total of 54 threatened and migratory animal species or their habitat have been previously recorded within the locality. Of these, 44 animal species are listed under the TSC Act and 25 animal species listed under the EPBC Act. Figure 5 of the Biosis Report shows the location where these species have been observed.

No threatened fauna were recorded during the Biosis field survey. However, the Study Area contains potential habitat for 23 threatened or migratory animal species listed on the TSC Act and/or the EPBC Act (Koala, Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Bentwing Bat, Eastern Freetail-bat, Grey-headed Flying Fox, Large-footed Myotis, Red-crowned Toadlet, Square-tailed Kite, Gang-gang Cockatoo, Glossy Black- cockatoo, Powerful Owl, Sooty Owl, Barking Owl, Masked Owl, Eastern Pygmy Possum, Satin Flycatcher, Black-faced Monarch, Rainbow Bee-eater, Regent Honeyeater, Swift Parrot, Southern Brown Bandicoot and Large-eared Pied Bat.

Table 3 of the Biosis Report lists the terrestrial fauna that may occur in the region and also indicates whether potential habitat for these species was identified during the Biosis field survey. A number of threatened marine or pelagic species or their habitats have been recorded within a 10 km radius of the Study Area. As the proposal will not impact upon marine species they were not been considered further in the Biosis Report.

4.3.6 Impact Assessment

4.3.6.1 Predicted Impacts

The typical disturbance footprint of each borehole site comprises a 50 m x 60 m compound with additional light vehicle parking. The actual area disturbed would be site specific. Additional construction of access tracks may be required. Biosis assumed that a total area of 80 m x 80 m (0.6 ha) for all disturbed areas was adequate to consider all direct and indirect impacts associated with the proposal.

Impacts associated with the proposal include:

- Disturbance to 2.4 ha of Coastal Sandstone Ridgetop Woodland at boreholes AI12B, AI14, AI15, AI18,
- Disturbance to 0.6 ha of Coastal Sandstone Gully Forest at borehole AI04B,
- Disturbance to 1.2 ha of Coastal Upland Swamp at boreholes AI08, AI10,
- Fragmentation of Coastal Sandstone Gully Forest at AI04B,
- Disturbance to 4.8 ha of disturbed areas supporting regenerating common native and exotic species at boreholes AI05, AI06, AI07, AI09, AI11, AI13, AI16, AI17.

Provided appropriate mitigation measures are implemented (as detailed in **Section 4.3.6.2**), this disturbance is not anticipated to have an impact on any issues of an ecological significance.

Unless the recommended amelioration measures are implemented, the indirect impacts associated with the proposal include:

- Potential for erosion during and after construction at all sites,
- Possible provision of suitable conditions for weed invasion,
- Increased human activity.

4.3.6.2 Proposed Mitigation Measures

The following measures will be implemented in order to mitigate the impacts of the proposal:

- Adjustment of the location of boreholes and access tracks to avoid native trees and significant habitat features such as sandstone outcropping, where required.

- Trees with hollows would be retained and protected, with no drilling within the critical root zone (extending to 2 m beyond the drip line) of the trees.

- Access to boreholes AI10, AI16, and AI18 may require trimming of branches along existing fire trails. Such branch trimming would be limited and restricted to smaller branches that do not support hollows. Should large branches with hollows be required to be removed, a suitably qualified ecologist would be on site during clearing to ensure no resident fauna are harmed. Cleared branches would be placed in adjoining vegetation, as they will provide habitat for fauna.

- Access to boreholes AI10, AI16 and AI18 will involve two creek crossings. These crossings will use established crossings along the established Fire Road 10Q and will not divert into other areas of the creeklines. Caution would be taken to prevent sedimentation run off and minimise disturbance along the creek.

- Where possible, proposed boreholes and access tracks would be located within existing cleared areas.

- Sediment and erosion control measures would be implemented on all sites to prevent erosion during and after construction.

- Disturbance to native vegetation would be minimised, or, where disturbance is unavoidable, borehole sites would be rehabilitated using locally sourced tube-stock and brush-matting. Rehabilitation would be undertaken by suitably qualified bush regenerators.

- Where clearing of native vegetation is unavoidable, native shrubs, logs and bush-rock would be stockpiled on the side of the proposed boreholes and access routes and replaced following completion of the works.

- If required, bush regeneration and weed control would be undertaken to ensure the flora and fauna of the locality are protected throughout the construction and operation phases of the proposal. This is particularly important for boreholes where intact native vegetation will be disturbed. Any bush regeneration and weed control would be undertaken by suitably qualified bush regenerators.

- Any chemicals used on site would be taken off site after use and disposed of appropriately.

- Machinery and vehicles would be washed down prior to use on site to avoid the transmission of weed seed or disease into areas of intact native vegetation, and,

- A suitably qualified ecologist would be on site during the initial site set up for each borehole, to ensure significant habitat features and species are not impacted by the proposal.

4.3.6.3 Part 3A Guidelines for Threatened Species Assessment

The impacts of the proposal on threatened biota listed under the TSC Act were undertaken following the Guidelines for Threatened Species Assessment under Part 3A of the ***Environmental Planning and Assessment Act,* 1979** (EP&A Act). Where threatened biota **is recorded** within a Study Area, an impact assessment is required under the EP&A Act. When threatened biota **is not recorded** during a survey, the presence of potential habitat for this species is used to determine the need to undertake an impact assessment under the EP&A Act. Where there is no potential habitat in the Study Area for threatened biota, there is unlikely to be any impact on these species and therefore these species are not required to be considered further.

The impact assessments included in Appendix 4 of the Biosis Report incorporate a consideration of the predicted impacts and amelioration measures as outlined in **Sections 4.3.6.1** and **4.3.6.2**, respectively.

Endangered Ecological Communities

The Study Area does not support any Endangered Ecological Communities (EEC) listed under the TSC Act.

Flora

Coastal Sandstone Ridgetop Woodland provides potential habitat for the threatened plant species *Acacia bynoeana, Cryptostylis hunteriana, Persoonia acerosa, Persoonia hirsuta* and *Pomaderris adnata*.

Coastal Sandstone Gully Forest provides potential habitat for the threatened plant species *Callistemon linearifolius* and *Epacris purpurascens* var*. purpurascens*.

Coastal Upland Swamp provides potential habitat for the threatened plant species *Epacris purpurascens* var*. purpurascens* and *Pultenaea aristata.*

Each of these species is listed as threatened on the TSC Act and, as such, the impact of the proposal on these species has been considered in Appendix 4 of the Biosis Report.

Fauna

No threatened fauna were recorded during the current survey. However, the Grey-headed Flying Fox, Koala, Red-crowned Toadlet, Giant Burrowing Frog, Greater Broad-nosed Bat, Eastern Freetail-bat, Eastern Bentwing-bat, Gang-gang Cockatoo, Powerful Owl, Sooty Owl and Eastern Pygmy-possum have been recorded within or in close vicinity of the Study Area. Where there is potential habitat (foraging or breeding resources) for a threatened species in the Study Area, further consideration must be given to the potential impact of the proposal on these species.

The proposal may significantly impact threatened species by causing any of the following situations to arise:

- Death or injury of individuals,
- Loss or disturbance of limiting foraging resources,
- Loss or disturbance of limiting breeding resources.

Limiting resources are specialised habitat components that species are dependent on for their ongoing survival. Such limiting resources are predominantly associated with specialised breeding habitats (such as tree hollows or suitable nest/maternity roost sites) that occur at low densities, with high levels of competition from a range of species. However for some species, limiting resources include specialised foraging habitats that have a restricted distribution (such as Koalas feeding only on specific tree species).

The Study Area contains potential habitat for the Grey-headed Flying Fox, Koala, Microchiropteran Bats (Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Bentwing Bat, Large-eared Pied Bat, Eastern Freetail-bat, Large-footed Myotis), Regent Honeyeater, Swift Parrot, Red-crowned Toadlet, Square-tailed Kite, Cockatoos (Gang-gang Cockatoo and Glossy Black- cockatoo), Forest Owls (Powerful Owl, Sooty Owl, Barking Owl and Masked Owl), Eastern Pygmy-possum, Migratory species (Rainbow Bee-eater, Satin Fly catcher, Black-faced Monarch) and Southern Brown Bandicoot.

