REPORT TO

Wilton Rezoning (Landowners Group)

on the

Preliminary Assessment of Surface Infrastructure & Gas Drainage Considerations for Appin Area 8 Mining and Wilton Junction New Town

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1 EXECUTIVE SUMMARY

In November 2011, the NSW Government initiated the Potential Housing Opportunities Program and invited landowners with suitably located substantial landholdings to nominate sites which might be able to deliver additional housing to address Sydney's housing supply shortfall. Walker Corporation, Governors Hill, Bradcorp and Lend Lease responded to the Program and nominated landholdings of more than 100ha in Wollondilly Shire, surrounding the Hume Highway-Picton Road intersection for consideration. This area has subsequently become known as Wilton Junction, and is the subject of this application.

Following a Wollondilly Shire Council resolution in May 2012, the four major landowners (collectively known as the Wilton Junction Landowners' Group) signed an agreement to work cooperatively with Council to prepare a high level Master Plan for Wilton Junction to deliver high quality new housing, jobs close to homes, supporting social and utilities infrastructure and services, and a range of complementary land uses.

A high level Master Plan and a Preliminary Infrastructure Requirements Report were considered by the Council on 17 December 2012, with Council resolving to give in-principle support to the proposal. Council also resolved to request that the rezoning be a state-driven process.

Subsequently, the NSW Government decided to coordinate the statutory planning process, led by the Department of Planning and Infrastructure (now the Department of Planning and Environment, DP&E). The Minister for Planning and Infrastructure (now the Minister for Planning and Environment) proposed to prepare a State Environmental Planning Policy (SEPP), as per Section 24 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This was done with a view to rezone the land through an amendment to the Wollondilly Local Environmental Plan 2011 (LEP) to facilitate the early delivery of housing and infrastructure, linked to an agreed Infrastructure, Servicing and Staging Plan.

The Department of Planning and Infrastructure issued Study Requirements (SRs) to the Proponents (Walker Corporation, Bradcorp and Governors Hill) to guide the planning investigations for a new town at Wilton Junction. The SRs set the criteria for carrying out environmental investigations across the Study Area (excluding both Bingara Gorge and the existing Wilton village which will not be affected by any proposed amendments to their current zoning and planning provisions). The investigations examine the potential for the Wilton Junction Study Area to be rezoned under a SEPP.

The Wilton Junction Landowners Group has engaged IMC Mining Group Pty Ltd (IMC) to assist with Issue 6 of the SRs by undertaking an assessment of the potential options available to BHP Billiton Illawarra Coal (BHPBIC) to install and operate surface infrastructure and gas drainage systems to support the proposed future development of the Appin Area 8 Mining Domain. IMC's assessment is to consider the potential implications and feasibility associated with the coexistence of coal mining with surface development of the Wilton Junction (WJ) area.

From this preliminary assessment of gas drainage and surface infrastructure considerations for Appin Area 8 located below the proposed Wilton Junction new

town development, it may be concluded that the continued development and application of in-seam gas pre-drainage by underground methods and goaf gas drainage through surface based methods is likely to provide sufficient gas extraction capacity to support safe and efficient mine operations. Other required surface infrastructure should not be unduly impacted by the development.

This assessment has discussed, in general terms, the gas drainage options that may be utilised by BHPBIC in Area 8 below Wilton Junction and provided a comparative cost of these options. Although it has been suggested that the required gas drainage may be achieved using predominantly underground methods, surface based methods provide a more cost effective and safer solution provided corridors and open areas can be provided as access sites to undertake the gas drainage drilling and extraction operations. Additionally, through the use of developing directional drilling technology it is likely possible and more cost effective to undertake much of the required drilling activities from outside of the Wilton Junction development area.

A number of areas have been identified within the proposed Wilton Junction investigation area that may potentially be available to BHPBIC to access and undertake surface based gas drainage and gas extraction operations. To this end, an indicative gas drainage design has been prepared for the most likely options to illustrate how the coexistence of urban development and underground mining could work. However, given the experience in Area 7 and Area 9, changes may be required to the Area 8 mine layout as additional exploration data is gathered and assessed by BHPBIC, and town planning and indicative drainage designs may require some alteration accordingly.

From the above discussion, it is apparent that there are technically feasible alternative methods to carry-out necessary gas drainage in Area 8 that could permit the co-existence of the Wilton Junction new town development and underground longwall mining by BHPBIC in this context. However, the decision on the optimal alternative will be one of weighing up the economics, which will be determined by both actual cost of implementation and the effectiveness of the method as expressed by mine productivity and mining costs.

In order to make these decisions, it will likely be necessary to firm up the mining layout for Area 8, which can only be achieved through additional exploration. The necessary additional exploration is not an inexpensive exercise nor is it advantageous to BHPBIC to undertake so far in advance of actual mining. Therefore, a gas drainage layout needs to be investigated that will provide maximum flexibility and sufficient redundancy to allow for the reorientation of the mine plan, if required.

On the other side of the coin, BHPBIC can assist the Landowners Group in providing this flexibility by engaging in open and meaningful discussions on their expected exploration and gas drainage requirements. This can be achieved through providing the latest Bulli seam geological modeling outcomes and long range operating projections, including expected gas drainage design. Through independent analysis of this data, the Landowners Group can better assess the likely mining and gas drainage options for Area 8 and the timing of those operations, and then develop a town plan that provides the required access areas for the mine's surface infrastructure and operational requirements.

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2 INTRODUCTION

In November 2011, the NSW Government initiated the Potential Housing Opportunities Program and invited landowners with suitably located substantial landholdings to nominate sites which might be able to deliver additional housing to address Sydney's housing supply shortfall. Walker Corporation, Governors Hill, Bradcorp and Lend Lease responded to the Program and nominated landholdings of more than 100ha in Wollondilly Shire, surrounding the Hume Highway-Picton Road intersection for consideration. This area has subsequently become known as Wilton Junction, and is the subject of this application.

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IMC has been asked by the Landowners Group to provide advice in relation to the following matters.

1. Report back on how the gas drainage and other infrastructure of Appin Area 8 below Wilton Junction (WJ) could be drained remotely from the proposed WJ development using techniques such as:
   a. Directional boreholes (using land owned by BHP, but not limited to these lands); or / and
   b. In-seam gas drainage

2. Report back on how the gas drainage and other infrastructure of Appin Area 8 below Wilton Junction, could use a combination of onsite and offsite gas drainage techniques through:
   a. Directional drilling from BHP's land adjacent to WJ
   b. In-seam gas extraction in advance of mining and
   c. Surface infrastructure on WJ land
   d. or some combination thereof.
   e. Also please include the area required for each individual drainage point viz a viz the total area, and potential locations.

3. Using the current master plan for Wilton Junction and the current mining layout provided by BHPBIC in their 2008 Environmental Assessment, provide an indicative cost differential for gas drainage and surface infrastructure for mining under the Wilton Junction area with urban development undertaken versus it being a greenfield site.

4. Provide examples in Australia where horizontal versus vertical drilling have been used to effect goaf gas drainage and the circumstances for its use.

5. Provide examples where surface development similar to Wilton Junction has occurred prior to mining, and how surface access for gas drainage was provided in these instances.

6. What processes need to be considered to create easements for the implementation of necessary surface infrastructure.

7. What would be the implications to the provision of easements as above should the mine plan for Area 8 change from that currently proposed.

The following report provides a preliminary assessment on the above.

In undertaking this assessment, IMC has engaged the services of Dr. Dennis Black of PacificMGM to provide advice on the optional gas drainage techniques that are

available either currently or are likely to be available at the time of eventual Area 8 development commencement.

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The results and analysis contained in this Report are based on a number of technical, circumstantial or otherwise specified assumptions and parameters.

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3 BACKGROUND INFORMATION

3.1 Mining and Development Plans

The underground mining method has been used to extract coal from the Bulli seam in the Appin area since the 1960's. BHP Billiton Illawarra Coal (BHPBIC), current owners of the Appin, Tower and West Cliff mining complex, have identified large areas for potential future longwall mining in their approved Part 3A development application, as shown in Figure 1.

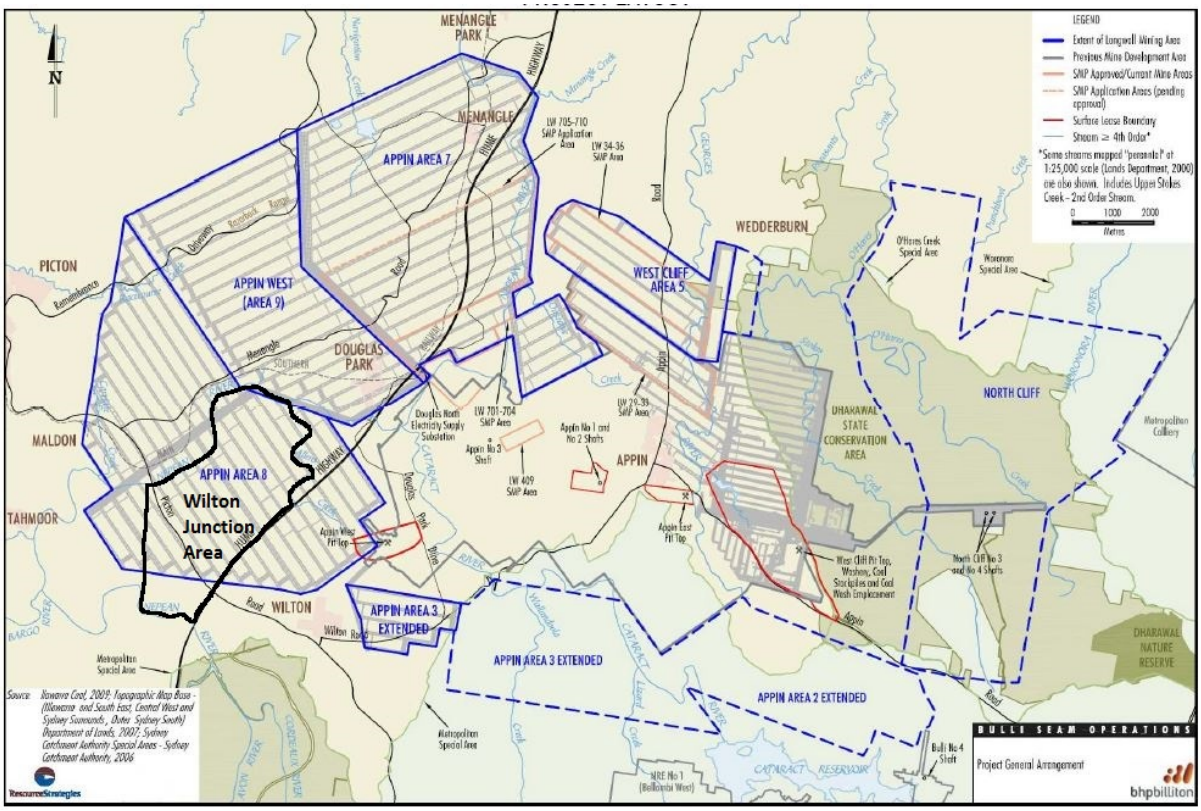

Figure 1 : BHP Billiton Illawarra Coal - Approved Layout of Bulli Seam Operations
(NSW PAC – Project Approval Document, 2011)

Also shown on Figure 1 is the outline of the Wilton Junction Rezoning development area (excluding the approved rezoning at Bingarra Gorge), which occupies a portion of the Bulli Seam Operations Area 8 mine plan area. Considering the entire approved longwall mining area, the Wilton Junction Rezoning area represents only approximately 7% of this mine area.

The indicated layout of the longwall panels in the proposed future mining domains is likely to be an 'ideal' layout that aims to maximise potential coal extraction. However, there is the possibility that the layout could change as more information is gathered by BHPBIC to accurately assess the quality of the coal, the geological conditions and the nature of the coal seam gas reservoir. Such changes to mine

layout have occurred in Appin Area 7 and Appin Area 9, as shown in Figure 2. It is therefore important to consider layout change of the layout of longwall panels in Area 8 so as to allow for change as the dataset of critical geological, geotechnical and gas data is expanded through targeted exploration drilling programs and more detailed mine design is undertaken.

Mining conditions in the Bulli seam are among the gassiest in Australia and gas drainage has been an integral part of mining in this coal seam since the 1980's. The management of coal seam gas has historically had a significant impact on mining operations in the Bulli seam and in several areas has resulted in significant changes to the layout of mine workings.

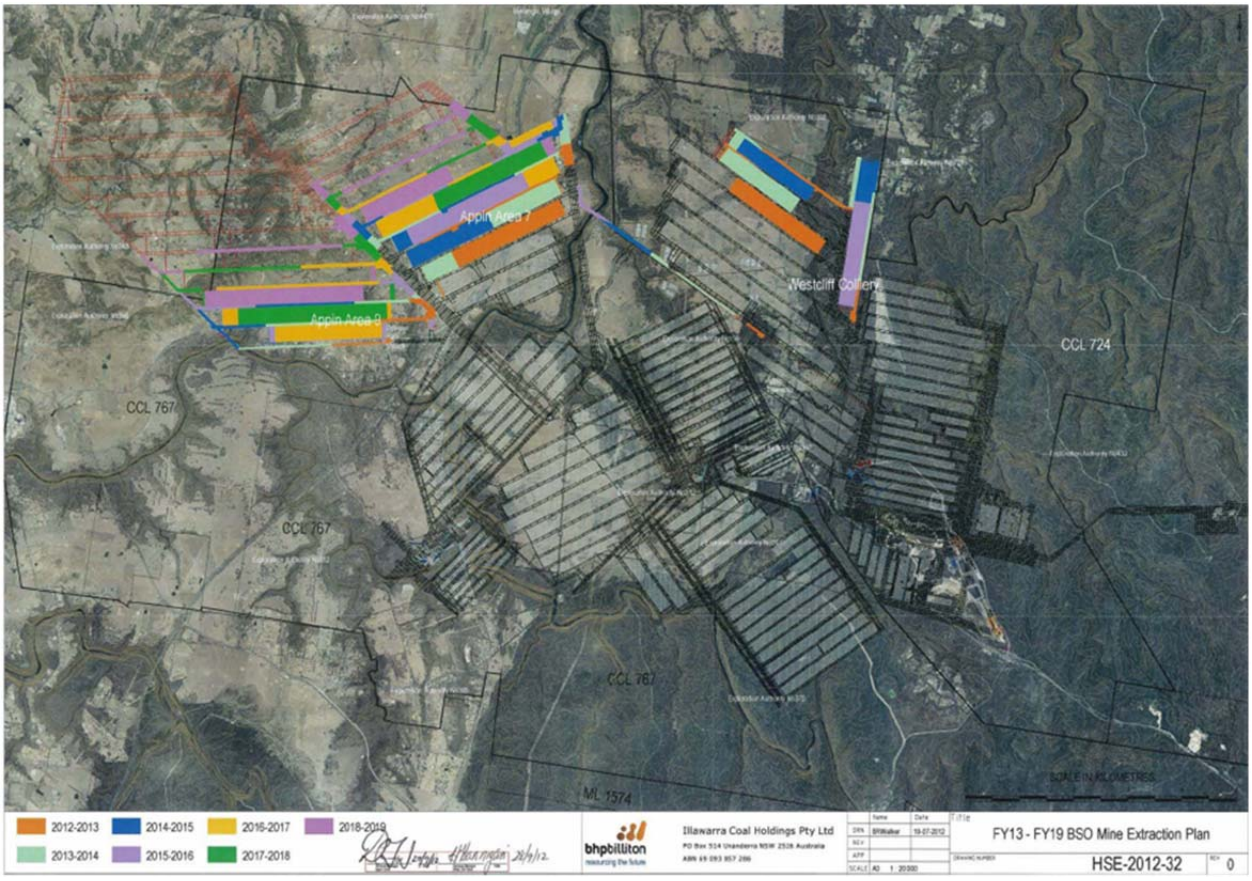

Figure 2 : BHP Billiton Illawarra Coal – Bulli Seam Operations Mine Extraction Plan
(BHPBIC, 2012a)

3.2 Longwall Mining Method

The longwall mining method is illustrated in Figure 3. In longwall mining, a panel of coal, typically around 150 to 300 metres wide and 1000 to 3500 metres long is totally removed by longwall shearing machinery, which travels back and forth across the coalface. The shearer cuts a slice of coal from the coalface on each pass and a face conveyor, running along the full length of the coalface, carries this away to discharge onto a belt conveyor, which carries the coal out to the main headings and

then out of the mine. Full extraction of the longwall panel of coal causes the roof rock above the coal seam to collapse, which in turn forms a depression on the surface as the overlying material slumps to fill the void previously occupied by the coal seam. The area of collapsed material is termed the goaf.