Impact assessments have been prepared for these species in Appendix 4 of the Biosis Report. The remaining 32 threatened species were not recorded within the Study Area and potential habitat for these species does not occur within the Study Area, therefore these species were not considered further.

Conclusions of the Impact Assessments

The impact assessments (Appendix 4 of the Biosis Report) concluded that the proposal is likely to have a minor impact on threatened biota, as listed on the TSC Act, provided recommended ameliorative measures are implemented.

Key Thresholds

The Part 3A Guidelines of the EP&A Act set out a number of key thresholds which need to be addressed to justify the impacts of the proposal on threatened species, populations or ecological communities. The key thresholds are:

- Whether or not the proposal, including actions to avoid or mitigate impacts or compensate to prevent unavoidable impacts, will maintain or improve biodiversity values,

- Whether or not the proposal is likely to reduce the long-term viability of a local population of the species, population or ecological community,

- Whether or not the proposal is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction,
- Whether or not the proposal will adversely affect critical habitat.

Biosis concluded that, based on the impact assessments following the Part 3A Guidelines of the *EP&A Act* for Threatened Species Assessment, the proposal is unlikely to reduce the long-term viability of, accelerate the extinction of and/or adversely affect critical habitat for threatened species and/or populations within the Study Area.

Maintenance of Biodiversity Values

Given that a total of 4.2 ha of relatively intact native vegetation, that provides potential habitat for a number of threatened species, will be impacted by the proposal, some biodiversity values of the locality will be lost. The loss of biodiversity values can be minimised by incorporating the proposed mitigation measures detailed in **Section 4.3.6.2**, particularly measures to avoid significant habitat features and to rehabilitate where areas of intact native vegetation are disturbed.

Provided that the mitigation measures detailed in **Section 4.3.6.2** are implemented, the proposal is likely to maintain the biodiversity values of the locality. Rehabilitation of disturbed area is critical to maintaining biodiversity values of the impacted areas

4.3.6.4 Commonwealth EPBC Act Significance Criteria

Under the Commonwealth ***Environment Protection and Biodiversity Conservation Act* 1999** (EPBC Act), if the proposal has the potential to have an adverse impact on threatened biota listed on the Act, the proposal must be referred to the Federal Minister for the Environment for further consideration. The Significant Impact Criteria are used to assess the likelihood of impact.

A full review of the Significant Impact Criteria is included in Appendix 5 in the Biosis Report. It incorporates a consideration of the predicted impacts and mitigation measures as **Sections 4.3.6.1** and **4.3.6.2**, respectively.

Endangered Ecological Communities

The Study Area does not support any Endangered Ecological communities listed under the EPBC Act.

Flora

Coastal Sandstone Ridgetop Woodland provides potential habitat for the threatened plant species *Acacia bynoeana, Cryptostylis hunteriana, Persoonia acerosa* and *Persoonia hirsuta*.

Coastal Upland Swamp provides potential habitat for the threatened plant species *Pultenaea aristata.*

Each of these species is listed as threatened on the EPBC Act. Consequently, the impact of the proposal on these species has been considered in Appendix 5 in the Biosis Report.

Fauna

Twenty five threatened fauna species and migratory species were recorded as having the potential to occur in the locality (DEWHA online database). The Study Area contains potential habitat for the Grey-headed Flying-fox, Satin Flycatcher, Black-faced Monarch, Rainbow Bee-eater, Regent Honeyeater, Swift Parrot, Southern Brown Bandicoot and Large-eared Pied Bat.

Assessments of the Significance Impact Criteria have been prepared for these species in Appendix 5 of the Biosis Report. Potential habitat for the remaining 17 threatened species does not occur within the Study Area or is not limiting and therefore Assessments of Significance are not required for these species.

Conclusions of the Significant Impact Criteria

The Significant Impact Criteria Assessments under the EPBC Act (Appendix 5 of the Biosis Report) found that the proposal is not likely to have a significant impact on threatened species, endangered ecological communities or their habitats, as listed on the EPBC Act, provided recommended ameliorative measures are implemented.

4.3.7 Conclusions

The proposal will involve clearing or modifying approximately 2.4 ha of Coastal Sandstone Ridgetop Woodland; 0.6 ha of Coastal Sandstone Gully Forest; 1.2 ha of Coastal Upland Swamp; and 4.8 ha of disturbed areas supporting regenerating common native and exotic species.

No Endangered Ecological Communities (EEC) listed on the TSC Act or EPBC Act were recorded by Biosis in the Study Area. No threatened plant species were recorded within the Study Area. However, potential habitat for eight threatened species (*Acacia bynoeana, Callistemon linearifolius, Cryptostylis hunteriana, Epacris purpurascens* var. *purpurascens, Persoonia acerosa, Persoonia hirsuta, Pomaderris adnata and Pultenaea aristata*) occurs within the Study Area.

Threatened bat species have recently been identified within disused mine workings, adits and portals of various mines in the Illawarra. In each of these cases, the disused mine infrastructure has been well-ventilated. The Eastern Bentwing Bat and the Large-eared Pied Bat are cave roosting species. Biosis noted that cave or mine infrastructure which may be utilised by these bat species will not be impacted by this proposal. The goaf areas being targeted for the exploration and monitoring program have been sealed for many years and are not open to the fresh air environment. As a result of this lack of ventilation, methane and other gas build up in these areas would be such that the existing atmosphere would not support life.

The proposal is likely to remove or modify potential habitat for 23 threatened or migratory animal species listed on the TSC Act and/or the EPBC Act (Koala, Greater Broad-nosed Bat, Eastern False Pipistrelle, Eastern Bentwing Bat, Eastern Freetail-bat, Large-footed Myotis, Red-crowned Toadlet, Square-tailed Kite, Gang-gang Cockatoo, Glossy Black- cockatoo, Powerful Owl, Sooty Owl, Barking Owl, Masked Owl, Eastern Pygmy-possum, Grey-headed Flying Fox, Satin Fly catcher, Black-faced Monarch, Rainbow Bee-eater, Regent Honeyeater, Swift Parrot, Southern Brown Bandicoot and Large-eared Pied Bat.

Impact Assessments following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act and Significant Impact Guidelines under the EPBC Act were carried out for threatened biota occurring or with potential habitat in the Study Area. It was found the impacts of the proposal are likely to be minor.

A number of mitigation measures are recommended in **Section 4.3.6.2** to reduce the potential impacts of the proposal on flora and fauna of the locality.

4.4 Archaeology, History and Heritage

4.4.1 Introduction

Biosis Research Pty Ltd (Biosis) was commissioned to undertake an assessment of the Program's impact on Aboriginal archaeological and historical cultural heritage aspects. A copy of their report, ***"Illawarra Coal Seam Gas Exploration Drilling Programme: Aboriginal and Historic Cultural heritage Assessment, January 2009"*** is included as **Appendix III** in this Environmental Assessment. This report investigates the 18 boreholes originally proposed. Apex has decided to install only 15 out of the 18 boreholes investigated at this time. The following discussions on Aboriginal archaeological and cultural heritage reflect the lower number of boreholes.

4.4.2 Aboriginal Community Consultation

Reporting and Aboriginal community consultation were carried out in accordance with guidelines prepared for projects being assessed and approved under Part 3A of the ***Environmental Planning and Assessment Act* 1979**.

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.

4.4.3 Heritage Registers and Databases

Searches were carried out of all relevant heritage registers and databases. There are no previously identified Aboriginal or historic heritage items within the areas affected by the Apex Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Program. Three of the proposed borehole locations are within 200 m of registered Aboriginal sites.

4.4.4 Environmental Context

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.

4.4.5 Survey Findings

A field inspection of the borehole locations was carried out over three days, between 2nd and 4th September 2008. The survey team included representatives from Biosis Research, the Illawarra Local Aboriginal Land Council and the Kullila Welfare and Housing Aboriginal Corporation.

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 because an isolated artefact (ISF AI04A) was found there. An alternative location (Borehole AI04B), although identified as an archaeological site by the Aboriginal stakeholders, does not represent PAD.

Apex plans to proceed with AI04B, in order to locate the borehole over a large remnant coal pillar within the Bulli Seam workings in the old Coal Cliff Mine beneath this site. Site AI04A is not suitable for the exploration activity. Vegetation removal and site rehabilitation measures will be implemented to mitigate and minimise any adverse environmental impacts.

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. Information regarding cultural values of the study area is presented in the following sections.

During a meeting, Ms Gough identified several themes of importance to her and her family; these are described more fully in Section 8.2.3 of the Biosis Report **(Appendix III)**. 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 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 would be respected by managing vegetation removal and restoration of sites at the completion of the boreholes function.

There is one publicly accessible borehole (AI05) located in a highly disturbed context within broader landscapes of good condition native vegetation. This borehole is considered to be located in an area 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.

4.4.6 Conclusions and Recommendations

Impacts which have been identified can be ameliorated through adoption of the following recommendations made in the Biosis report:

Recommendation 1 – Preference of Borehole AI04B

Borehole AI04B is the only one of AI04A and AI04B 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. Borehole AI04B is the only location suitable for drilling.

The Aboriginal community have requested that if this site is selected, that monitors be engaged during the site clearance process. Monitoring is not an archaeological process and is not endorsed by DECC. Monitoring would be undertaken for cultural reasons and 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

Borehole AI05 is the only borehole that might be reasonably considered publicly accessible. The program 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 will 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 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. In accordance with the Biosis recommendation, seed banks would be established for each of these boreholes, and at the conclusion of the testing program, the areas would be rehabilitated by Apex.

Recommendation 4 – Aboriginal Objects Stop Work Provision

No 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 to assess the find. Section 75U, Part 3A of the ***Environmental Planning and Assessment Act* 1979** does not negate 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 will cease in the vicinity of the find and an archaeologist would be called in to assess the find. Section 75U Part 3A of the ***Environmental Planning and Assessment Act* 1979** does not negate section 146 of the ***Heritage Act* 1977**. Notification of discovery of historic relics is still required under the ***Heritage Act 1977***.

4.5 Air Quality and Dust

Dust is a potential issue during the drilling program. All drilling rigs are fitted with dust attenuation devices to ensure Occupational Health and Safety requirements for the drill operators are achieved. This will ensure that there would be no adverse impact upon human health or the environment.

Where necessary, a water cart/spraying will be used on site to reduce dust generation on bare areas around the boreholes. In addition, the number of vehicles accessing the site will be controlled. This will be required by Sydney Catchment Authority and forms part of the Standard Conditions that SCA will insist Apex has before granting entry to the Special Areas.

Apart from AI05 and AI06, the boreholes are isolated from the public. Borehole AI05 is 160 m from a residence and AI06 is 310 m from the nearest residence. Given the isolated nature of the boreholes and the minimum time when gas will be extracted (predicted to be 1 week at each borehole) Apex believe that odour will not be an issue for the proposed Program.

4.6 Acoustics

Heggies Pty Ltd (Heggies) was commissioned to undertake a noise and vibration assessment of the proposed activities. A full copy of their report titled, ***"Apex Energy, Illawarra Exploration Drilling and Gas Monitoring Project Noise and Vibration Assessment, December 2008"*** is included in **Appendix IV** of this Environmental Assessment. This report investigates the 18 boreholes originally proposed. Apex has decided to install only 15 out of the 18 boreholes investigated at this time. The following discussions on acoustics reflect the lower number of boreholes.

4.6.1 Establishing Existing Noise Environment

Between 4th and 15th December 2008 a background noise monitoring program at three unattended and two operator-attended locations was undertaken in accordance with DECC requirements and the DGRs. The noise measurement procedures employed throughout the monitoring program 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).

The results of the unattended and operator-attended noise monitoring are summarised in **Table 4.5**, **Table 4.6** and **Table 4.7**.

Location 1 is the Glenbernie Orchard residence north east of AI05 and adjacent to Darkes Forest Road. Location 2 is a residence south west of AI06 off the Darkes Forest Road. Location 3 is a residence at 257 Princes Highway, Helensburgh located east of AI03. Borehole AI03 is no longer proposed.

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 4.6** presents a summary of the daytime noise recorded at operator-attended noise monitoring locations.

Table 4.5 – Unattended Statistical Ambient Noise Levels (4th December 2008 to 15th December 2008)

Time	Noise Parameter	Location 1 Closest Receiver to AI05	Location 2 Closest Receiver to AI06	Location 3 Closest Receiver to AI03
Daytime (dBA)	LA_1	59	53	57
	LA_{10}	49	47	50
	LA_{90}	35	38	37
	LA_{eq}	53	52	55
Evening (dBA)	LA_1	55	48	53
	LA_{10}	44	42	48
	LA_{90}	35	34	34
	LA_{eq}	53	47	52
Night	LA_1	43	43	44
	LA_{10}	40	38	38
	LA_{90}	31	29	30
	LA_{eq}	43	43	49

Location 4 is the Old Illawarra Road in Hellensburgh and Location 5 is in Saywell Place, Wombarra. The daytime monitoring was undertaken at 13:37 hours on 4th December 2008 at Location 4 and at 14:21 hours on 4th December at Location 5. The evening and night-time

monitoring was undertaken at 21:47 hours on 15th December 2008 at Location 4 and at 20:52 hours on 15th December 2008 at Location 5.

Table 4.6 – Daytime Operator-attended Noise Monitoring

Noise Parameter	Location 4	Location 5
LA_1	65	57
LA_{10}	52	50
LA_{50}	45	42
LA_{90}	40	41
LA_{eq}	53	48
L_{max}	82	72
Typical Maximum Noise Levels	Princes Hwy Traffic 46-58 dBA Local road traffic 56-71 dBA Wind in trees 42-44dBA Birds 46-65 dBA Planes 42-47 dBA	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 dBA

Table 4.7 presents a summary of the evening noise recorded at the operator-attended noise monitoring locations.

Table 4.7 – Evening Operator-attended Noise Monitoring

Noise Parameter	Location 4	Location 5
LA_1	54	51
LA_{10}	44	44
LA_{50}	35	43
LA_{90}	33	42
LA_{eq}	41	44
L_{max}	58	65
Typical Maximum Noise Levels	Insects 34-39 dBA Freeway Traffic 33-38 dBA Princes Hwy Traffic 36-58 dBA Local road traffic 38-57 dBA People 57 dBA	Ocean 42-43 dBA Local traffic 46-57 dBA Insects 43-45 dBA People 44-56 dBA

4.6.2 Noise Assessment

Noise modelling for this assessment was undertaken using the SoundPLAN computer noise modelling software. The noise modelling took into account ground topography and was based on the representative source noise levels listed in Table 8 and Table 9 of the Heggies Report. In accordance with the INP requirements, predictive noise modelling was computed for both calm and noise enhancing weather conditions.

The calculated operational noise levels predictions were based on a typical drill site layout (**Figures 3.3, 3.4** and **3.5**). The drill site sound power levels were obtained though measurements of representative drill rigs conducted by Heggies on 7th 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.

4.6.2.1 Construction Noise

The following 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.

The duration of the construction activity at any drill site would be less than 4 weeks. For this timeframe the DECC's airborne noise objective for residential receivers indicates that noise from construction activities should be managed such that the LA_{10} noise level, measured over a period of not less than 15 minutes, should not exceed the background LA_{90} 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 a conservative LA_{10}(15 minute) noise objective of LA_{90}(15 minute) RBL + 25 dBA was adopted.

Table 4.8 presents the daytime construction noise goals for residential and commercial receivers.

Indicative "worst case" construction noise levels at sensitive receivers are shown in Table 11 of the Heggies Report. The predictions were calculated assuming adverse weather conditions with 3 m/s and wind direction source to receiver and all construction sites operating concurrently.

Table 4.8 – Daytime Construction Noise Goals

Background Noise Monitoring Location	Residential Receivers	Commercial Receivers
Location 1	55dBA	60dBA
Location 2	58dBA	63dBA
Location 3	57dBA	62dBA
Location 4	60dBA	65dBA
Location 5	61dBA	66dBA

Table 11 of the Heggies Report shows that the project construction noise emission levels are predicted to comply with the construction noise goals at all proposed drill sites.

4.6.2.2 Operational Noise

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

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

Intrusive Criterion

LA_{eq}(15 minute) should not exceed the RBL by more than 5 dBA. **Table 4.9** presents a summary of the location and time specific intrusive criteria.