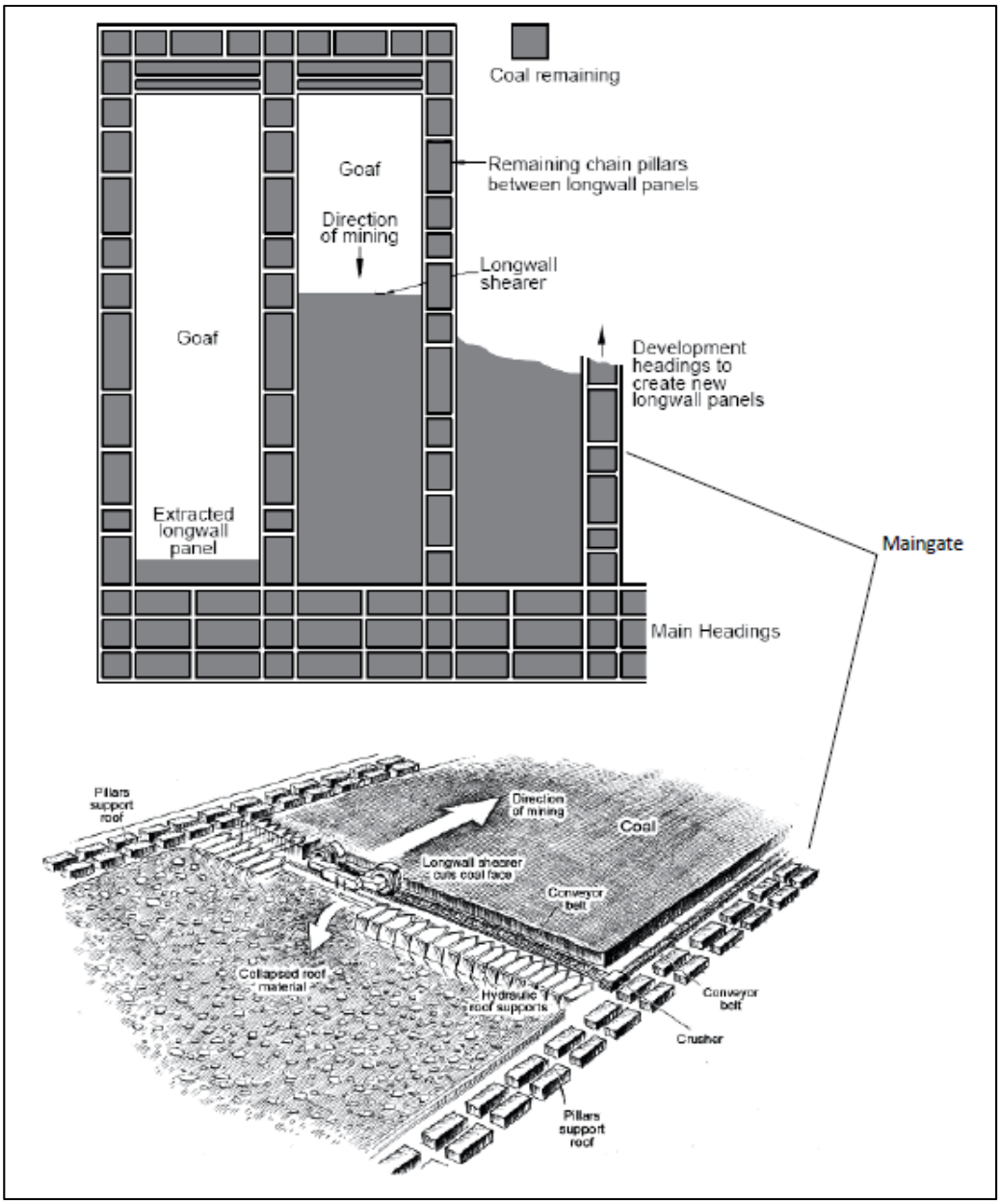

Figure 3 : Illustration of the Longwall Mining Method

Before the extraction of a longwall panel commences, a development unit consisting of continuous mining equipment extracts coal to form roadways (known as headings) around the longwall panel. These roadways form the mine ventilation passages and provide access for people, machinery, electrical supply, communication systems, water pump out lines, compressed air lines and gas

drainage lines. The roadways that provide access from the mine entrance to the longwall panels are referred to as the main headings. Once the main headings have been established, additional development headings known as gateroads are driven on both sides of the longwall panel and are connected together across the end of the longwall. The gateroad containing the belt conveyor is known as the maingate, while the other gateroad is called the tailgate.

3.3 Stratigraphy

Although the Bulli seam is the focus of mining operations in the Wilton Junction area, there are a number of coal seams below the Bulli seam that have the potential to liberate gas into the mine workings following goaf formation. These coal seams include:

- Bulli seam (BUSM) – working seam;
- Balgownie seam (BASM);
- Cape Horn seam (CHSM);
- Upper Wongawilli seam (UWSM); and
- Lower Wongawilli seam (LWSM).

The sandstone and claystone units present above the Bulli seam also have the potential to contain gas and it can be expected that a portion of this gas will also be liberated into the goaf area following the extraction of the Bulli seam by the longwall unit.

Although specific details of the stratigraphy in the Wilton Junction area have not been provided, it may be assumed that the stratigraphy in the area will be similar to that shown in Figure 4.

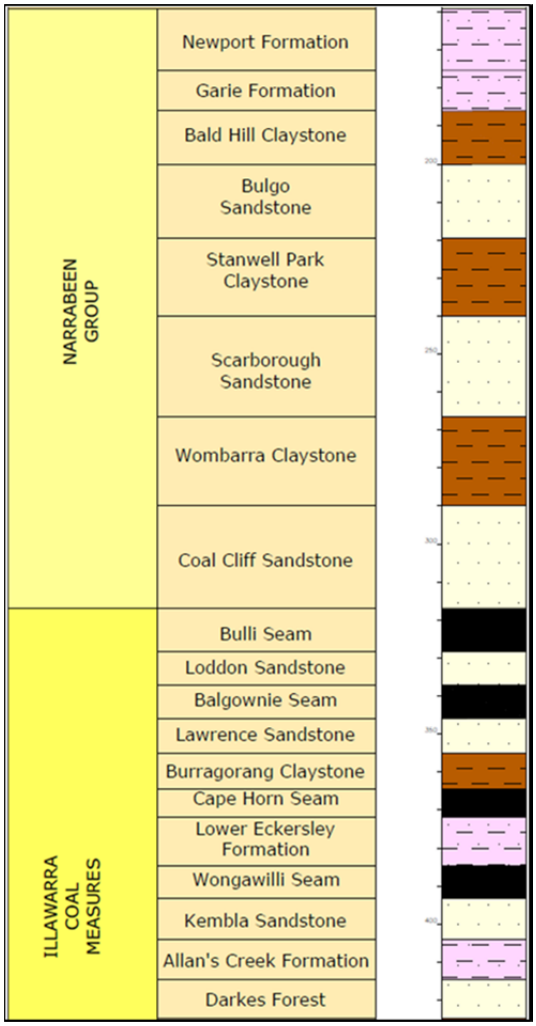

Figure 4 : General Stratigraphy of the Illawarra Coal Measures

3.4 Gas Drainage Methods

Gas drainage is an integral part of coal mining in the Bulli seam to both manage the outburst risk and to maintain the concentration of coal seam gases in the mine workings to below statutory limits.

Although influenced by the amount of gas (gas content) present in the Bulli seam, and adjacent coal seams and adjacent gas bearing strata, it can be expected that all current and future longwall mining in the Bulli seam will utilise gas drainage to:

a) reduce the gas content of the Bulli seam, and potentially adjacent coal seams, prior to mining (pre-drainage), and

b) reduce the amount of gas released into the longwall ventilation circuit from the goaf (goaf drainage).

Figure 5 provides details of the gas content of the Bulli seam (m^3/t) relative to existing and current planned Appin Area 7 and Area 9 domain mine workings. It can be seen that mine workings have preferentially been located in areas where the in situ gas content of the Bulli seam is generally less than $13m^3/t$, and in the case of

Area 7, the planned mine layout has been changed to avoid a large area of increased gas content.

In addition to a number of fundamental mine design considerations, such as seam thickness, coal quality, horizontal stress magnitude and orientation, and geological structures, it is considered likely that the size and nature of the coal seam gas reservoir in the Appin Area 8 mining domain will impact the mine design, resulting in eventual changes to the current proposed mine layout, regardless of the existence of the Wilton Junction development.

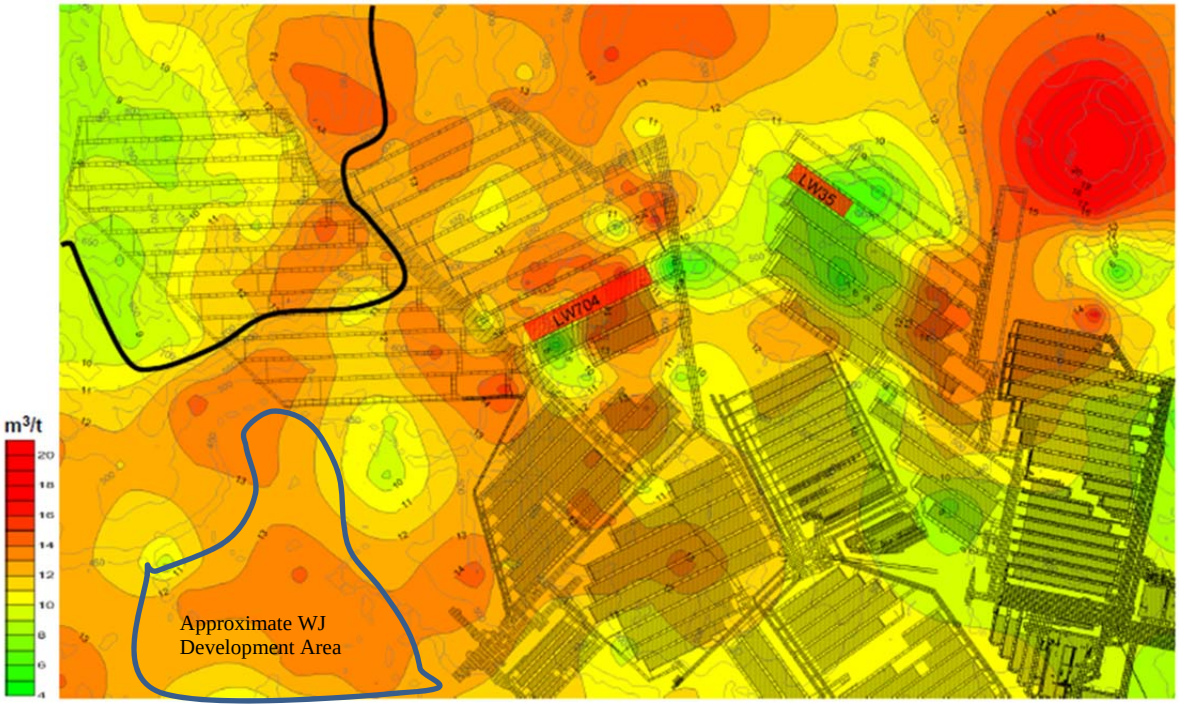

Figure 5 : Bulli Seam Gas Content – Appin and West Cliff Mines
(Elvy, 2012)

3.4.1 Underground to In-seam (UIS) Gas Drainage

Underground to in-seam (UIS) drilling was first used in 1980 to assist in draining gas from the Bulli seam ahead of mining. This pre-drainage method has since developed to become the primary means of gas drainage and outburst risk management used in the Bulli seam. UIS gas drainage is carried out within the underground mine workings, with boreholes being drilled from open roadways to drain gas from adjacent planned workings prior to the area being mined.

Figure 6 shows a typical layout of UIS boreholes (in blue) used in Bulli seam mines to pre-drain the coal seam prior to mining.

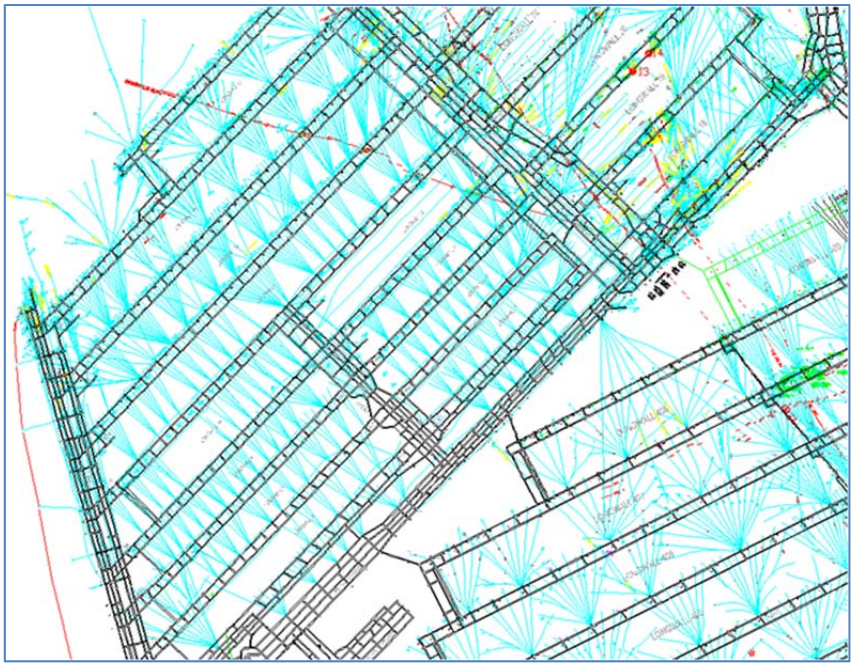

Figure 6 : Typical Layout of UIS Boreholes used in Bulli Seam Gas Drainage

3.4.2 Surface to In-seam (SIS) Gas Drainage

Surface to in-seam (SIS) gas drainage involves drilling boreholes from the surface to intersect, and extend along the coal seam for a long distance, typically greater than 1500 metres. Compared to UIS boreholes, SIS boreholes are longer, have a larger diameter, and are significantly more expensive to install. In coal mine applications, SIS gas drainage boreholes are typically installed well ahead of mining (>3-5 years) and are aligned parallel to planned mine workings. A cross-section of a typical SIS pre-drainage gas well, employing the medium radius drilling (MRD) technology is shown in Figure 7.

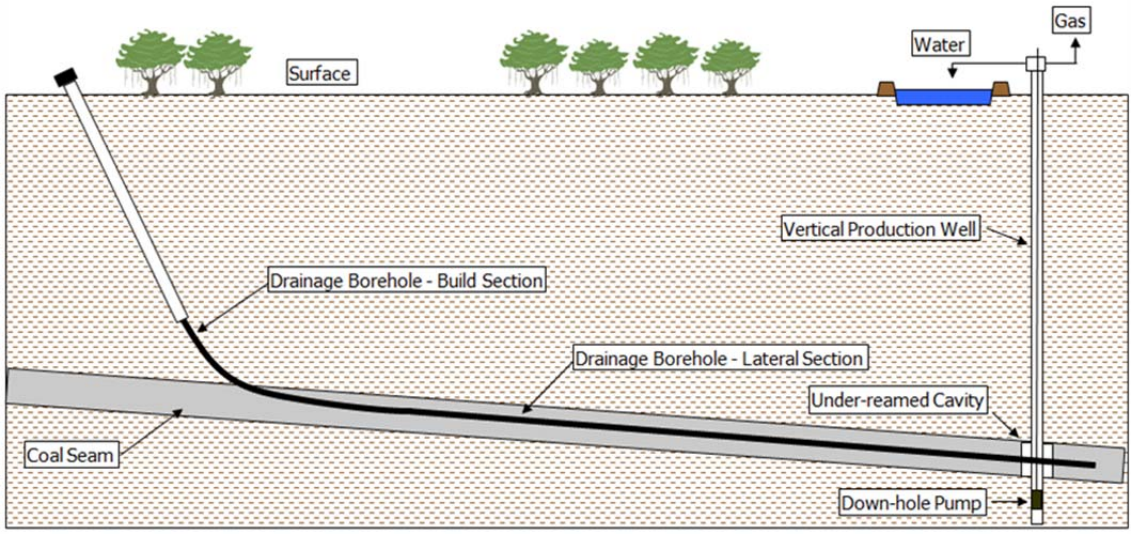

Figure 7 : Cross-section View of a Typical SIS Pre-drainage Gas Well Employing MRD Technology

3.4.3 Underground Goaf Gas Drainage

Various methods have been used in Bulli seam mines to drain gas from active and sealed longwall goaf areas (Black and Aziz, 2009). These underground based methods include:

a) Cross-measure boreholes – boreholes drilled above and/or below the working seam located along the length of the longwall panel;

b) Back-of-block drainage – boreholes drilled above the working section to connect into the goaf to remove accumulated high purity gas;

c) Goaf seal drainage – removal of gas from sealed goaf via pipes passing through seals; and

d) Horizontal directional drilling – long boreholes drilled above and/or below the working seam and oriented parallel to the longwall panel which connect to the forming goaf to drain the accumulating gas.