Table 4.9 – Location and Time Specific Intrusive Criteria

Background Noise Monitoring Location	Daytime LA_{eq}. (15 minute) (dBA)	Evening time. LA_{eq} (15 minute) (dBA)	Night-time. LA_{eq} (15 minute) (dBA)
Location 1	40	40	36
Location 2	43	39	34
Location 3	42	39	35
Location 4	45	38	38
Location 5	46	47	47

Amenity Criterion

Table 4.10 provides a summary of the location and time specific amenity criterion. **Tables 4.9** and **4.10** show that, with the exception of the golf course, the intrusive criterion is the limiting criterion and consequently was selected as the operational noise goals for the Project.

Indicative operational noise levels for both calm and noise enhancing weather conditions (i.e. a wind speed of 3 m/s and direction source to receiver) at the nearest sensitive receivers to each drill site are presented in Tables 14, 15 and 16 of the Heggies Report. Table 14 shows indicative daytime drilling operational noise levels, Table 15 shows indicative evening drilling operational noise levels and Table 16 shows indicative night-time drilling operational noise levels.

Table 4.10 – Summary of Relevant Amenity Criterion

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Acceptable LA_{eq} (dBA)	Recommended Maximum LA_{eq} (dBA)
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
School 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

Table 4.11 summarises the data from Tables 14, 15 and 16 in Heggies report. This data shows that noise exceedances are predicted for AI05 and AI06 only.

Table 4.11 – Indicative Drilling Operational Noise Levels

Location	Time	Conditions	Distance / m	Objective	LA_{eq} dBA	Assessment
AI05	Day	Calm	160	40	59	Exceed (19 dBA)
		Windy	160	40	59	Exceed (19 dBA)
	Evening	Calm	160	40	59	Exceed (19 dBA)
		Windy	160	40	59	Exceed (19 dBA)
	Night	Calm	160	36	59	Exceed (23 dBA)
		Windy	160	36	59	Exceed (23 dBA)
AI06	Day	Calm	310	43	39	Complies
		Windy	310	43	43	Complies
	Evening	Calm	310	39	39	Complies
		Windy	310	39	43	Exceed (4 dBA)
	Night	Calm	310	34	39	Exceed (5 dBA)
		Windy	310	34	43	Exceed (9 dBA)

Table 4.11 shows that, while drilling is in operation unless amelioration measures are implemented, noise exceedances up to 23 dBA are likely at the nearest receivers to drill site AI05 through the night-time periods and by 19 dBA during day time and evening time periods. At AI06 it is anticipated that, unless amelioration measures are implemented noise exceedances up to 9 dBA are likely through night-time period under the worst case weather conditions.

4.6.3 Noise Mitigation

Due to the likely exceedances of up to 23 dBA at drill sites AI05 and up to 9 dBA at 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,
- Controlling the transmission of noise,
- Controlling noise at the receiver.

Controlling Noise at the Source

There are two approaches: Best Management Practice (BMP) and Best Available Technology Economically Achievable (BATEA).

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 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.

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.

Controlling Noise at the Receiver

The two approaches to controlling noise at the receiver involve either negotiating an agreement with the landholder or implementing acoustic treatment of dwellings to control noise.

Apex will implement appropriate BMP and BATEA practices. They will provide noise barriers at AI05 and AI06 to reduce noise levels experienced at the nearest residences. In addition, they will attempt to negotiate agreements with the affected residents should the barriers not enable the noise criteria to be met.

Appropriate monitoring would be undertaken during drilling operations to confirm that the criteria are being achieved. This will include a combination of operator-attended and real-time noise monitoring. Should this monitoring demonstrate non-compliance, Apex would undertake investigations and planned actions to ameliorate the non-compliance.

Should these approaches not resolve any acoustic issues satisfactorily, drilling would be limited to those times of day when criteria are met after implementation of amelioration measures.

4.6.4 Vibration Assessment

Heggies also undertook a vibration assessment of the proposed drilling. The assessment was produced in accordance with the DECC's guidelines. 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:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed (human perception or human comfort vibration),

- Those where the building contents may be affected,

- Those in which the integrity of the building or the structure itself may be prejudiced.

Section 5 of the Heggies Report contains a detailed description of the various criteria for assessing vibration impacts and the outcomes of their vibration assessment.

Heggies concluded that the risk of cosmetic damage arising from vibration associated with the drilling operations at the nearest residential receivers is negligible. They also concluded that human discomfort will be avoided during any vibration intensive activities.

4.6.5 Acoustic and Vibration Impact Summary

Table 4.12 includes a summary of the noise and vibration impacts from the Program. No vibration impacts are predicted.

Acoustic impacts are likely at residences closest to boreholes AI05 and ASI06 unless ameliorative measures are implemented. Apex proposes to use best practice to minimize noise emitted from these sites, negotiate with the landholders, install temporary noise barriers and monitor the results during drilling activity. Should satisfactory outcomes not be achieved, drilling will only occur during times when criteria are predicted to be achieved following implementation of the range of ameliorative measures listed.

Table 4.12 – Residential Impact Summary

Borehole	Noise Impact at nearest residence	Vibration Impact at Nearest Residence	Mitigation to conduct 24 hour operations
AI04	Adverse comment unlikely	Adverse comment unlikely	Nil
AI05		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.
AI06		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.
AI07	Adverse comment unlikely	Adverse comment unlikely	Nil
AI08	Adverse comment unlikely	Adverse comment unlikely	Nil
AI09	Adverse comment unlikely	Adverse comment unlikely	Nil
AI10	Adverse comment unlikely	Adverse comment unlikely	Nil
AI11	Adverse comment unlikely	Adverse comment unlikely	Nil
AI12	Adverse comment unlikely	Adverse comment unlikely	Nil
AI13	Adverse comment unlikely	Adverse comment unlikely	Nil
AI14	Adverse comment unlikely	Adverse comment unlikely	Nil
AI15	Adverse comment unlikely	Adverse comment unlikely	Nil
AI16	Adverse comment unlikely	Adverse comment unlikely	Nil
AI17	Adverse comment unlikely	Adverse comment unlikely	Nil
AI18	Adverse comment unlikely	Adverse comment unlikely	Nil

4.7 Waste Management

During the drilling program, waste will be generated on site from the following sources:

- Packaging from materials and supplies,
- Wastewater from temporary office and toilet facilities,
- General office waste,
- Vehicle servicing wastes.

Packaging wastes will be separated into metal, wood and other recyclable streams. These separated waste materials will be recycled in an approved manner. Non-recyclable materials will be collected separately and will be disposed off-site in an approved waste facility.

General office waste will be collected and disposed off-site at a licensed waste facility.

Vehicle servicing wastes will consist of oils and greases together with assorted hydrocarbon containers. Mobile vehicles will not be serviced on site. This will be undertaken at appropriate off site workshops. Any oils, greases and containers will be collected for recycling.

4.8 Soil Management

Topsoil from the area surrounding the borehole will be stripped and stockpiled prior to the commencement of drilling. This topsoil will be used to resurface disturbed areas prior to revegetation.

The topsoil will be stockpiled in an appropriate area. Sedimentation fences will be used to prevent sediment from making its way into water courses during rain. Subsoil material may be moved around the site to provide a flat drill pad. The topsoil will be returned to any cut and fill batters requiring revegetation.

The site will be seeded with native flora species consistent with those currently surrounding the site.

4.9 Greenhouse Gases

Heggies Pty Ltd (Heggies) was commissioned to undertake a Greenhouse Gas Assessment for the Project. A copy of their report titled, "***Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Project Greenhouse Gas Assessment December 2008"*** is included in **Appendix V**. This report investigates the 18 boreholes originally proposed. Apex has decided to install only 15 out of the 18 boreholes investigated at this time. The following discussions on greenhouse gas emissions reflect the lower number of boreholes.

4.9.1 Coal Seam Gas Quality and Quantity

It is expected that coal seam gas to be extracted will consist of the following:

- 80% methane (CH_4),
- 10% carbon dioxide (CO_2),
- 10% inert gases.

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% and 100% of coal seam gas flow will be flared, the potential for some venting directly to the atmosphere exists.

4.9.2 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 is presented in **Table 4.13.**

Table 4.13 – 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

4.9.3 Greenhouse Gas Assessment

The greenhouse gas assessment was conducted in accordance with the methodologies established by the various policies and guidelines which are detailed in Appendix A of the Heggies Report. Provision is made in such methodologies for three greenhouse gas emission scopes:

- **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 motive power during the establishment of the proposed boreholes. Greenhouse gas sources associated with off-site electricity generation (**Scope 2**) are therefore not included in the assessment.

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*** (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 were they considered as part of the assessment.

An assessment of the predicted greenhouse gas emissions from project operations has been undertaken for each of the project-related greenhouse gas sources. Coal seam gas emissions were estimated based on NGA Factors and on gas emission and composition data provided by Apex.

4.9.3.1 Emissions 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 were calculated for a range of scenarios, defined by:

- Expected maximum, minimum and average gas flow rates as discussed in **Section 4.9.4.2**,
- Flaring rates of 0%, 70% and the expected proportions of 90% and 100% as discussed in **Section 4.9.4.2**.

Heggies considered that these scenarios provided a broad indication of greenhouse gas emissions that could be expected from the Project. For the purposes of the assessment, testing at each borehole was assumed to occur for a period of one week. It has been conservatively assumed that all 15 holes will be flow monitored. Diesel combustion-related greenhouse gas emissions remained constant for each scenario.

4.9.3.2 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 and the GWP for CH_4 were 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 Table1 of the NGA Factors.

Greenhouse gas emissions associated with coal seam gas borehole monitoring by scenario are presented in **Table 4.14**.

Table 4.14 – 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

Additionally, a comparison of daily greenhouse gas emissions is presented in **Figure 4.1.**

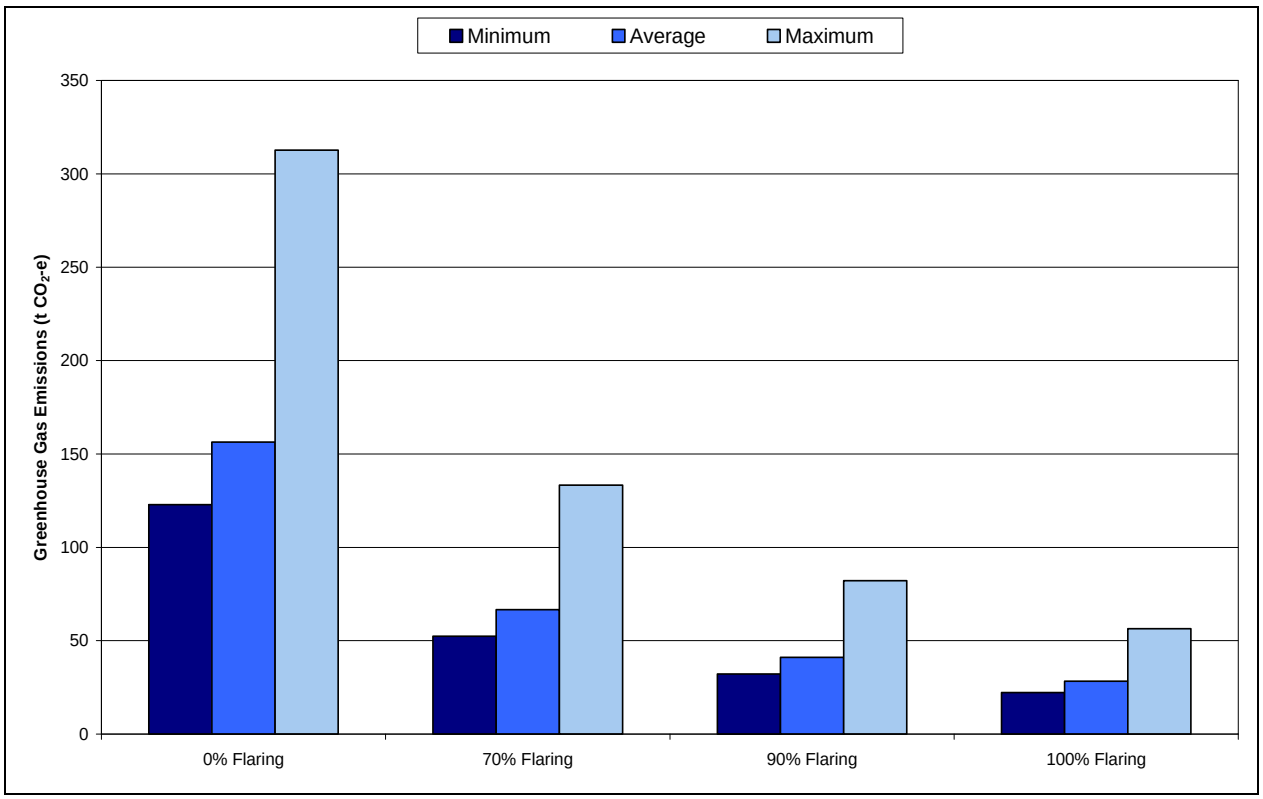


Figure 4.1 – Comparison of Daily Greenhouse Gas Emissions by Percentage Gas Flaring and Gas Flow Rate

Source: Heggies Greenhouse Report (Appendix V of this Environmental Assessment)

Table 4.14 and **Figure 4.1** show 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 4.15.**

Table 4.15 – 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

Table 4.15 shows 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 2794 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 between 3,556 t CO_2-e and 19,699 t CO_2-e over an active week across any one of the 15 proposed borehole locations.

4.9.3.3 Diesel Gas Combustion Emissions

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.

Table 4.16 presents the calculated greenhouse emissions associated with the combustion of diesel during the establishment of each borehole.

Table 4.16 – 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

Table 4.16 shows 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 15 boreholes will generate approximately 204 t CO_2-e.

4.9.3.4 Total Greenhouse Gas Emissions

The total greenhouse gas emissions associated with the establishment of all boreholes and active monitoring of coal seam gas for a one week period are presented in **Table 4.17**. 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 4.17 – 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	204	2,998	0.002%	0.0005%
Expected Average Minimum (14,000 m^3/day, 100% Flaring)	3,556	204	3,760	0.002%	0.0007%
Expected Average (14,000 m^3/day, 90% Flaring)	5,171	204	5,375	0.003%	0.0009%
Expected Average Maximum (14,000 m^3/day, 0% Flaring)	19,699	204	19,903	0.012%	0.0035%
Expected Maximum (28,000 m^3/day, 0% Flaring)	39,399	204	39,603	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)

Table 4.17 shows that the total greenhouse gas emissions expected to be 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 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 0.0002% and 0.003% and between 0.0007% and 0.0009% of total NSW and Australian greenhouse gas emissions for 2006, respectively.

4.9.4 Conclusions

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,
- 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***.

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 15 boreholes will range between 3,760 t CO_2-e and 5,375 t CO_2-e. This equates to between 0.0002% and 0.003% and between 0.0007% and 0.0009% of total NSW and Australian greenhouse gas emissions for 2006 respectively.

4.10 Rehabilitation

Rehabilitation of the borehole sites is required by the PEL. Boreholes that are not required for future gas production would be rehabilitated. The rehabilitation works will include:

- Removal of surface infrastructure,
- The capping or filling of borehole,
- Top soil stockpiles spread over the area,
- Revegetation of the area with native flora.

DPI-MR will impose rehabilitation bond requirements on Apex. This will ensure that there are finances available to the DPI-MR to enable them to rehabilitate disturbed areas should that need arise.

Apex has also committed to repair any damaged SCA roads and tracks as a result of their exploration activities within the catchment areas.

4.11 Traffic

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 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 week's concentrated access to undertake gas flow testing. This would require a trailer mounted gas flaring chamber to be delivered to the site immediately prior to the one week gas monitoring period. During the week-long gas testing, the site would be accessed by up to 5 small vehicles per day. The trailer-mounted gas flaring will be removed at the completion of the gas monitoring period. 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.

4.11.1 Existing Public Road Intersections

The proposed access points for program traffic re-entering public roads were inspected on 14th January 2009. A full copy of the Summary Report is included as **Appendix VI, *"Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Program Traffic Impact Summary, January 2009"***. This report investigates the 18 boreholes originally proposed. Apex has decided to install only 15 out of the 18 boreholes investigated at this time. The following discussions on traffic impacts reflect the lower number of boreholes.

Table 4.18 provides a summary of that inspection. Note Figure 3.1 in **Appendix VI** shows the location of the various gates through which the re-entry would be made. Photographs 1 to 30 in **Appendix VI** assist in understanding existing conditions at each gate entry.