3.4.4 Surface Goaf Gas Drainage

Surface based drilling techniques have also been used to assist in extracting gas from the goaf during Bulli seam longwall mining operations. The two surface goaf drainage methods involve drilling either vertical goaf wells or Medium Radius Drilling (MRD) goaf wells (Black and Aziz, 2008, and Black and Aziz, 2009).

Vertical Goaf Wells

Vertical goaf wells are a common method used to extract gas from longwall goaf areas. To be effective in managing goaf gas emissions, the distance between goaf wells, although subject to local conditions, is typically 300m or less, with the wells spaced along the length of each longwall panel. Figure 8 shows a cross-section view of a simplified vertical goaf well layout relative to the retreating longwall.

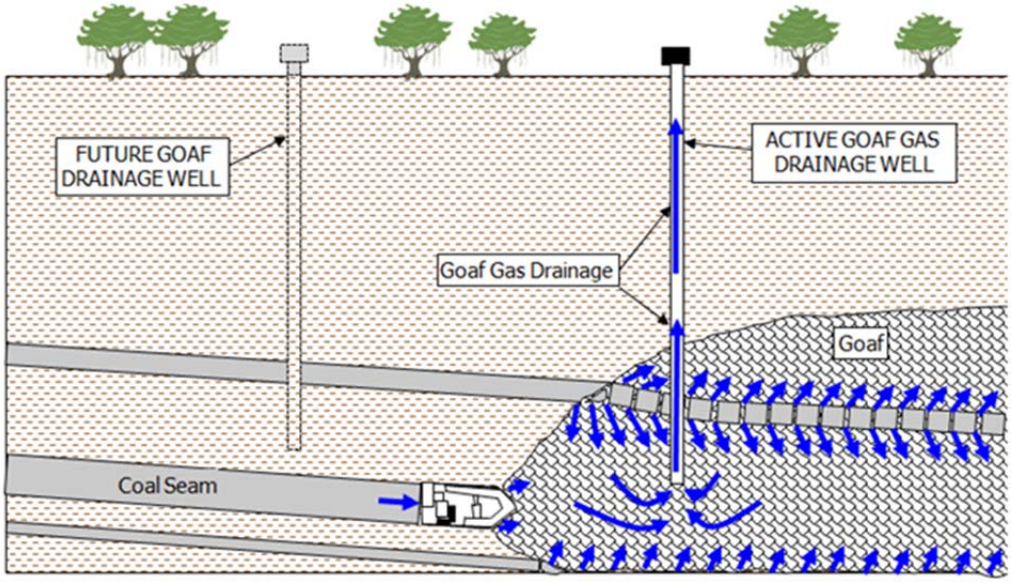

Figure 8 : Cross-section View of a Typical Vertical Goaf Drainage Well

MRD Goaf Wells

Use of the developing MRD technology represents a viable alternative to vertical boreholes for goaf gas extraction. This method involves drilling horizontal boreholes up to about 2500m in length above and/or below the target mining seam into the partial caving zone, prior to goaf formation. As the longwall retreats, the MRD drainage boreholes connect to the goaf and are used to draw gas to the surface using a suction plant, similar to that used with the vertical system. The significant potential advantages of the MRD goaf gas drainage method include:

a) The point of connection between the drainage borehole and the longwall face remains relatively consistent therefore the gas production rate is expected to be less variable than the vertical well alternative;

b) The effect on reducing gas emissions close to the longwall face will be maintained for the length of the borehole; and

c) Significantly less surface disturbance will be necessary as a single MRD surface installation has the potential to service two separate longwall panels and replace at least three vertical SGWs in each panel.

Figure 9 shows a cross-section view of a simplified MRD goaf well layout relative to the retreating longwall.

The MRD technology for goaf gas drainage as opposed to vertical goaf wells is currently being used by BHPBIC in West Cliff Area 5 and Appin Area 7, believed to be primarily due to surface access restrictions and/or a desire to reduce the surface footprint of gas extraction activities. However, in conjunction with the MRD goaf wells, BHPBIC continues to plan for a number of vertical goaf wells also. It is therefore unclear to IMC how effective the use of the MRD technology for goaf gas drainage is for the Bulli Seam operations.

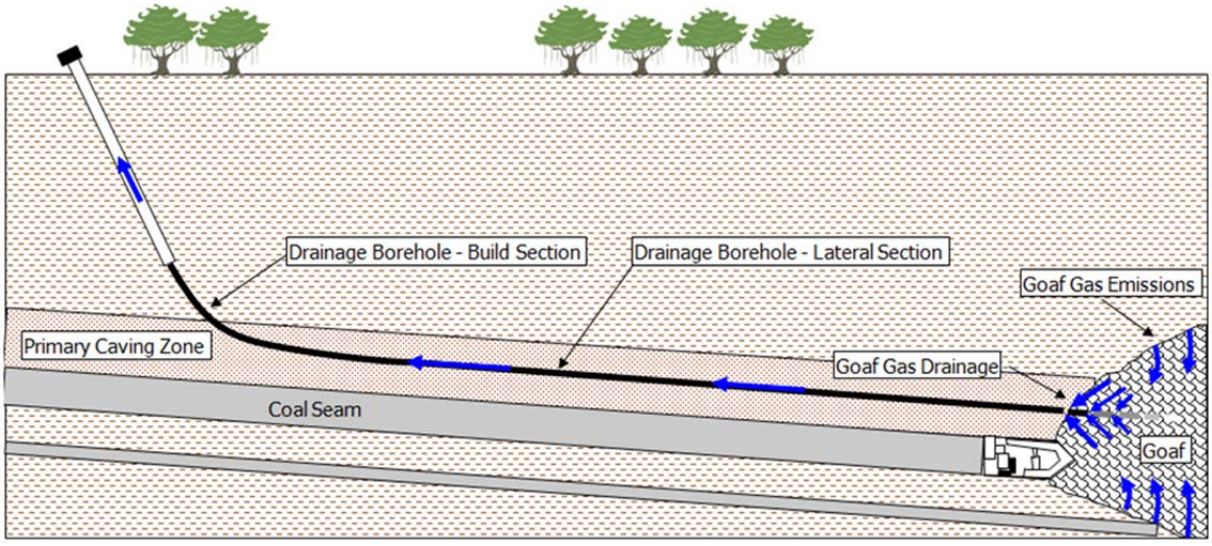

Figure 9 : Cross-section View of a Typical MRD Goaf Drainage Well

The MRD method for goaf gas drainage has also been used by Xstrata at their Blakefield South operations in the Hunter Valley of NSW (Justen, 2010). In this instance, the horizontal holes were used due to surface access limitations as well as the presence of the overlying South Bulga longwall workings, which make the establishment of vertical wells through the already caved ground difficult.

The MRD method for goaf gas drainage is also reportedly being trialed by Anglo Coal at their Grasstree and Moranbah North operations in the Bowen Basin of Queensland (Packham, 2011). In addition to addressing areas of difficult surface access, the horizontal holes at Grasstree are being trialed to enhance the connection between the vertical goaf wells and the gas desorption zone (i.e. increase effectiveness of the wells), which presumably will lead to a reduction in the number of vertical wells (they are on a 50 – 100m spacing currently), while at Moranbah North they are being trialed due to the difficult near surface drilling conditions that make the vertical wells quite expensive to construct.

4 POTENTIAL ISSUES AND OPTIONS – AREA 8 GAS DRAINAGE

This section discusses various options that may be used to drain gas from the Appin Area 8 coal reserves as well as install other necessary surface infrastructure with minimal impact on the Wilton Junction surface development.

4.1 Co-existence Zone – Appin Area 8 and Wilton Junction

Figure 10 shows the extent of the Wilton Junction development investigation area (including Bingarra Gorge) relative to the current proposed Appin Area 8 mining layout coinciding with the investigation area. It should be noted that additional longwall panels have been planned in the Area 8 domain to the northwest of the Nepean River that are not shown in Figure 10 (see Figure 1). Whilst underground mining is presently underway in Area 7, and development has commenced into Area 9, BHPBIC has indicated that the mining of the Area 8 domain will not commence for 10-15 years.

Figure 10 : Wilton Junction Development Area Relative to Proposed Appin Area 8 Mine Layout

4.2 Confirmation of Area 8 Mine Layout

Given that mining of Area 8 is not likely to commence for at least a decade or more, and then could commence in the area to the northwest of the Nepean River, it is unlikely that a great deal of exploration will be carried out in the Wilton Junction area in the short term (next 5 years). Therefore, in the absence of detailed resource data, the proposed layout of the longwall panels in Area 8 is considered indicative and it is likely that the mine layout will either be confirmed or change as more detailed information is gathered.

The following are among the many potentially significant factors that may impact the mine design.

- Gas content of the Bulli seam and adjacent coal seams and gas bearing strata.
- Composition of seam gas present in the Bulli seam and adjacent coal seams and gas bearing strata.
- Thickness of the Bulli seam.
- Permeability of the Bulli seam.
- Geological structures, such as faults and dykes.
- Magnitude and orientation of horizontal stress.
- Strike and dip of the coal seams.
- Stand-off distance from significant surface features e.g. rivers (Nepean River, Allens Creek), roads, rail, etc.

4.3 Area 8 Pre-drainage Options

As previously indicated in Figure 5, the Bulli seam gas content in Area 8 underlying Wilton Junction is similar to the content in the other mining domains and will likely require similar levels of gas drainage to support mining. The figure does show, however, that the gas content of the Bulli seam covering a large area underlying the Wilton Junction development is greater than 13m^3/t. Although requiring confirmation, if the composition of the seam gas is methane rich, then pre-drainage in this area will be required to reduce the gas content by approximately 4-5 m^3/t in order to place the area below the current outburst threshold limit. Additional gas content reduction will likely be required to reduce the rate and total amount of gas released into the mine working during mine operations. If the gas composition is carbon monoxide (CO) rich, then the gas drainage problem becomes compounded due to the greater difficulty in draining CO gas compared to methane. A high CO composition could severely restrict mine development in this area, regardless of Wilton Junction being developed or not.

4.3.1 Underground to In-seam Pre-drainage

The UIS method will continue to play a leading role in pre-draining the Bulli seam in Area 8. In addition to the conventional ‘fan’ drilling patterns, shown in Figure 6, UIS drilling is also required to drill boreholes parallel to the advancing development

roadways to check and confirm that the gas content has been successfully reduced below the outburst threshold limit.

UIS gas drainage boreholes are typically installed to pre-drain one gateroad in advance of current workings. A significant advantage of this method is that it is able to respond quickly to changes in mine layout thus avoiding unnecessary drilling, or incorrect placement of boreholes relative to mine workings. This method also provides a good geological (structural) investigative tool. A potentially significant negative factor, however, is that time available to achieve the required gas content reduction is typically in the order of 6-12 months. Should the characteristics of the Bulli seam be such that gas does not rapidly drain from the coal, more intensive UIS drilling may be required, as well as considering the use of alternative drilling methods that provide increased drainage time or drainage enhancement techniques that serve to stimulate the rate of gas emission from the coal, to effect adequate pre-drainage and prevent mining delays.

To assist in designing an appropriate pre-drainage strategy, it will be important to determine the degree of gas saturation and drainage characteristics of the Bulli seam within Area 8.

Based on the Appin Area 8 mine layout presented by BHPBIC in Section 2 – Project Description of the Bulli Seam Operations Environmental Assessment (BHPBIC, 2008), it may be possible to commence gas drainage in a number of the northeastern longwall panels using long UIS boreholes from drill sites located in existing mine workings (e.g. Area 9 and Tower colliery), as shown in Figure 11. Using current available drilling technology, it is possible for such UIS longholes to be drilled to a distance in the order of 1500-2000 metres.

Should the final design and mining schedule of Area 8 limit access to drill from mine workings in adjoining mining domains, it may be possible to drill longholes from the central and southern Main headings within Area 8, provided the sequence of Main headings development is kept in advance of gateroad development, as illustrated in Figure 12. The drainage time provided from this approach would practically be in the order of 12-24 months and potentially longer should the Main headings be developed further in advance of the gateroads.

Using presently available UIS drilling equipment to complete the long holes from central and southern Main headings may not provide for coverage of the entire length of the longer proposed longwall panels. However there has been increasing industry support for the development of larger capacity drill rigs suitable for use in underground coal mines. It is reasonable to expect that the development of such rigs could be achieved within 5-10 years and therefore could be utilised for the benefit of Appin Area 8.

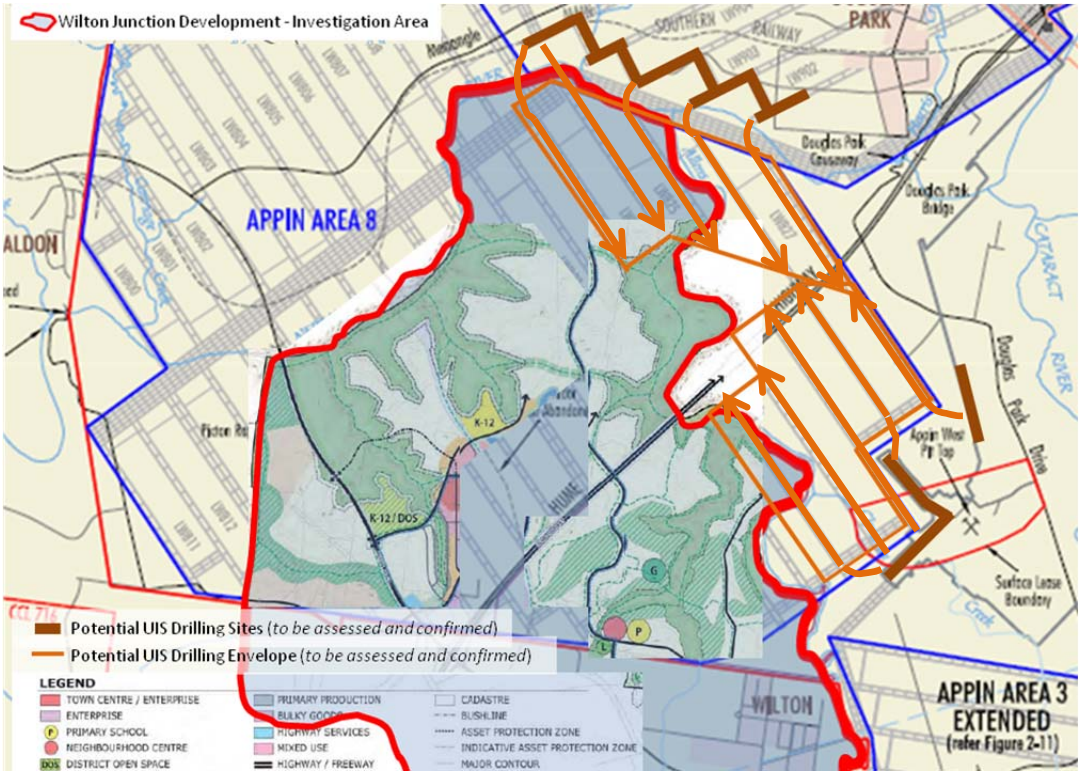

Figure 11 : UIS Longhole Pre-drainage of Area 8 Panels from Existing Adjacent Workings

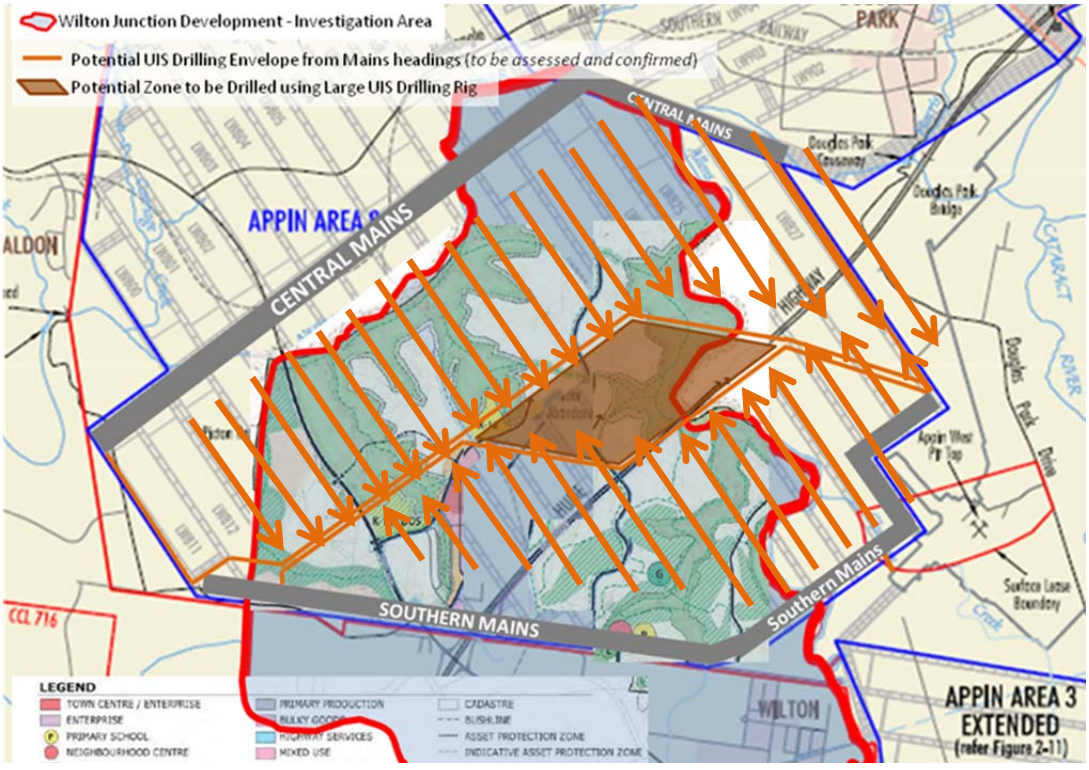

Figure 12 : UIS Longhole Pre-drainage Drilling from Central and Southern Main Headings

The development of high capacity underground drill rigs may also benefit underground goaf gas extraction, as discussed in Section 4.4.