Table 4.18 identifies that there are 7 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 4.18 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.

Table 4.18 – Conditions at Access to Public Roads

Gate ID*	Boreholes Accessed	Road Intersection	Road and Traffic Comments
1	AI10 AI14 AI16 AI18	Appin Road.	Gate located 26 m from road edge. Approximately 100 m to west speed control changes from 100 kph to 80 kph. Two lanes from west and single lane from east. Extensive off-road parallel parking available. Site distances at least 170 m to west and 180m to east. **Normal safety arrangements required.** Refer photographs 1 to 3 **Appendix VI**.
2	AI17	Princes Highway	Gate located 10m from edge of road. Speed control 100 kph. Parallel parking available along road edge. Site distance at least 140 m to south and 350 m+ to north. **Specific safety arrangements required for heavy vehicles to access this gate.** Refer photographs 4 to 6 **Appendix VI**.
3	AI15	Princes Highway	Gate located 13 m from edge of road. Speed control 100 kph. Parallel parking available along road edge. Site distance at least 250 m to south and 120 m to north. **Specific safety arrangements required for heavy vehicles to access this gate**. Refer photographs 7 to 9 **Appendix VI**.
4	AI11 AI12B AI13	Princes Highway	Gate located 45 m from edge of road. Speed control 100 kph. Parallel parking not available along road edge. Site distance at least 130 m to south and 180 m to north. **Specific safety arrangements required for heavy vehicles to access this gate.** Refer photographs 10 to 12 **Appendix VI**.
5	AI04B, AI07 AI08 AI09	Princes Highway	Gate located 18 m from edge of road. Speed control 100 kph. School Zone restrictions applicable. Deceleration lane available from north. Some parallel parking available. Site distances at least 210 m to north and 250 m to south. **Normal safety arrangements required**. Refer photographs 13 to 15 **Appendix VI**.
6	AI05	Darkes Forest Road	Gate located 25 m from road edge. Rural bitumen two lanes wide. Site distances at least 90 m to west where a very sharp corner exists and 140 m to the east. **Specific safety arrangements required for heavy vehicles to access this gate.** Refer photographs 25 to 27 **Appendix VI**.
7	AI06	Darkes Forest Road	Gate located 17 m from road edge. Rural bitumen two lanes wide. Parallel parking available. Site distances at least 250 m to west and 90 m to the east, where a very sharp corner exists. **Normal safety arrangements required for vehicles to access this gate.** Refer photographs 28 to 30 **Appendix VI**.

* Refer to Figure 3.1 in **Appendix VI**

4.11.2 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.

- Each 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 are 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.

4.11.3 Specific Traffic Arrangements

Table 4.18 identifies a number of gated access points that require specific traffic arrangements to ensure safe utilisation. In addition to the normal safety arrangements, these access points will be subject to the additional arrangements and procedures outlined in this section.

Particular attention would 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 reflective, flashing or highlighted during night time.

- Each 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.

4.11.4 Conclusions

Traffic safety rules and procedures would be developed to ensure public and employee safety during all operational stages of the program.

5 PROGRAM ENVIRONMENTAL MANAGEMENT

Apex Energy NL acknowledges the importance to manage the environmental implications of the Illawarra Coal Seam Gas Drilling and Gas Monitoring Program. Apex has longer term plans to develop gas reserves in the NSW Southern Coalfields and intend to operate this current Program in a way that demonstrates their commitment to appropriate environmental management. Apex considers this to be an essential factor in establishing Government and the general community support for their longer term aspirations.

Environmental management of the program will be achieved through an integrated series of policies, plans and procedures and a suitable management structure that clearly defines responsibility, accountability and reporting requirements. The policies, plans and procedures will be supported by training of staff and contractors to ensure they all have the appropriate knowledge and skills.

The main objective for the environmental management of the Program will include establishing Apex as an environmentally responsible company.

5.1 Management Structure

Apex will establish a simple Project Management Structure to ensure effective environmental management of the Program.

The Apex Directors responsible for the Program would be responsible for all matters relating to environmental management.

The Directors would appoint a Project Manager who has the day to day responsibility of ensuring that all site activities are undertaken in accordance with the various policies, plans and procedures. The Project Manager will co-ordinate environmental performance monitoring to measure adherence to approval and licence conditions and compliance with applicable legislation.

Apex may appoint an Environmental Consultant for advice and recommendations and to undertake an internal auditing/inspection and consulting role as required.

5.2 Policies, Plans and Procedures

Apex will operate the Program in accordance with a Health Safety and Environmental Policy.

This Policy will be supported by a range of Plans and Procedures that will define how Apex will operate the Program.

Prior to establishing the borehole sites, the Drilling Contractor will prepare a Site Environmental Management Plan. This Plan will address a range of environmental issues for which the Contractor is responsible, including the management of site water, fuels and oils, chemicals and wastes.

Each drill site will be designed in accordance with the specific site requirements. The design will incorporate risk management techniques and will involve input from relevant stakeholders in order to ensure their requirements are met. The pre-establishment liaison and planning will result in a site specific Management Plan that will identify how all aspects of the site will be managed by Apex.

Gas flows will occur in accordance with a Well-testing and Flaring Management Plan that will be created using a standard risk management approach including consultation with Government and industry experts. The Well-testing and Flaring Management Plan will be authorised by DPI-Mineral Resources prior to any release of gas.

Other documented work arrangements will be developed as required.

5.3 Employee and Contractor Training

The Project Manager will be responsible for ensuring that all Program personnel are suitably trained, and possess the necessary skills to undertake their designated activities with due consideration of environmental considerations.

6 DRAFT STATEMENT OF COMMITMENTS

This section has been prepared in accordance with the requirements of Part 3A of the ***Environmental Planning and Assessment Act* 1979**, and presents a compilation of the actions and initiatives that Apex Energy commits to implement if the Illawarra Coal Seam Gas Exploration Drilling and Gas Monitoring Program is approved. These commitments are designed to effectively manage, mitigate, guide and monitor the Project from initial construction through to full production and eventually rehabilitation of the Project Site.

The Environmental Assessment of the Project has identified a range of environmental, social and management outcomes and measures, all required to avoid or reduce the environmental and social impacts of the Project.

All parties involved in the design, establishment and operational phases of the Project will be required to undertake their work in accordance with these commitments. The commitments are presented in tabular form (**Table 6.1**) and identify the committed action and timing of commitments.

Table 6.1 – Project Commitments

Action	Timing
1. During drilling operations actions will be undertaken to protect aquifers from any operational impacts.	During borehole establishment and drilling
2. Use of any of the boreholes for future gas production is dependent on exploration outcome and appropriate prior approvals.	Potential future activity
3. Holes will require a blow-out prevention (BOP) device on the wellhead which is secured to steel casing cemented in to a depth of at least 10% of the estimated final hole depth, or as required under the ***Petroleum Act* 1992.**	During borehole drilling.
4. Each drill site will be designed in accordance with the specific site requirements. The design will incorporate risk management techniques and will involve input from relevant stakeholders in order to ensure their requirements are met. The pre-establishment liaison and planning will result in a site specific Management Plan that will ensure the site is managed appropriately.	Prior to drilling
5. Gas flows will occur in accordance with a Well-testing and Flaring Management Plan that will be created using a standard risk management approach including consultation with Government and industry experts. The Well-testing and Flaring Management Plan will be authorised by DPI-Mineral Resources prior to any release of gas.	During gas monitoring
6. Flaring will be undertaken in a purpose built mobile gas flaring chamber.	During gas monitoring