Drilling long boreholes in-seam for gas drainage may also benefit the mine operator by providing valuable exploration data, such as recovering core samples for coal seam gas or coal quality testing, and the identification of potentially significant geological features, that can be used to update the mine plan and production schedules.

4.3.2 Surface to In-seam Pre-drainage

The potentially significant benefit of SIS pre-drainage is that the drilling can be carried out separate to, and many years in advance of, mine operations. The SIS pre-drainage method therefore has the potential to offer significantly longer drainage time than could be achieved using UIS.

To offset the high cost of SIS pre-drainage, these boreholes are ideally installed 5-10 years prior to mining in order to maximise the total potential gas extracted from each borehole, and thereby minimise the number of holes required.

The layout of the mine workings is therefore an important factor that must be considered in the design of an SIS pre-drainage drilling program. It is preferred that SIS boreholes be located separate to development roadways and are not intersected by mine workings until the coal in the area has been adequately pre-drained, with gas content being confirmed by UIS compliance drilling.

Figure 13 presents conceptual surface corridors that may be available to setup MRD drilling rigs to install SIS pre-drainage boreholes into the Bulli seam below Wilton Junction. The rigs used in coal mine SIS pre-drainage drilling are typically capable of drilling 1500-2000 metres, however, larger rigs are available that are capable of drilling longer boreholes.

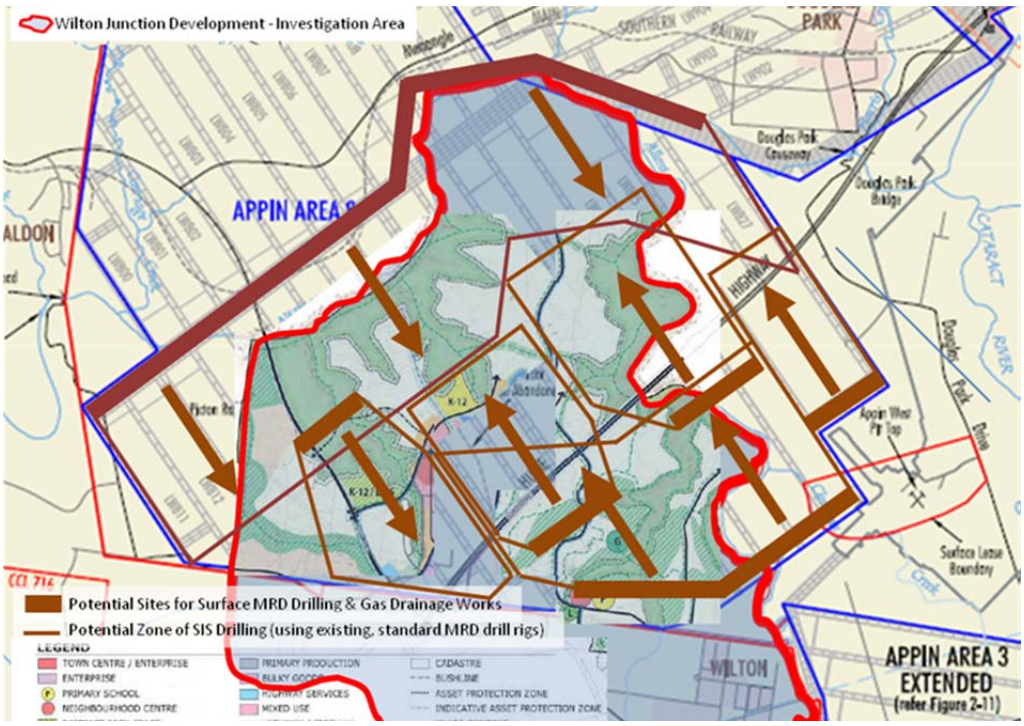

Figure 13 : Conceptual SIS Drilling Locations and Pre-drainage Zones

It has been previously reported that MRD drilling at BHPBIC sites is undertaken inside of a fenced compound that typically measures 50 metres x 40 metres, as illustrated in Figure 14 (Cardno, 2009) and shown in Figure 15 (Cardno, 2011).

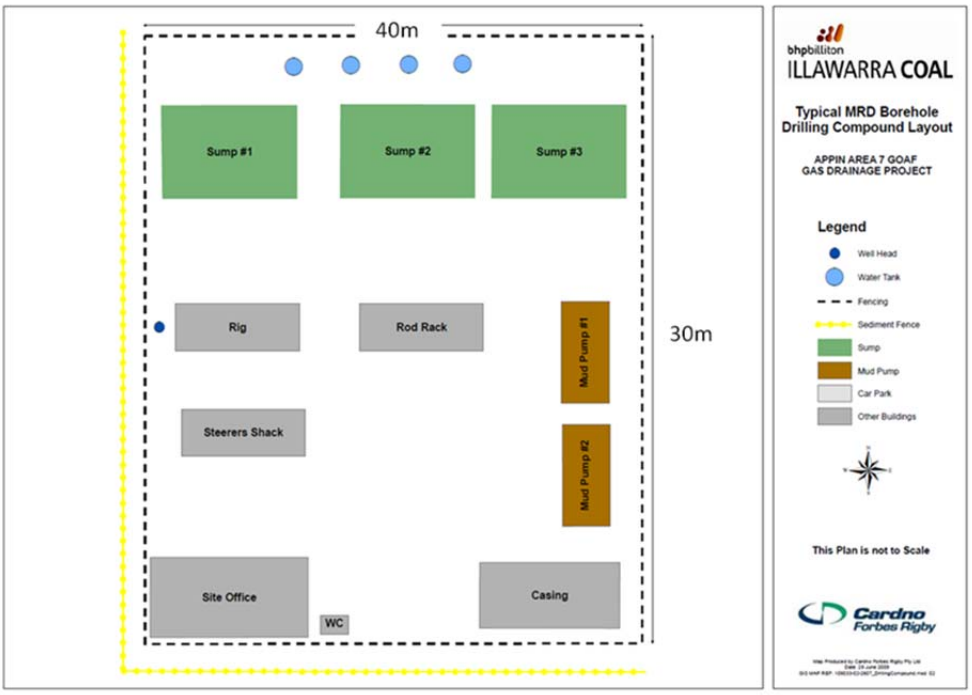

Figure 14 : Typical MRD Drilling Compound Layout
(Cardno, 2009)

Figure 15 : Actual MRD Drill Site at Appin
(Cardno, 2011)

4.4 Area 8 Goaf Drainage Options

It is reasonable to expect the size of the gas reservoir in Area 8 to be similar to Area 7 and Area 9, thus necessitating the continued use of goaf drainage to support safe and efficient longwall mining.

A number of areas exist on the surface overlying BHPBIC's and other's Bulli seam operations, including state conservation areas, Sydney water catchment structures, steep cliffs, etc. Such areas restrict surface access to drill and install equipment to aid the extraction of gas from the underlying workings. Therefore, goaf gas extraction has historically been achieved by predominantly underground methods. In 2006, surface-based goaf gas extraction commenced at West Cliff colliery using vertical gas wells (Meyer, 2006) and this method continues to be preferably employed by BHPBIC (and elsewhere in Australia) where surface access is available, primarily as surface based methods:

- are less labour intensive and generally more cost effective;
- are inherently safer because they remove workers from underground; and
- eliminate interaction with the underground mining operations.

4.4.1 Underground-based Goaf Drainage Methods

Section 3.4.3 lists four (4) underground-based methods that may be used to extract goaf gas. In Bulli seam operations, cross-measure drainage has been the dominant method. This method involves drilling a series of boreholes perpendicular to the length of each longwall panel from the Bulli seam maingate or tailgate to the Wongawilli seam. As the formation of the goaf causes fracturing of the surrounding strata ahead of the longwall face, the cross-measure boreholes are used to extract gas from the underlying coal seams.

Using UIS drill rigs to drill long goaf drainage boreholes is another method that has the potential to significantly increase the volume of goaf gas extracted from within the underground workings. Long boreholes may be drilled parallel to the longwall blocks, from drill sites located along each gateroad, into the caving zone above and/or below the working seam, as illustrated in Figure 16.

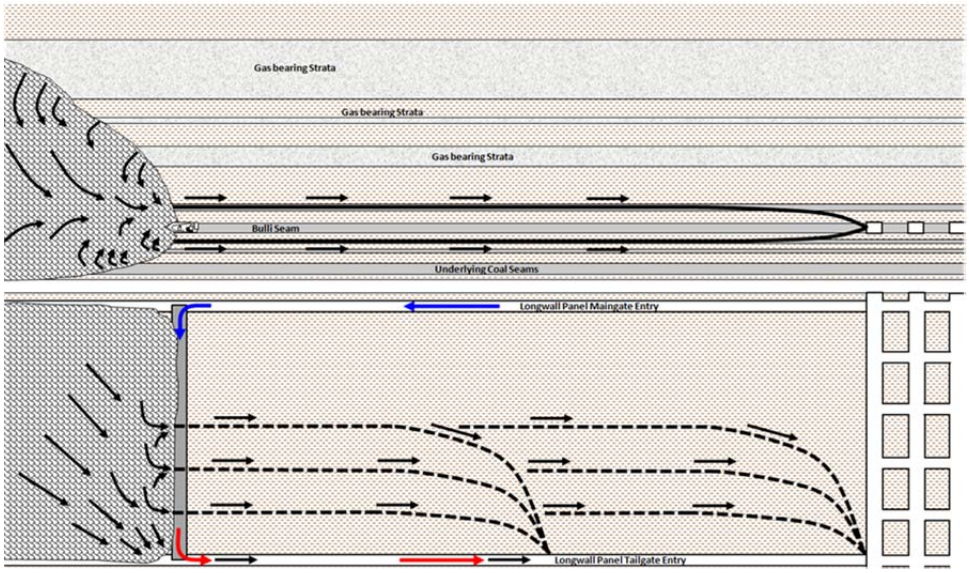

Figure 16 : Conceptual Layout of UIS Goaf Drainage Boreholes (longholes)

The application of this method is presently limited by the capacity of existing underground drill rigs. With increasing demand for the development of an MRD-style drill rig that is suitable, and approved, for use in underground mines, it is reasonable to expect that within 5-10 years there will be equipment available to drill longer, larger diameter boreholes, from within existing underground workings, to support high capacity goaf gas extraction.

An alternative drilling pattern, that may be more suited to a large capacity drill rig, features multiple long, larger diameter goaf drainage boreholes that are drilled from a single drilling site located in the Main headings, as illustrated in Figure 17.

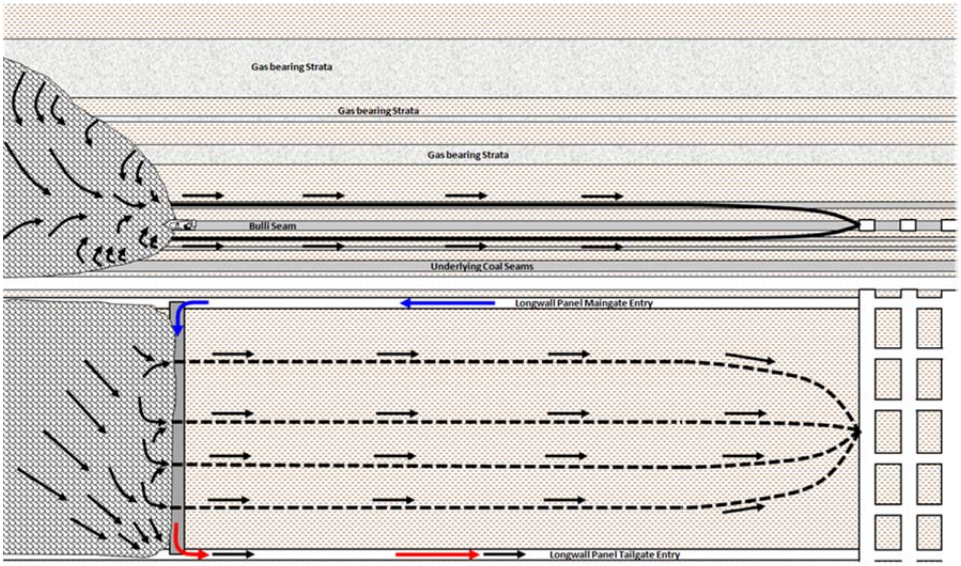

Figure 17 : Conceptual Layout of UIS Goaf Drainage Boreholes suited to Large Capacity Drill Rigs

4.4.2 Surface-based Goaf Drainage Methods

As discussed in Section 3.4.4, the two (2) drilling methods available to install boreholes for the purpose of extracting goaf gas from the surface include vertical goaf wells and MRD (horizontal) goaf wells.

Vertical Goaf Wells

Vertical goaf wells have the potential to be a very effective method to extract goaf gas to the surface. This method does have a large surface footprint, with the spacing between gas wells typically being 300 metres or less (depending on ground conditions). The area required at each drilling site typically measures 40 metres x 50 metres, as shown in Figure 18 (Cardno, 2009).

Figure 19 shows the 'bushland' areas (in brown) within the proposed Wilton Junction development, including the 50m wide fire barrier to be left around them. Although yet to be confirmed, these areas would likely be accessible to drill vertical goaf wells and install gas reticulation pipelines. Other than the corridor for the proposed Maldon to Dumbarton railway line, which may or may not be constructed before mining, and along Picton Road there appears to be limited "natural" access within the central section of the Wilton Junction master plan. Therefore, purpose

built open spaces will be required to be left and/or an alternative goaf drainage method is likely to be required as discussed below.

In areas where surface access is limited, it may be possible to drill multiple 'offset vertical' gas wells from a single drill site. In such areas, a drill rig capable of drilling angled boreholes would be required. Initially the borehole would be drilled at an angle and then steered into the vertical plane once the required offset distance had been achieved. The installation of two offset vertical goaf wells from a single drill site is illustrated in Figure 20. Similar offset wells could also be drilled from the one site in the perpendicular plane. Using this method, the vertical well sites required on surface could be located as much as 600m apart.

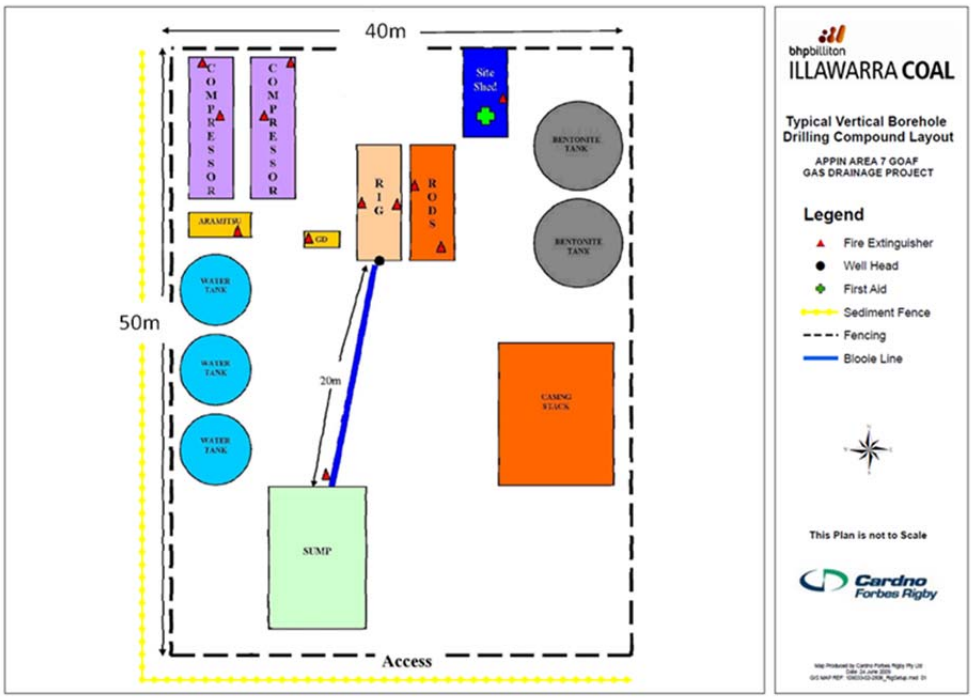

Figure 18 : Typical Vertical Goaf Drainage Well Drilling Compound Layout
(Cardno, 2009)

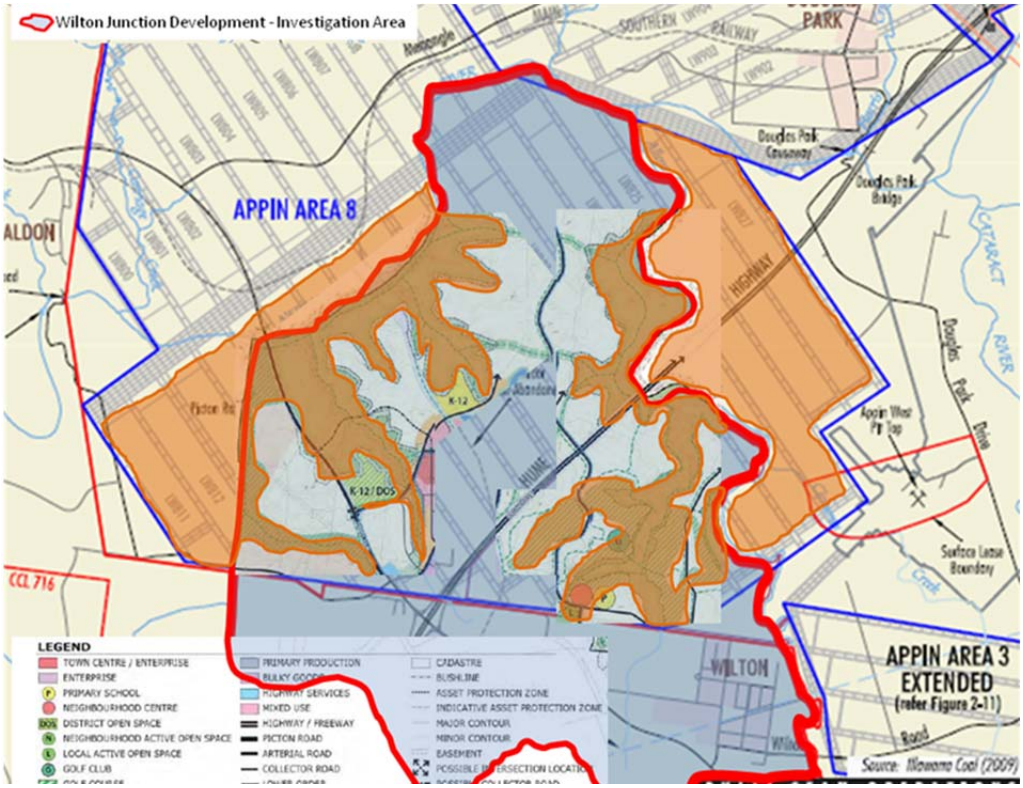

Figure 19 : Potential Areas for the Drilling of Vertical Goaf Drainage Wells

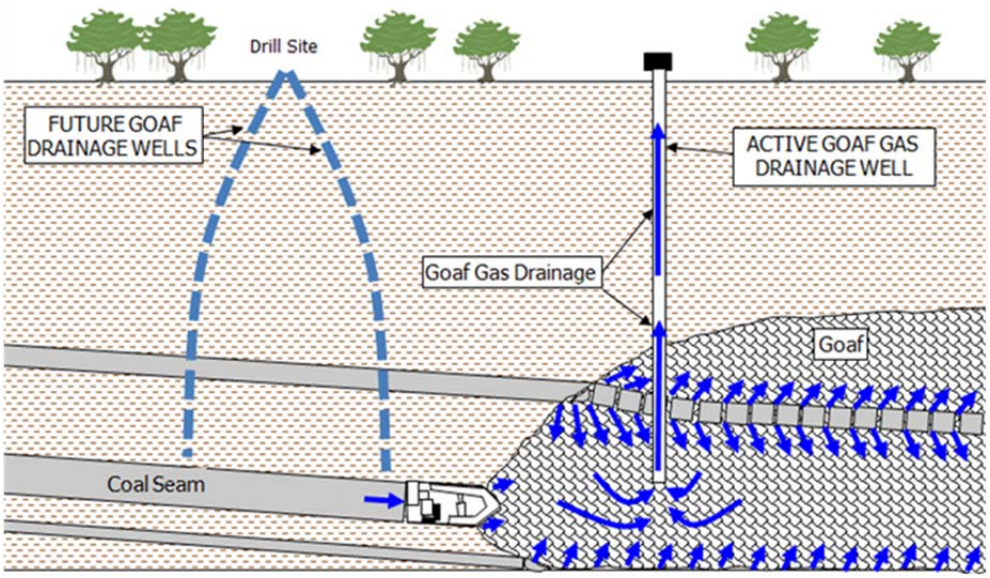

Figure 20 : Section View of Conceptual 'Offset Vertical' Goaf Drainage Wells Drilled from a Common Drill Site

MRD and ERD Goaf Wells

The use of the medium radius drilling (MRD) method to drill boreholes specifically for goaf gas extraction is a relatively new application of this technology (Black and Aziz, 2008). Typical surface drill rigs are capable of directionally drilling boreholes

around 2000m in length and greater than 300 mm in diameter, however, high capacity surface drill rigs are now available that have the capability to drill a 300mm diameter hole up to 4000 metres long (Justen, 2010). The use of similar, high capacity drill rigs, termed extended reach drilling (ERD), would enable the installation of goaf drainage boreholes from outside of the Wilton Junction development that would cover most of the proposed Area 8 mine workings located beneath the Wilton Junction development area, as shown in Figure 21.

In order to increase the suction and/or reduce the potential risk of an MRD/ERD goaf drainage borehole blocking and being unable to maintain the required goaf gas extraction rate, the early drilling designs have included a series of vertical goaf wells that are intersected by the MRD lateral borehole section as a contingency, as shown in Figure 22 (Justen, 2010). As experience grows and the use of MRD/ERD goaf wells becomes more common, it is possible that the inclusion of the vertical goaf wells in the drainage design may no longer be required.

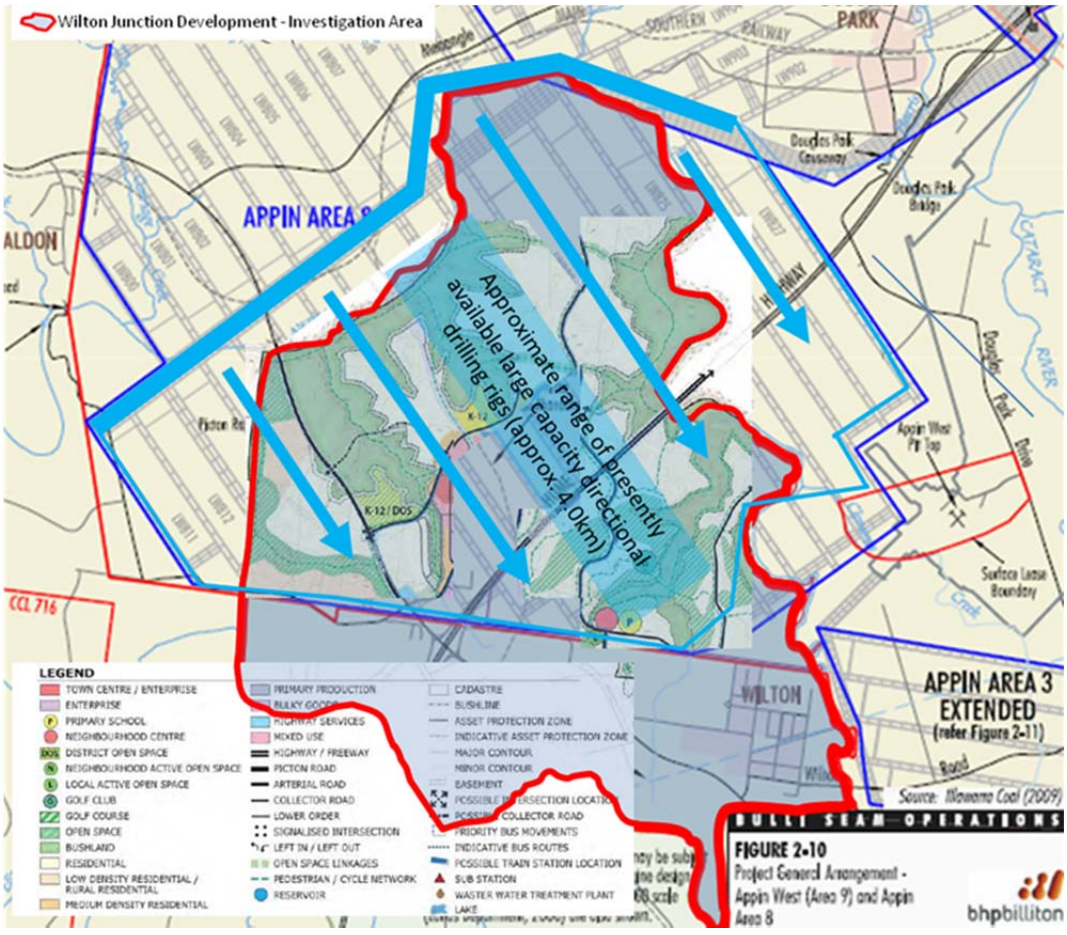

Figure 21 : Potential Corridor where ERD Goaf Drainage Wells may be Installed

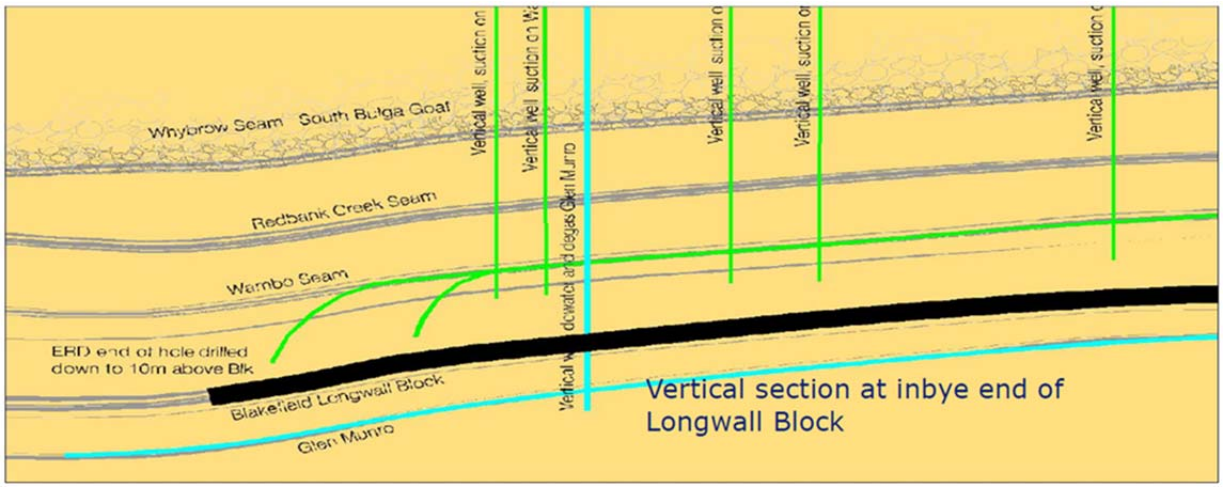

Figure 22 : Section View of MRD Drainage Well with Vertical Well Intersections
(Justen, 2010)

4.4.3 Comparative Costs of Goaf Drainage Methods

From the above discussion, it is apparent that there are alternative methods of goaf gas drainage for the area associated with Wilton Junction new town that would permit the coexistence of its development and underground mining by BHPBIC. Therefore, the decision on the most attractive method of goaf gas drainage for Wilton Junction needs to consider both the effectiveness of the method employed and the financial, social and environmental costs involved with implementing that method.

In order to gauge the comparative financial costs, IMC have held discussion with drilling contractors experienced in the various methods of goaf gas drainage discussed here. Based on those discussions, a comparative annual cost for each of the surface based methods as well as the conventional underground in seam (UIS) cross measure method have been estimated. The results are provided in Table 1, while Figure 23 provides particulars of the offset vertical and MRD/ERD well design.

As indicated on Table 1, the MRD, ERD and UIS cross-measure alternatives provide for roughly equal and potentially the least expensive methods for effecting goaf drainage, followed closely by straight vertical wells. The most expensive alternative appears to be the offset vertical wells, which are some 50% more costly (at maximum deviation) than the other alternatives.

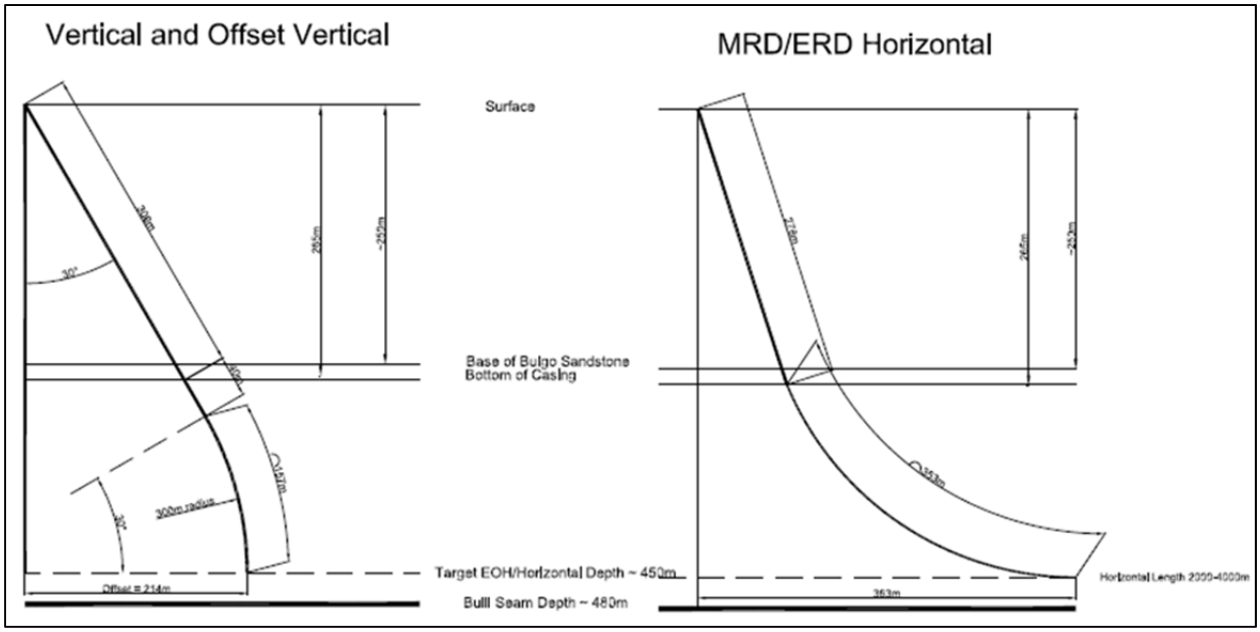

Figure 23 : Goaf Well Design Parameters for Comparative Costing

Table 1 : Comparative Cost of Goaf Drainage Alternatives

	Vertical Wells			Offset Vertical Wells			MRD Wells			ERD Wells			UIS (cross-measure) per Year		
	units	rate	cost	units	rate	cost	units	rate	cost	units	rate	cost	units	rate	cost
Mob/Demob	0.074	$240,000	$17,778	0.106	$240,000	$25,532	0.67	$480,000	$320,000	0.75	$480,000	$360,000	1	$100,000	$100,000
Drill Site Establishment	1	$50,000	$50,000	0.5	$50,000	$25,000	1	$100,000	$100,000	1	$100,000	$100,000	120	$10,000	$1,200,000
Drilling	23 shifts	$13,660	$314,180	33 shifts	$13,660	$450,780	76 shifts	$28,575	$2,171,700	136 shifts	$37,148	$5,052,060	28,800m	$140	$4,032,000
Casing	265m	$100	$26,500	300m	$100	$30,000	280m	$100	$28,000	280m	$100	$28,000	na		
Well Control Equipment	26 days	$1,830	$47,580	38 days	$1,830	$69,540	38 days	$1,830	$69,540	68 days	$1,830	$124,440	na		
Direction Drilling Services	na			14 shifts	$6,600	$92,400	56 shifts	$13,200	$739,200	116 shifts	$13,200	$1,531,200	na		
Total comparative cost per well			$456,038			$693,252			$3,428,440			$7,195,700			$5,332,000
Cost per m of longwall retreat			$2,280			$3,466			$1,714			$1,799			$1,777
Comparative cost per year			$6,840,567			$10,398,779			$5,142,660			$5,396,775			$5,332,000

Assumptions: Longwall retreat average 3000m per year
Vertical Wells - 200m spacing, average 450m deep, 26 days (including off days) per well to complete, 1 well per drill pad, 13.5 wells constructed per year per drill
Offset Vertical Wells - 200m target spacing, average 450m target depth at maximum offset (215m), 38 days (including off days) per well to complete, 2 wells per drill pad, 9.4 wells constructed per year pe
MRD Wells - 200mm diameter, 2000m horizontal length, 38 days to complete on 24/7 operations, 1.5 wells required per year on average
ERD Wells - 200mm diameter, 4000m horizontal length, 68 days to complete on 24/7 operations, 0.75 wells required per year on average
UIS - 4 x 60m deep holes on 25m set-up spacing, 240m drilled per set-up, 120 set-ups required per year
Average 1 mobilisation/demobilisation cost per year for vertical, offset vertical, and UIS operations

However, when we consider the effectiveness of the methods, there is evidence that the MRD method still requires some vertical wells in consort to effect the necessary suction and drainage volume, which would tend to balance or reverse the cost efficiency versus vertical wells, while the UIS method is used as a last resort due to increased safety risks for workers, higher drainage pipe costs, and generally poor effectiveness of the method resulting in increased delays to mining and higher mining costs.