Action	Timing
7. Apex proposes to undertake additional exploration and gas data acquisition at some time in the near future. This future activity will be dependent on the initial results and involves two main technologies. The first involves zero radius drilling through coal seams from existing core boreholes. The second promotes methanogenic bacteriological activity. These will be subject to further approval in a separate application and assessment process.	Potential future activity
8. The final location of each borehole will be confirmed after consideration of detailed environmental assessment of each site.	Prior to drilling
9. Apex would liaise with SCA to obtain agreement with a series of requirements to enable the activities to proceed.	Prior to drilling
10. Boreholes have been sited to minimise vegetation clearing and soil disturbance and compaction.	Completed
11. Any cleared vegetation and topsoil will be stockpiled and re-spread over the site on completion of operations.	During site clearing
12. Vehicles will be restricted to defined parking and unloading areas.	During drilling
13. Exploration hole drilling will require excavation of a sump to collect cuttings and expelled water. Following completion of drilling, the sump will be allowed to settle. The sump would be backfilled with material originally excavated from it and the disturbed area covered with topsoil and any remnant vegetation.	During and immediately following drilling
14. Following completion of operations all excavations will be backfilled and the site rehabilitated.	Following completion of all operations at each site
15. Silt fences will be erected where appropriate and maintained until a suitable level of rehabilitation has been achieved. All silt fencing will be removed when no longer required.	Prior to and during drilling
16. On-site storage of fuel and lubricants will be kept to a minimum and safely stored on site in bunded pallets. Hydrocarbon spill kits will be available on site.	During drilling
17. Drilling equipment will be required to be clean of soil and free of oil leaks prior to entering the site.	Prior to drilling
18. Any oil leaks that develop will require immediate repair and drilling contractors will be required to have a supply of oil absorbent material on hand.	During drilling
19. Apex will ensure that the drilling fluids are removed from site at the completion of drilling and the water containing KCl disposed of in an appropriate manner.	At the completion of drilling

Action	Timing
20. All packaging, damaged or surplus equipment and drilling supplies will be removed from site prior to or at the completion of operations. Food wastes and similar will be deposited in secure capped bins and removed on a daily basis to maintain hygiene and minimise scavenging by wildlife.	During and immediately following drilling
21. Fire precautions will include spark arrestors on the drilling rig, and no smoking or sources of ignition within 30m of the wellhead. There will be fire extinguishers on the drilling rig. Apex will provide cleared areas for hot work (grinding, cutting and welding) and a "butt bin" for smoking. All hot work will be done with an observer standing by and fire extinguishers on hand.	During all site activities
22. A "portaloo" will be installed on site and maintained on a regular basis.	During drilling
23. Where possible, the drilling activity will occur every day over 24 hours per day.	During drilling
24. Within SCA areas, the site boundary will be marked by coloured tape suspended between steel droppers with warning signs. In open areas Apex will provide temporary security fencing and warning signs around the boundary of each site.	During drilling and gas monitoring
25. Exploration well testing may produce groundwater from the seams. It is proposed that such water be stored in the ground sumps or in above ground tanks and removed off-site by tanker or temporary above ground poly-pipe. Ultimate disposal will comply with DECC requirements.	During gas testing
26. All safety and environmental requirements set out in the SCA Access Agreement will be adhered to.	During all site activity
27. The exploration program will provide details of water quality and quantity to assist planning of any future activities.	Data collection to assist potential future activity
28. A sedimentation fence will be constructed immediately down slope of the drill sites. The sedimentation fences will be installed in accordance with requirements as described in "**Soils and Construction", 1st Edition, March 2004**".	Prior to drilling commencing and first stage of site set up
29. Should any surface drains and/or sedimentation basins be required during construction, they will be constructed in accordance with the Landcom publication, ***"Soils and Construction" Volume 1, Fourth Edition, March 2004"***.	During site establishment and during drilling and gas monitoring
30. The construction contractor will prepare a Site Environmental Management Plan that will address site water management details.	Prior to site access

Action	Timing
31. On-site storage of fuel, lubricants, potassium chloride and any other chemicals would be kept to a minimum and these items would be stored in bunded pallets.	During drilling
32. In the event of a spill of produced groundwater onsite which is not contained within site sumps or above ground tanks, a water quality sampling and testing service would be employed to ensure that any 'normal' stormwater runoff retained by the bund wall has not been contaminated and, if it has, that prompt removal by tanker would occur.	During drilling and gas monitoring
33. For core drilling sites, where excavated sumps are used for the circulation of drilling fluid, if possible drilling fluid would be confined within the mud pits and temporarily covered with say a tarpaulin so that mixing with stormwater is prevented.	During core drilling
34. Significant amounts of produced groundwaters which can be confined within on-site tanks or pits would have pH and EC monitored prior to tankering away off site.	During drilling and gas monitoring
35. To assess requirements for management of excessive volumes of produced groundwaters i.e. volumes which have not been successfully confined within on site tanks or pits and are contained behind the site bund wall, water samples would be collected to determine water quality in the event of possible loss of containment. This would be done by measuring pH and EC onsite, and collection by an appropriately trained person of samples to be sent to a NATA-accredited laboratory for determination of key chemical analytes as identified in **Table 4.2** of the EA.	During drilling and gas monitoring
36. On demand, water quality sampling and analysis would be conducted in the unlikely event that there is any uncontrolled release from the site water containment system.	During drilling and gas monitoring
37. The plant species *Darwinia grandiflora* was recorded at borehole AI10 within Coastal Upland Swamp. The exact location of this species will be flagged, so it can be adequately protected and avoided by the proposal during and after construction of the borehole. A suitably qualified ecologist will be on site during the initial borehole site set up, to ensure this species is not impacted by the proposal.	Prior to drilling commencing
38. Apex will adjust the location of boreholes and access tracks to avoid native trees and significant habitat features such as sandstone outcropping, where required.	Prior to drilling commencing
39. Trees with hollows would be retained and protected, with no drilling within the critical root zone (extending to 2m beyond the drip line) of the trees.	Determined prior to drilling commencing

Action	Timing
40. Access to boreholes AI10, AI16, and AI18 may require trimming of branches along existing fire trails. Such branch trimming would be limited and restricted to smaller branches that do not support hollows. Should large branches with hollows be required to be removed, a suitably qualified ecologist would be on site during clearing to ensure no resident fauna are harmed. Cleared branches would be placed in adjoining vegetation, as they will provide fauna habitat.	Prior to drilling commencing
41. Access to boreholes AI10, AI16 and AI18 will involve two creek crossings. These crossings will use established crossings along the established Fire Road 10Q and will not divert into other areas of the creeklines. Caution would be taken to prevent sedimentation run off and minimise disturbance along the creek.	Prior to drilling commencing and during all site activities
42. Where possible, proposed boreholes and access tracks would be located within existing cleared areas.	Prior to drilling commencing
43. Sediment and erosion control measures would be implemented on all sites to prevent erosion during and after construction.	Prior to and during site activities
44. Disturbance to native vegetation would be minimised, or, where disturbance is unavoidable, borehole sites would be rehabilitated using locally sourced tubestock and brush-matting. Rehabilitation would be undertaken by suitably qualified bush regenerators.	Prior to, during and after site activities
45. Where clearing of native vegetation is unavoidable, native shrubs, logs and bush-rock would be stockpiled on the side of the proposed boreholes and access routes and replaced following completion of the works.	Prior to any site clearing
46. If required, bush regeneration and weed control would be undertaken to ensure the flora and fauna of the locality are protected throughout the construction and operation phases of the proposal. This is particularly important for boreholes where intact native vegetation will be disturbed. Any bush regeneration and weed control would be undertaken by suitably qualified bush regenerators.	Prior to, during and after site activities
47. Any chemicals used on site would be taken off site after use and disposed of appropriately.	During drilling and gas monitoring
48. Machinery and vehicles would be washed down prior to use on site to avoid the transmission of weed seed or disease into areas of intact native vegetation.	Prior to machinery and vehicles being used on site
49. A suitably qualified ecologist would be on site during the initial site set up for each borehole, to ensure significant habitat features and species are not impacted by the proposal.	Prior to drilling commencing and during site confirmation

Action	Timing
50. During construction Apex will ensure that all diesel motors are noise attenuated to minimise noise impacts during construction. Apex will monitor noise during drilling operations. Testing operation will be largely inaudible and will not require mitigation.	During drilling and gas monitoring
51. Apex will install 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.	During site establishment
52. No 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 to assess the find.	During all site activities
53. No historic heritage constraints have been identified within the project study area. Should unanticipated historic relics be identified during project works, all works would cease in the vicinity of the find and an archaeologist would be commissioned to assess the find.	During all site activities.
54. Where necessary, a water cart will be used on site to reduce dust generation.	During site establishment and drilling
55. Apex will implement appropriate BMP and BATEA practices. They will provide noise barriers at AI05 and AI06 to reduce noise levels experienced at the nearest residences. In addition, they will attempt to negotiate agreements with the affected residents should the barriers not enable the noise criteria to be met.	During site establishment and drilling
56. Appropriate monitoring would be undertaken during drilling operations to confirm that the criteria are being achieved. Should this monitoring demonstrate non-compliance, Apex would undertake investigations and plan actions to ameliorate the non-compliance.	During drilling
57. Should the approaches described in commitments 55 and 56 not resolve the noise issues, drilling would be limited to those times of day when criteria are met.	During drilling at AI05 and AI06
58. Packaging wastes will be separated into metal, wood and other recyclable streams. These separated waste materials will be recycled in an approved manner.	During all site activities
59. Non-recyclable materials will be collected separately and will be disposed off-site in an approved waste facility.	During all site activities
60. Wastewater from the temporary site buildings will be collected on-site prior to transport off-site for disposal at an appropriately authorised disposal facility.	During all site activities