4.5 Other Surface Facilities

4.5.1 Gas Extraction Facilities

With all surface-based gas drainage systems, there is a need to capture the gas at the well head and either safely release it into the atmosphere at the well head site by free venting (rarely used) or flaring, or transporting the gas elsewhere by pipelines for use in power generation.

The currently preferred option for BHPBIC in Area 7 is to extract the gas from individual vertical wells through connecting the well to a gas reticulation pipeline (Figure 24), which in turn is connected to a centrally located extraction plant, from where the gas from multiple wells is further transported via pipeline to the EDL power generation units located at the Appin West pit top. In this case, the pipelines (nominally 250mm in diameter from individual wells and up to 600mm in diameter for trunk lines) are placed in a trench and covered to prevent damage and allow access above the pipes.

For MRD holes, the extraction plant is connected directly to the well as shown in Figure 25.

As previously discussed, and depending on the location of the well head, the gas reticulation pipes can be located within the bushland and associated fire barrier corridors around the perimeter of the WJ development area. For internal sites, pipelines could be located along the road easements, as previously postulated by IMC and incorporated in the Wollondilly LEP for Bingarra Gorge development (Figure 26).

4.5.2 Ventilation Facilities

In addition to gas drainage wells, the mining of Appin Area 8 is likely to require the construction of mine ventilation facilities to provide the necessary air volumes for safe extraction. By design and to minimise costs, these are almost exclusively located to intersect the Main headings of the mine at either end of the longwall blocks in order that they can serve a number of panels. Given the proposed Main headings for Area 8 are located almost entirely outside of the Wilton Junction development area, there is not likely to be any impediment to their location or construction as a result of the development.

Figure 24 : Typical Connection to Vertical Drainage Wells
(Cardno, 2011)

Figure 25 : Gas Extraction Plant Connected to MRD Drainage Well
(Cardno, 2011)

Figure 26 : Proposed Bingara Gorge Gas Drainage Layout
(IMC, 2003)

4.6 Alternative Goaf Drainage Layouts for Wilton Junction

4.6.1 Vertical Wells

Based on the above discussion, and using the Bingara Gorge solution as a guide, a similar, indicative layout of drill sites and drainage pipelines for the Wilton Junction Master Plan (assuming a 200m vertical well spacing) is presented in Figure 27. This indicative layout assumes the use of the preferred and industry proven vertical wells (with offset technology as required) for goaf gas capture, and uses designated open spaces and perimeter bush land to locate the drill sites, with the network of pedestrian/cycle paths and road easements to locate the drainage lines. The drainage lines, in turn, connect back into the underground pipeline network in the Area 8 main headings for conveyance of the extracted gas to the Appin gas facilities.

It is understood that the perimeter bush land is to be placed into an environmental trust by the Landowners Group in order to preserve its ecological values. While some of the surface drill sites and gas drainage lines are proposed to be sited within these trust lands, these facilities would be accommodated and rehabilitated appropriately in order to preserve the ecological values in the long term.

There is an area in the north central portion of the Wilton Junction site where there are no currently planned open spaces in which to locate drill sites, and this results in

inadequate coverage of the vertical goaf wells. In this area, the Wilton Junction plan will need altering to include open space in order to manage the interaction issues. It should also be noted that the above design assumes a 200m well spacing. This well spacing may be inadequate, as evidenced by revised well requirements for the 704 panel in Area 7 and experience elsewhere in the Bowen Basin of Queensland. Should well spacing need to be decreased, then the number of drilling sites would likely need to increase and the lack of adequate coverage provided by the offset vertical method could be exasperated.

4.6.2 MRD Wells

As an alternative, a similar indicative layout for goaf gas drainage at Wilton Junction using industry trialed MRD technology and maximum 2200m horizontal hole lengths has been developed. The indicative MRD drainage layout is provided in Figure 28. For completeness, the layout has assumed the requirement of supplemental vertical wells on 600m spacing.

As shown, the use of MRD wells provides for a less intrusive method of gas drainage for Wilton Junction coexistence, with the MRD drilling sites located outside the development or along the northwestern and eastern perimeter. The number of vertical well drilling sites in the interior is markedly reduced.

The MRD drilling method requires 24 hours per day, 7 days per week drilling operations. Even located on the edges of the development, provision of adequate noise and lighting barriers to minimize the disturbance of Wilton Junction residents will be required.

4.6.3 Effect of Altered Mine Layout

As previously mentioned, it is quite possible that the final mining layout for Area 8 could be different to that projected currently. To gauge the effect on the indicative goaf drainage layouts presented above, Figure 29 presents the vertical drainage well target pattern assuming the mine layout is rotated 90 degrees to a similar orientation as historic mining.

As indicated, the spread of vertical well target locations is similar to the current orientation, and it is likely that the same or similar offset vertical well drilling sites as indicated for the current mine plan could be implemented for the rotated plan. Additionally as indicated in Figure 29, there are also natural corridors for locating the MRD drill sites along the eastern perimeter and along the Maldon to Dombarton rail corridor, which is assumed to be vacant. Should this not be the case, the drilling sites could be located along Picton Road as well.

What Figure 29 illustrates is that, using offset vertical and/or MRD drilling technology, surfaced based gas drainage can be carried out for a range of mine layouts by accommodating the drill sites and drainage pipelines along the Wilton Junction perimeter and within the bushland and open spaces elsewhere.

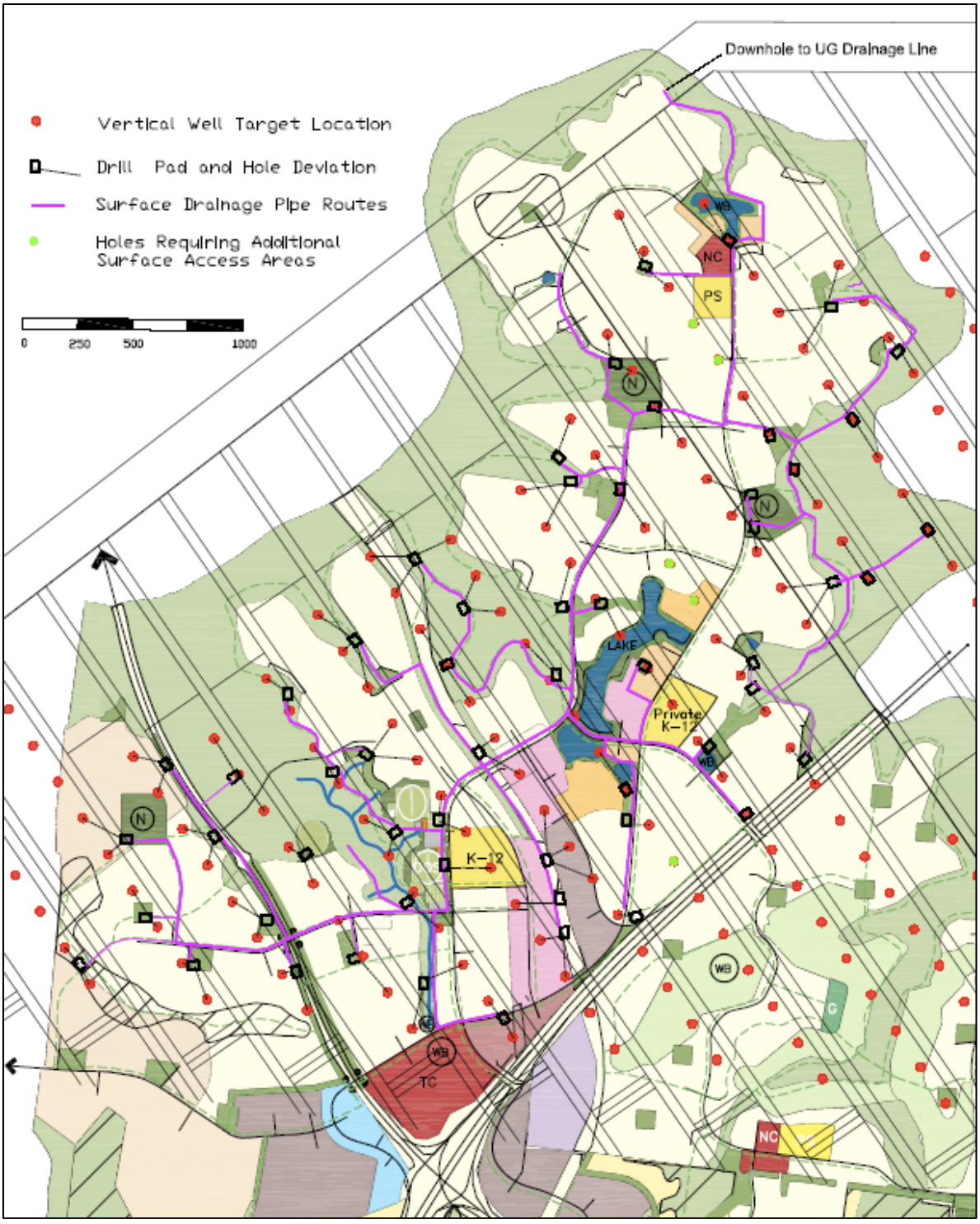

Figure 27 : Indicative Wilton Junction Goaf Drainage Layout using Vertical Wells

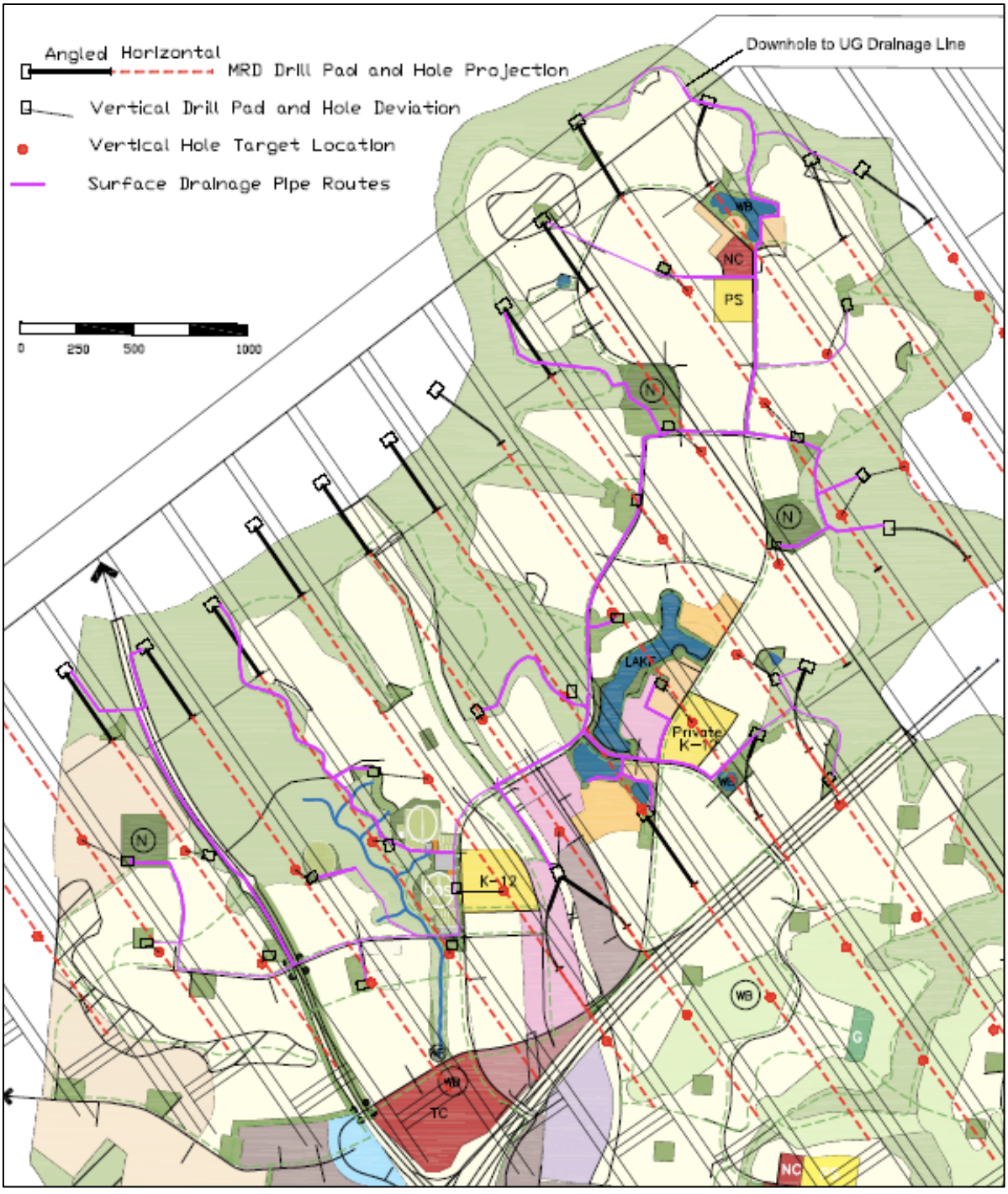

Figure 28 : Indicative Wilton Junction Goaf Drainage Layout using MRD Wells

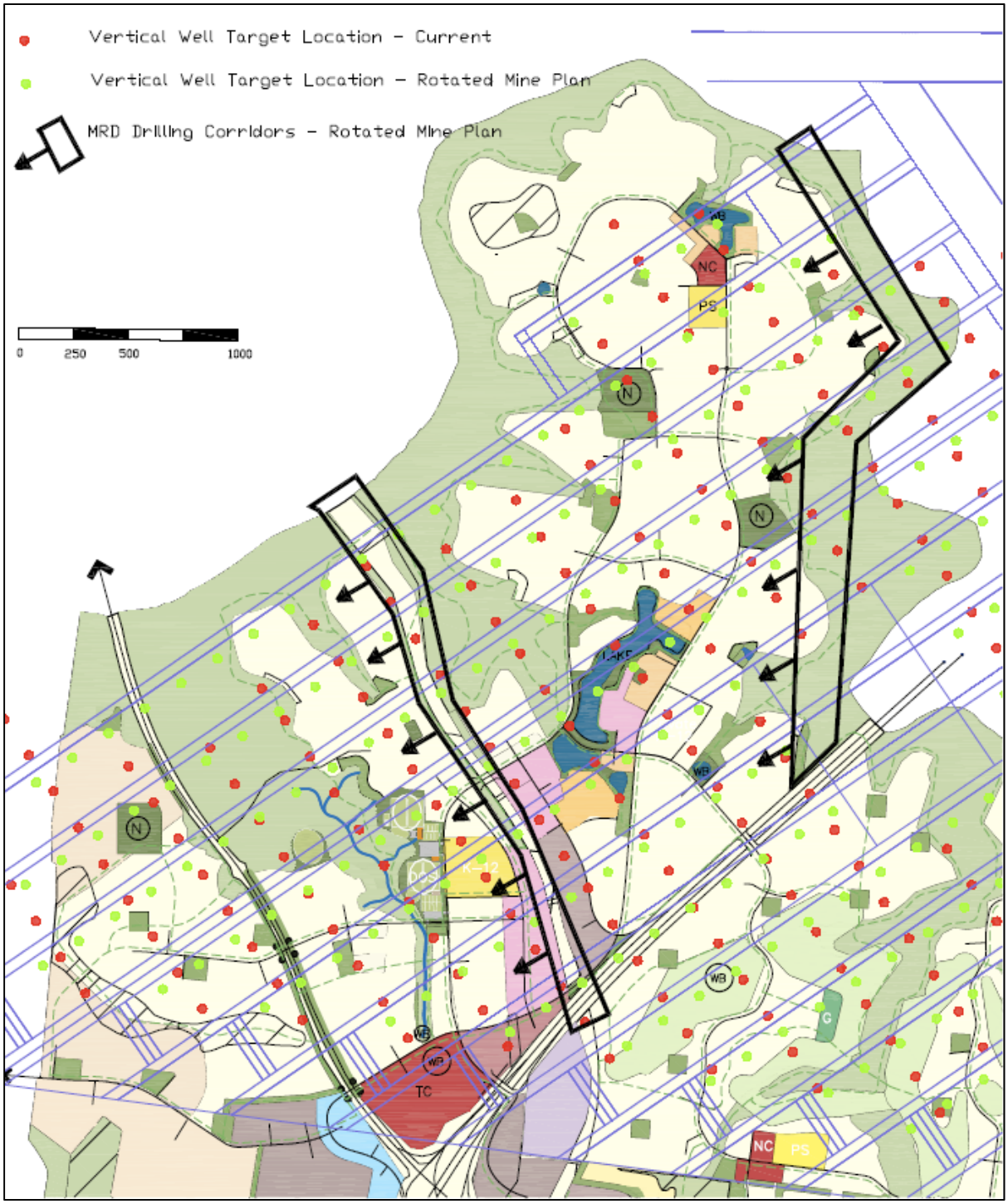

Figure 29 : Effect of Rotated Mine Layout on Goaf Drainage Options

5 PRACTICALITIES OF URBAN DEVELOPMENT AND MINING COEXISTENCE

5.1 Similar Situations

The coexistence of underground mining and urban development as proposed for Wilton Junction is not in itself unique.

There are many examples of undermining existing urban development, particularly in Eastern Europe and the United States, but also nearby Wilton Junction at Tahmoor. However, based on the available literature, none of these situations involved the coexistence of surface based gas drainage operations, whether due to the fact that the undermining pre-dated the use of these techniques, lower seam gas regimes precluded goaf drainage requirements, or as at Tahmoor, surface based gas drainage methods are not presently used.

5.2 Reducing Risk

The key to coexistence of Wilton Junction new town development and future underground mining by BHPBIC will be the ability to reduce risk to both parties.

In order to reduce risk, there needs to be open and meaningful discussions between the parties, and in particular BHPBIC's expected exploration and gas drainage requirements. This can be achieved through providing the latest Bulli seam geological modeling outcomes and long range operating projections, including expected gas drainage design to the Landowners Group. Through independent analysis of this data, the Landowners Group can better assess the likely mining and gas drainage options for Area 8 and the timing of those operations, and then develop a town plan that provides the required access areas for the mine's surface infrastructure and operational requirements.

6 REFERENCES

Black, D J and Aziz, N I, 2008. The evolution in coal mine gas extraction – a response to economic, environmental and community pressures, in *Proceedings of the 16th Coal Congress of Turkey*, Chamber of Mining Engineers of Turkey, Zonguldak, Turkey, 26-28 May, pp.149-156 [http://www.pacificmgm.com.au/index.php/publications].

Black, D J and Aziz, N I, 2009. Developments in coal mine methane drainage and utilisation in Australia, in *Proceedings of the Ninth International Mine Ventilation Congress*, Department of Mining Engineering, Indian School of Mines University, Dhanbad, India, 10-13 November, pp.445-460 [http://www.pacificmgm.com.au/index.php/publications].

BHP Billiton Illawarra Coal (BHPBIC), 2012a. Bulli Seam Operations – Mining Operations Plan (October 2012 – September 2019), pp.145.

BHP Billiton Illawarra Coal (BHPBIC), 2008. Bulli Seam Operations – Section 2 Project Description, pp.49.

BHP Billiton Illawarra Coal (BHPBIC), 2012b. Gas Drainage Management Plan - West Cliff Longwalls 36-37, pp.42.

BHP Billiton Illawarra Coal (BHPBIC), 2012c. Appendix A.1 – Gas Drainage Management Plan - West Cliff Longwalls 36-37

BHP Billiton Illawarra Coal (BHPBIC), 2013. Wilton Junction Proposal – Review of Coal Resources, p 30.

Cardno Forbes Rigby (Cardno), 2009. Environmental Assessment – Appin Area 7 Goaf Gas Drainage Project, report prepared for BHP Billiton Illawarra Coal, Job Number 109033-02 / Report 001 Rev1, p.134.

Elvy, B, 2012. Future of Coal Mining in the Illawarra, Presented at the ACARP Gas and Outburst Seminar, Wollongong. [http://www.uow.edu.au/eng/outburst/html/Research%20&%20Publication/outburst_pres.html]

Justen, M, 2010. Beltana Blakefield South Mine Ventilation System, presented at the ACARP Gas and Outburst Seminar, Wollongong. [http://www.uow.edu.au/eng/outburst/html/Research%20&%20Publication/outburst_pres.html]

Meyer, T, 2006. Surface goaf hole drainage trials at Illawarra Coal, in *Proceedings of the 7th Australasian Coal Operators' Conference COAL2006*, Australasian Institute of Mining and Metallurgy. Wollongong.

Packham, R, 2011. Advances in Gas Drainage and Gas Management Within AAMC, presented at Gas and Coal Outburst Committee Seminar. Wollongong

Wilton Junction Development Consortium (WJDC), 2013. Wilton Junction Co-existence of Coal Mining and Surface Development, p.72

IMC Mining Consultants Pty Ltd, 2003. Report No. IMC0959, Independent Opinion on Mining Issues at Wilton Park, p. 14

REPORT TO

Wilton Rezoning (Landowners Group)

on the

Preliminary Assessment of Surface Infrastructure & Gas Drainage Considerations for Appin Area 8 Mining and Wilton Junction New Town

Date: 16 June 2014
Project No: 01104
Report No: IMC01476R

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1 EXECUTIVE SUMMARY

In November 2011, the NSW Government initiated the Potential Housing Opportunities Program and invited landowners with suitably located substantial landholdings to nominate sites which might be able to deliver additional housing to address Sydney's housing supply shortfall. Walker Corporation, Governors Hill, Bradcorp and Lend Lease responded to the Program and nominated landholdings of more than 100ha in Wollondilly Shire, surrounding the Hume Highway-Picton Road intersection for consideration. This area has subsequently become known as Wilton Junction, and is the subject of this application.

Following a Wollondilly Shire Council resolution in May 2012, the four major landowners (collectively known as the Wilton Junction Landowners' Group) signed an agreement to work cooperatively with Council to prepare a high level Master Plan for Wilton Junction to deliver high quality new housing, jobs close to homes, supporting social and utilities infrastructure and services, and a range of complementary land uses.

A high level Master Plan and a Preliminary Infrastructure Requirements Report were considered by the Council on 17 December 2012, with Council resolving to give in-principle support to the proposal. Council also resolved to request that the rezoning be a state-driven process.

Subsequently, the NSW Government decided to coordinate the statutory planning process, led by the Department of Planning and Infrastructure (now the Department of Planning and Environment, DP&E). The Minister for Planning and Infrastructure (now the Minister for Planning and Environment) proposed to prepare a State Environmental Planning Policy (SEPP), as per Section 24 of the Environmental Planning and Assessment Act 1979 (EP&A Act). This was done with a view to rezone the land through an amendment to the Wollondilly Local Environmental Plan 2011 (LEP) to facilitate the early delivery of housing and infrastructure, linked to an agreed Infrastructure, Servicing and Staging Plan.

The Department of Planning and Infrastructure issued Study Requirements (SRs) to the Proponents (Walker Corporation, Bradcorp and Governors Hill) to guide the planning investigations for a new town at Wilton Junction. The SRs set the criteria for carrying out environmental investigations across the Study Area (excluding both Bingara Gorge and the existing Wilton village which will not be affected by any proposed amendments to their current zoning and planning provisions). The investigations examine the potential for the Wilton Junction Study Area to be rezoned under a SEPP.

The Wilton Junction Landowners Group has engaged IMC Mining Group Pty Ltd (IMC) to assist with Issue 6 of the SRs by undertaking an assessment of the potential options available to BHP Billiton Illawarra Coal (BHPBIC) to install and operate surface infrastructure and gas drainage systems to support the proposed future development of the Appin Area 8 Mining Domain. IMC's assessment is to consider the potential implications and feasibility associated with the coexistence of coal mining with surface development of the Wilton Junction (WJ) area.

From this preliminary assessment of gas drainage and surface infrastructure considerations for Appin Area 8 located below the proposed Wilton Junction new

town development, it may be concluded that the continued development and application of in-seam gas pre-drainage by underground methods and goaf gas drainage through surface based methods is likely to provide sufficient gas extraction capacity to support safe and efficient mine operations. Other required surface infrastructure should not be unduly impacted by the development.

This assessment has discussed, in general terms, the gas drainage options that may be utilised by BHPBIC in Area 8 below Wilton Junction and provided a comparative cost of these options. Although it has been suggested that the required gas drainage may be achieved using predominantly underground methods, surface based methods provide a more cost effective and safer solution provided corridors and open areas can be provided as access sites to undertake the gas drainage drilling and extraction operations. Additionally, through the use of developing directional drilling technology it is likely possible and more cost effective to undertake much of the required drilling activities from outside of the Wilton Junction development area.

A number of areas have been identified within the proposed Wilton Junction investigation area that may potentially be available to BHPBIC to access and undertake surface based gas drainage and gas extraction operations. To this end, an indicative gas drainage design has been prepared for the most likely options to illustrate how the coexistence of urban development and underground mining could work. However, given the experience in Area 7 and Area 9, changes may be required to the Area 8 mine layout as additional exploration data is gathered and assessed by BHPBIC, and town planning and indicative drainage designs may require some alteration accordingly.

From the above discussion, it is apparent that there are technically feasible alternative methods to carry-out necessary gas drainage in Area 8 that could permit the co-existence of the Wilton Junction new town development and underground longwall mining by BHPBIC in this context. However, the decision on the optimal alternative will be one of weighing up the economics, which will be determined by both actual cost of implementation and the effectiveness of the method as expressed by mine productivity and mining costs.

In order to make these decisions, it will likely be necessary to firm up the mining layout for Area 8, which can only be achieved through additional exploration. The necessary additional exploration is not an inexpensive exercise nor is it advantageous to BHPBIC to undertake so far in advance of actual mining. Therefore, a gas drainage layout needs to be investigated that will provide maximum flexibility and sufficient redundancy to allow for the reorientation of the mine plan, if required.

On the other side of the coin, BHPBIC can assist the Landowners Group in providing this flexibility by engaging in open and meaningful discussions on their expected exploration and gas drainage requirements. This can be achieved through providing the latest Bulli seam geological modeling outcomes and long range operating projections, including expected gas drainage design. Through independent analysis of this data, the Landowners Group can better assess the likely mining and gas drainage options for Area 8 and the timing of those operations, and then develop a town plan that provides the required access areas for the mine's surface infrastructure and operational requirements.

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2 INTRODUCTION

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IMC has been asked by the Landowners Group to provide advice in relation to the following matters.

1. Report back on how the gas drainage and other infrastructure of Appin Area 8 below Wilton Junction (WJ) could be drained remotely from the proposed WJ development using techniques such as:
   a. Directional boreholes (using land owned by BHP, but not limited to these lands); or / and
   b. In-seam gas drainage

2. Report back on how the gas drainage and other infrastructure of Appin Area 8 below Wilton Junction, could use a combination of onsite and offsite gas drainage techniques through:
   a. Directional drilling from BHP's land adjacent to WJ
   b. In-seam gas extraction in advance of mining and
   c. Surface infrastructure on WJ land
   d. or some combination thereof.
   e. Also please include the area required for each individual drainage point viz a viz the total area, and potential locations.

3. Using the current master plan for Wilton Junction and the current mining layout provided by BHPBIC in their 2008 Environmental Assessment, provide an indicative cost differential for gas drainage and surface infrastructure for mining under the Wilton Junction area with urban development undertaken versus it being a greenfield site.

4. Provide examples in Australia where horizontal versus vertical drilling have been used to effect goaf gas drainage and the circumstances for its use.

5. Provide examples where surface development similar to Wilton Junction has occurred prior to mining, and how surface access for gas drainage was provided in these instances.

6. What processes need to be considered to create easements for the implementation of necessary surface infrastructure.

7. What would be the implications to the provision of easements as above should the mine plan for Area 8 change from that currently proposed.

The following report provides a preliminary assessment on the above.

In undertaking this assessment, IMC has engaged the services of Dr. Dennis Black of PacificMGM to provide advice on the optional gas drainage techniques that are

available either currently or are likely to be available at the time of eventual Area 8 development commencement.

Disclaimer

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The results and analysis contained in this Report are based on a number of technical, circumstantial or otherwise specified assumptions and parameters.

Data supplied by the Client and companies endorsed by and associated with the Client have not been validated by IMC or PacificMGM and are assumed to be correct and accurate for the purpose of producing this Report.

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3 BACKGROUND INFORMATION

3.1 Mining and Development Plans

The underground mining method has been used to extract coal from the Bulli seam in the Appin area since the 1960's. BHP Billiton Illawarra Coal (BHPBIC), current owners of the Appin, Tower and West Cliff mining complex, have identified large areas for potential future longwall mining in their approved Part 3A development application, as shown in Figure 1.

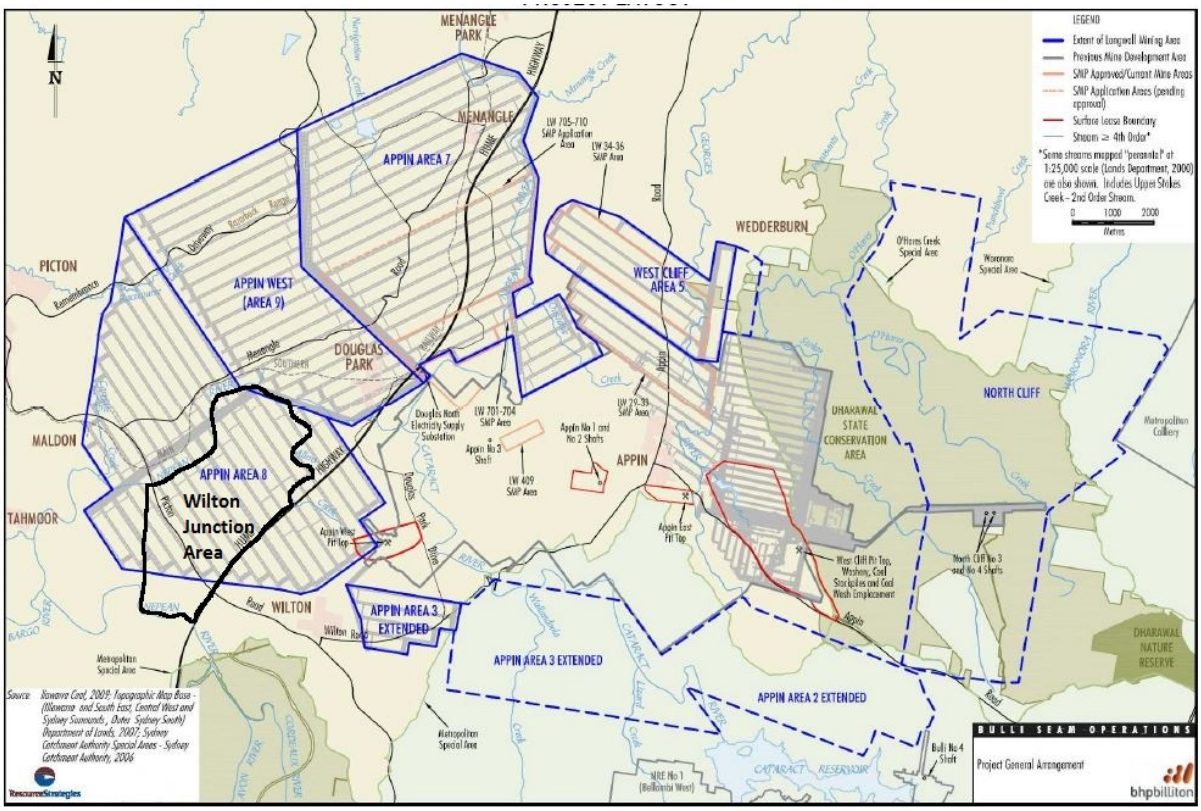

Figure 1 : BHP Billiton Illawarra Coal - Approved Layout of Bulli Seam Operations
(NSW PAC – Project Approval Document, 2011)

Also shown on Figure 1 is the outline of the Wilton Junction Rezoning development area (excluding the approved rezoning at Bingarra Gorge), which occupies a portion of the Bulli Seam Operations Area 8 mine plan area. Considering the entire approved longwall mining area, the Wilton Junction Rezoning area represents only approximately 7% of this mine area.