Action	Timing
61. Vehicle-servicing wastes will consist of oils and greases together with assorted hydrocarbon containers. Mobile vehicles will not be serviced on site. This will be undertaken at appropriate off site workshops. Any oils, greases and containers will be collected for recycling.	During all site activities
62. Topsoil from the area surrounding the borehole will be stripped and stockpiled prior to the commencement of drilling. This topsoil will be used to resurface disturbed areas prior to revegetation.	During site establishment
63. The site will be seeded with native flora species consistent with those currently surrounding the site.	During site rehabilitation at the completion of site activities
64. 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.	During gas monitoring
65. Rehabilitation of the borehole sites is required by the PEL. Boreholes that are not required for future gas production would be rehabilitated.	At the completion of site activities
66. Apex will instruct all contractors and employees in the procedures for passing through the gates safely.	Prior to accessing each borehole site
67. Traffic safety rules and procedures would be developed to ensure public and employee safety during all operational stages of the program.	Prior to accessing each borehole site

7 DIRECTOR GENERAL'S REQUIREMENTS

The Director General's Requirements (DGRs) were received on 18th September 2007 and are included in full in **Appendix VIII**. **Table 7.1** summarises the DGRs and details which sections of the Environmental Assessment they are addressed. Some of the DGRs are of an administrative nature only and have been or will be addressed during the ongoing assessment process.

Table 7.1 – Director General's Requirements and Environmental Assessment Section Reference

Department	Requirement	Environmental Assessment Section
DoP	1. Advise the DoP two weeks prior to submitting the EA to enable the DoP to arrange for public exhibition.	Administrative requirement
DoP	2. DoP will assess the final EA for adequacy and may request further information be provided and included before public exhibition.	Administrative requirement
DoP	3. An electronic version of the EA must be hosted on a suitable website with a link to the Department's website.	Administrative requirement
DoP	4. The EA 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 identified by the DoP (Refer 5 following) and any other significant issues identified in the general overview of environmental impacts of the project 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	 • EA **Section 1** • EA **Sections 2** and **3** • EA **Section 3.9** • EA **Section 4.1** • Refer Requirement 5 on next page

Department	Requirement	Environmental Assessment Section
	programme/plans will be reported.	
	• A Statement of Commitments, outlining environmental management, mitigation and monitoring measures.	• EA **Section 6**
	• 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,	• EA **Section 1**
	• A signed statement from the author of the Environmental Assessment certifying that the information contained in the report is neither false nor misleading.	• EA **Pages 1-2**
DoP	5. Key Issues identified by the DoP are:	
	• Soil and Water. Particularly sediment and surface water control during and following construction, soil disturbance and compaction, and groundwater quantity and quality.	• EA **Sections 4.2** and **4.8,** EA **Appendix 1**
	• Flora and Fauna. Including impacts on native vegetation through clearing and disturbance and the requirement for offsetting.	• EA **Section 4.3** and **Appendix II**
	• Noise and Vibration	• EA **Section 4.6** and **Appendix IV**
	• Greenhouse gases	• EA **Section 4.9** and **Appendix V**
	• Aboriginal heritage	• EA **Section 4.4** and **Appendix III**
	• Rehabilitation	• EA **Sections 3.6**, **4.9** and **4.3.6.2**
DoP	6. The EA must take into account relevant State Government technical and policy guidelines.	Refer all Specialist Consultant Reports in **Appendices I** to **V**.
DoP	7. During the preparation of the EA Apex should consult with the relevant local, State and Commonwealth Government authorities, service providers, community groups or affected landowners. The consultation process and the issues raised must be described in the EA. In particular, Apex 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 EA.	EA **Section 3.10**

DECC	8. DECC require that the following environmental impacts 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 and Waste. These matters have to be addressed in accordance with the relevant guidelines. The details of matters to be assessed are discussed more fully in 9 to 18 below.	Refer Requirements 9 to 18.
DECC	9. 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 land uses, planning zonings, potential sensitive receptors, surface and subsurface area/features of conservation significance and environmental sensitivity. These should include areas containing natural and cultural heritage values.	EA **Sections 3** and **4**. All Specialist Consultants Reports in **Appendices I** to **V**.
DECC	10. 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.	EA **Sections 3** and **4**. All Specialist Consultants Reports in **Appendices I** to **V**.
DECC	11. The EA should determine if any potential impacts may occur directly or indirectly on DECC Estate.	Borehole AI05 in disturbed area within Dharawal State Conservation Area. EA **Section 4.3**.
DECC	12. In relation to Impacts on Water Quality and Quantity, DECC requested the following project objectives: • 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 a 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. An assessment needs to be provided in the EA demonstrating how the objectives will be achieved. The proponent should confirm in the EA, the	EA **Sections 3.1**, **3.10** and **4.22**

	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 SCA is also suggested and should be documented in the EA. The EA should address erosion and sediment controls applicable to construction of the site. DECC also consider 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. Hanging swamps of regional significance occur in the Illawarra Escarpment area. Hanging swamps are extremely sensitive ecosystems which are dependent 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 locations and changes in hydrology.	Subsidence not predicted. EA **Section 3.6**. No Hanging Swamps affected. EA **Section 4.3.1**.
DECC	13. In relation to Impacts on Threatened Species and Their Habitat, DECC have requested that a field survey of the site should be conducted and documented in accordance with the draft "Guidelines for Threatened Species Assessment". 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 possibility of impacting bats living in old mine workings should be assessed. Many threatened species and endangered ecological communities occur near the borehole sites and should also be taken into consideration.	EA **Section 4.3** and **Appendix II** All mining areas accessed will be sealed entries and bats could not access.
DECC	14. In relation to Impacts on Aboriginal Cultural Heritage Values, DECC have requested that the EA 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. The assessment should identify the nature and extent of impacts on Aboriginal cultural heritage values across the project area. It should describe the actions that will be taken to avoid or mitigate	EA **Section 4.4** and **Appendix III**

	impacts or compensate to prevent unavoidable impacts of the project on Aboriginal cultural heritage values. 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.	
DECC	15. In relation to Greenhouse Gas Emissions, DECC have requested a greenhouse gas assessment of the project. The EA should identify the amounts of gas proposed to be released and address measures to minimise the release of greenhouse gases into the atmosphere.	EA **Section 4.9** and **Appendix V**
DECC	16. In relation to Impacts of Noise and Vibration, DECC have requested that the project 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. The 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.	EA **Section 4.6** and **Appendix IV**
DECC	17. In relation to Impacts on Air Quality, DECC have requested that Apex ensure that sensitive receptors are protected from any adverse impacts from dust or odour. In addition, the development should ensure that: • Emissions should not cause any adverse impact upon human health or the environment, and there must be no offensive odour beyond the boundary of the premises. • 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. • Vehicular kilometres travelled are minimised.	EA **Section 4.5**
DECC	18. In relation to Waste, DECC have requested that the development should ensure that: • It is in accordance with the principles of 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. • No waste disposal occurs on site except in accordance with an EPA Licence.	EA **Section 4.7**

DPI-MR	19. Provide detailed information on the sealing of wells.	EA **Section 3**
DPI-MR	20. Identify proposed rehabilitation outcomes.	EA **Sections 3.6**, **4.9** and **4.3.6.2**
DPI-MR	21. Characterise and identify any groundwater impacts.	EA Section **4.2.2.3** and EA **Appendix I**
DPI-MR	22. Define safety management given the interactions with operational mine.	EA **Section 3**
DPI-MR	23. Identify any Title issues given the interaction with coal mine leases.	EA **Section 2**