The indicated layout of the longwall panels in the proposed future mining domains is likely to be an 'ideal' layout that aims to maximise potential coal extraction. However, there is the possibility that the layout could change as more information is gathered by BHPBIC to accurately assess the quality of the coal, the geological conditions and the nature of the coal seam gas reservoir. Such changes to mine

layout have occurred in Appin Area 7 and Appin Area 9, as shown in Figure 2. It is therefore important to consider layout change of the layout of longwall panels in Area 8 so as to allow for change as the dataset of critical geological, geotechnical and gas data is expanded through targeted exploration drilling programs and more detailed mine design is undertaken.

Mining conditions in the Bulli seam are among the gassiest in Australia and gas drainage has been an integral part of mining in this coal seam since the 1980's. The management of coal seam gas has historically had a significant impact on mining operations in the Bulli seam and in several areas has resulted in significant changes to the layout of mine workings.

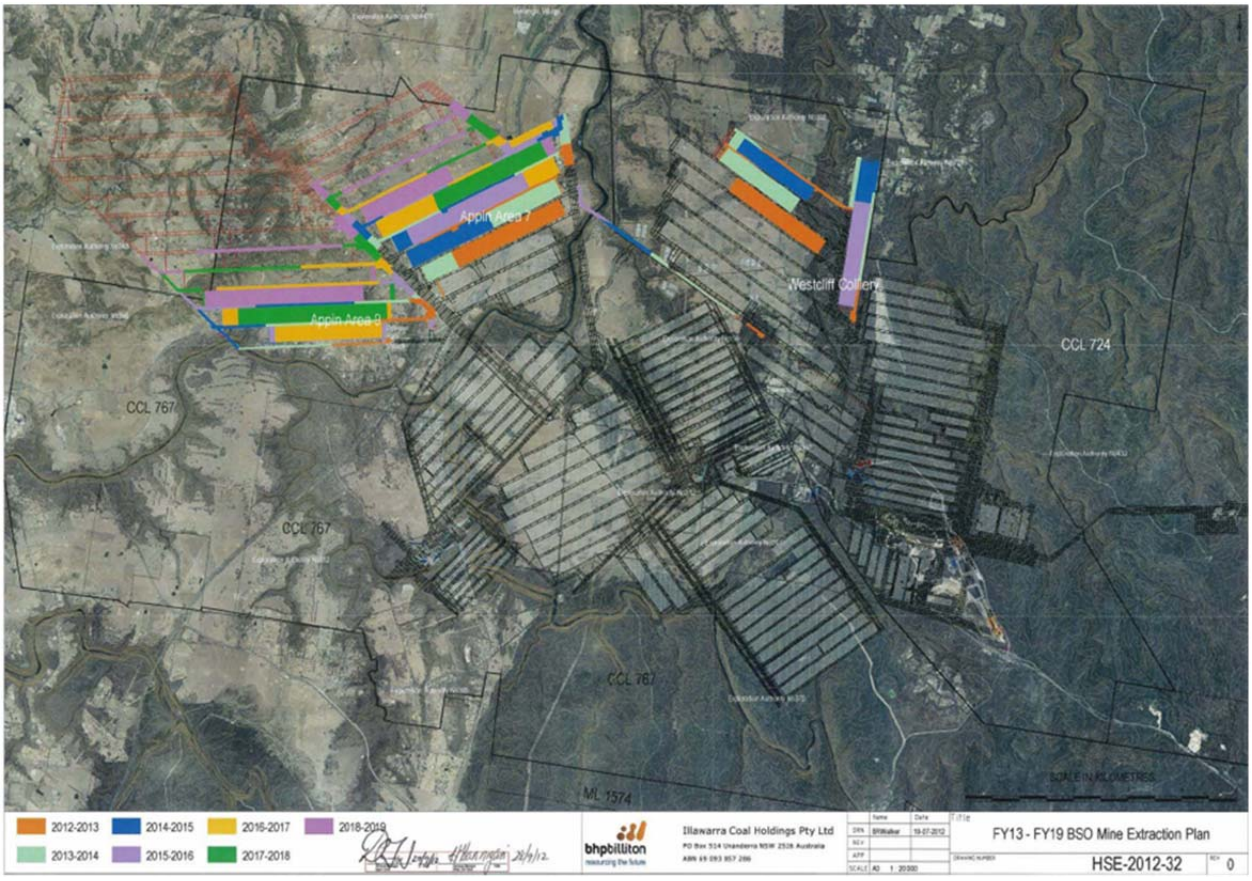

Figure 2 : BHP Billiton Illawarra Coal – Bulli Seam Operations Mine Extraction Plan
(BHPBIC, 2012a)

3.2 Longwall Mining Method

The longwall mining method is illustrated in Figure 3. In longwall mining, a panel of coal, typically around 150 to 300 metres wide and 1000 to 3500 metres long is totally removed by longwall shearing machinery, which travels back and forth across the coalface. The shearer cuts a slice of coal from the coalface on each pass and a face conveyor, running along the full length of the coalface, carries this away to discharge onto a belt conveyor, which carries the coal out to the main headings and

then out of the mine. Full extraction of the longwall panel of coal causes the roof rock above the coal seam to collapse, which in turn forms a depression on the surface as the overlying material slumps to fill the void previously occupied by the coal seam. The area of collapsed material is termed the goaf.

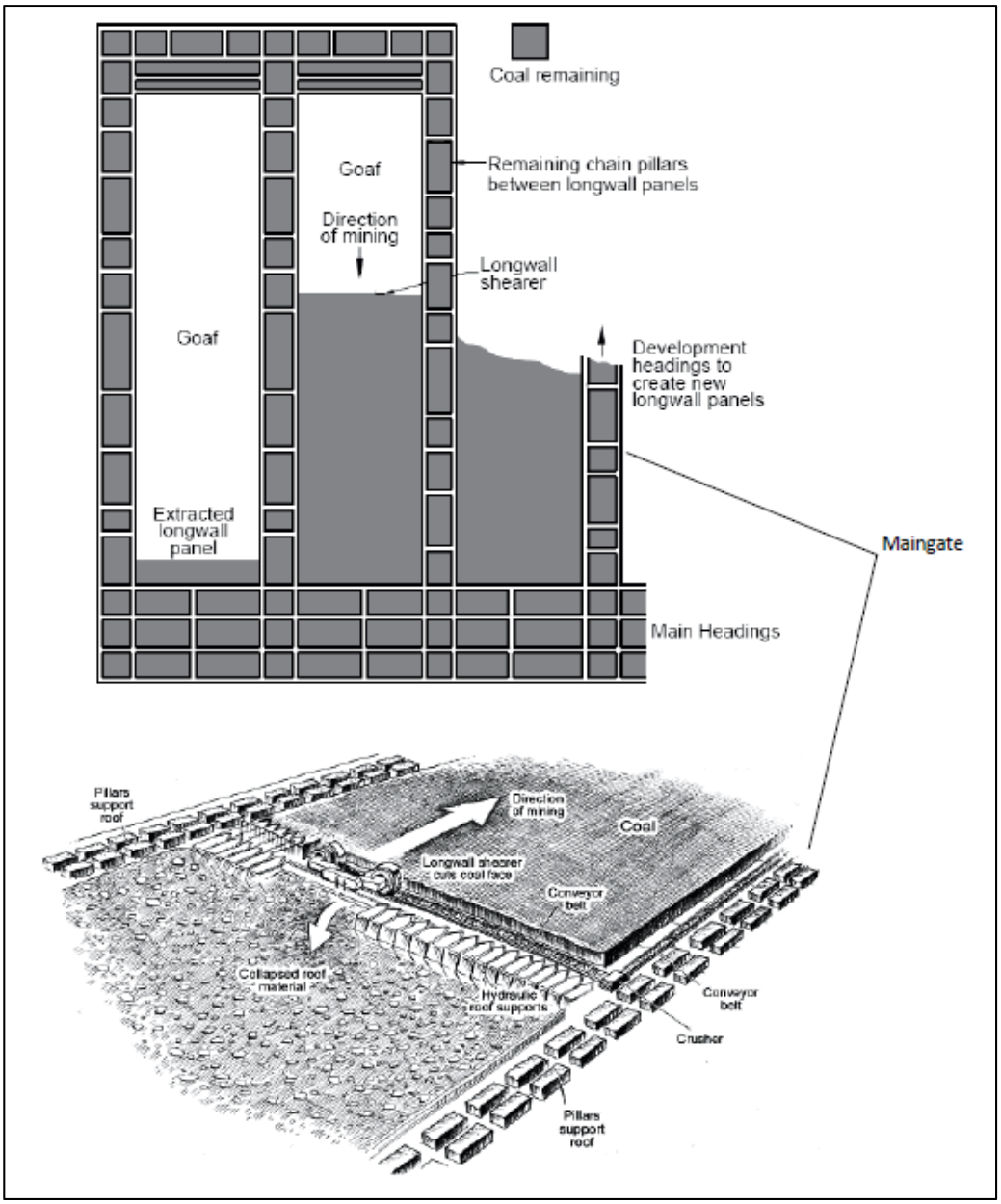

Figure 3 : Illustration of the Longwall Mining Method

Before the extraction of a longwall panel commences, a development unit consisting of continuous mining equipment extracts coal to form roadways (known as headings) around the longwall panel. These roadways form the mine ventilation passages and provide access for people, machinery, electrical supply, communication systems, water pump out lines, compressed air lines and gas

drainage lines. The roadways that provide access from the mine entrance to the longwall panels are referred to as the main headings. Once the main headings have been established, additional development headings known as gateroads are driven on both sides of the longwall panel and are connected together across the end of the longwall. The gateroad containing the belt conveyor is known as the maingate, while the other gateroad is called the tailgate.

3.3 Stratigraphy

Although the Bulli seam is the focus of mining operations in the Wilton Junction area, there are a number of coal seams below the Bulli seam that have the potential to liberate gas into the mine workings following goaf formation. These coal seams include:

- Bulli seam (BUSM) – working seam;
- Balgownie seam (BASM);
- Cape Horn seam (CHSM);
- Upper Wongawilli seam (UWSM); and
- Lower Wongawilli seam (LWSM).

The sandstone and claystone units present above the Bulli seam also have the potential to contain gas and it can be expected that a portion of this gas will also be liberated into the goaf area following the extraction of the Bulli seam by the longwall unit.

Although specific details of the stratigraphy in the Wilton Junction area have not been provided, it may be assumed that the stratigraphy in the area will be similar to that shown in Figure 4.

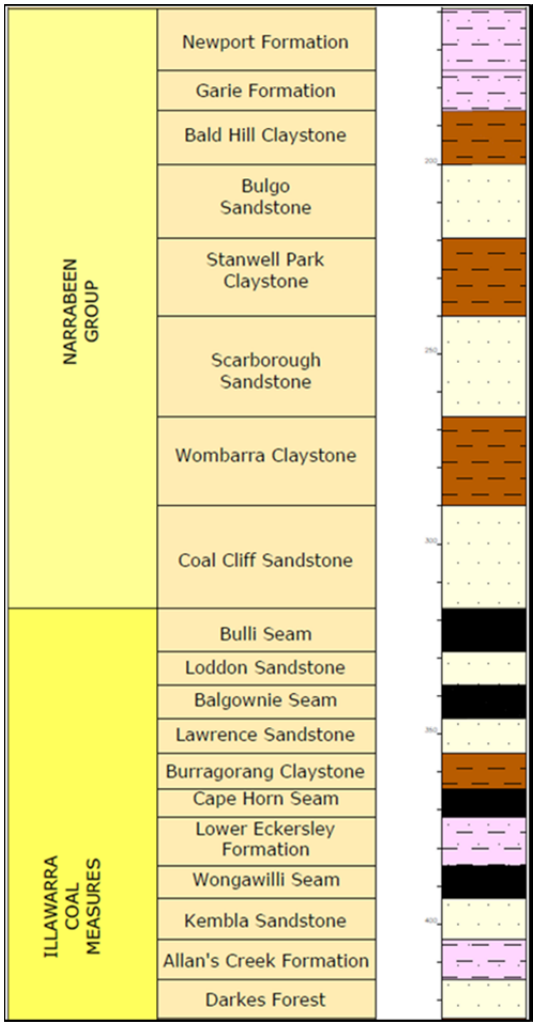

Figure 4 : General Stratigraphy of the Illawarra Coal Measures

3.4 Gas Drainage Methods

Gas drainage is an integral part of coal mining in the Bulli seam to both manage the outburst risk and to maintain the concentration of coal seam gases in the mine workings to below statutory limits.

Although influenced by the amount of gas (gas content) present in the Bulli seam, and adjacent coal seams and adjacent gas bearing strata, it can be expected that all current and future longwall mining in the Bulli seam will utilise gas drainage to:

a) reduce the gas content of the Bulli seam, and potentially adjacent coal seams, prior to mining (pre-drainage), and

b) reduce the amount of gas released into the longwall ventilation circuit from the goaf (goaf drainage).

Figure 5 provides details of the gas content of the Bulli seam (m^3/t) relative to existing and current planned Appin Area 7 and Area 9 domain mine workings. It can be seen that mine workings have preferentially been located in areas where the in situ gas content of the Bulli seam is generally less than $13m^3/t$, and in the case of

Area 7, the planned mine layout has been changed to avoid a large area of increased gas content.

In addition to a number of fundamental mine design considerations, such as seam thickness, coal quality, horizontal stress magnitude and orientation, and geological structures, it is considered likely that the size and nature of the coal seam gas reservoir in the Appin Area 8 mining domain will impact the mine design, resulting in eventual changes to the current proposed mine layout, regardless of the existence of the Wilton Junction development.

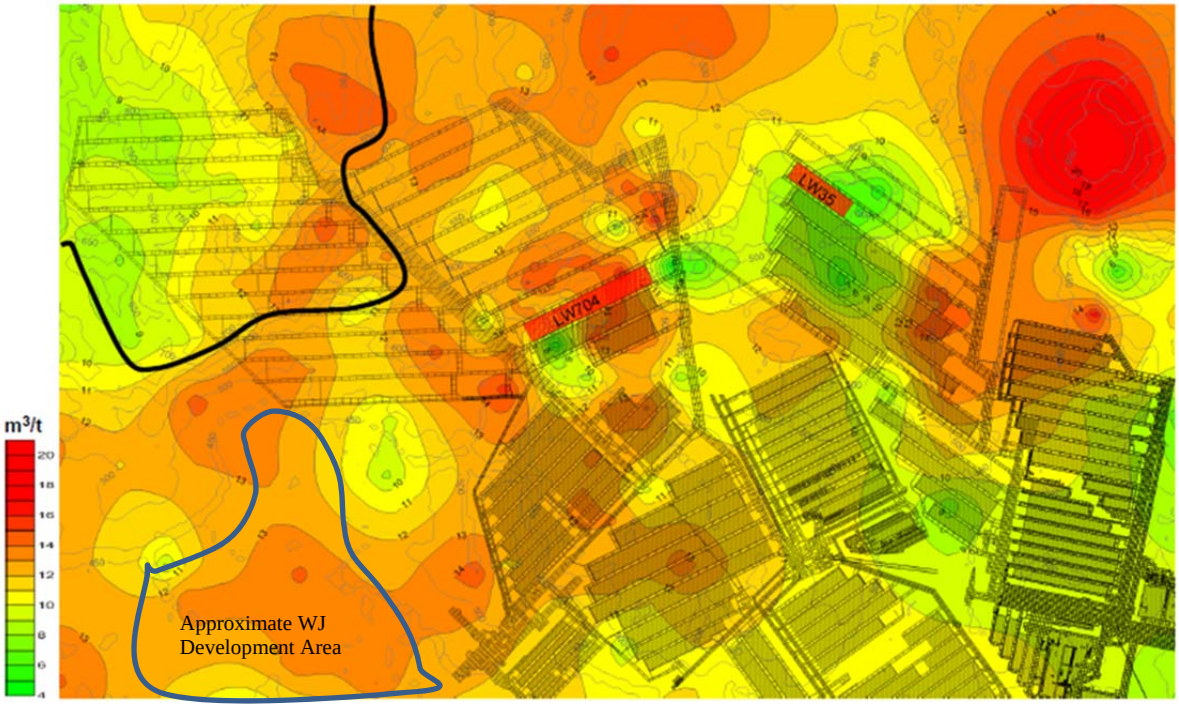

Figure 5 : Bulli Seam Gas Content – Appin and West Cliff Mines
(Elvy, 2012)

3.4.1 Underground to In-seam (UIS) Gas Drainage

Underground to in-seam (UIS) drilling was first used in 1980 to assist in draining gas from the Bulli seam ahead of mining. This pre-drainage method has since developed to become the primary means of gas drainage and outburst risk management used in the Bulli seam. UIS gas drainage is carried out within the underground mine workings, with boreholes being drilled from open roadways to drain gas from adjacent planned workings prior to the area being mined.

Figure 6 shows a typical layout of UIS boreholes (in blue) used in Bulli seam mines to pre-drain the coal seam prior to mining.

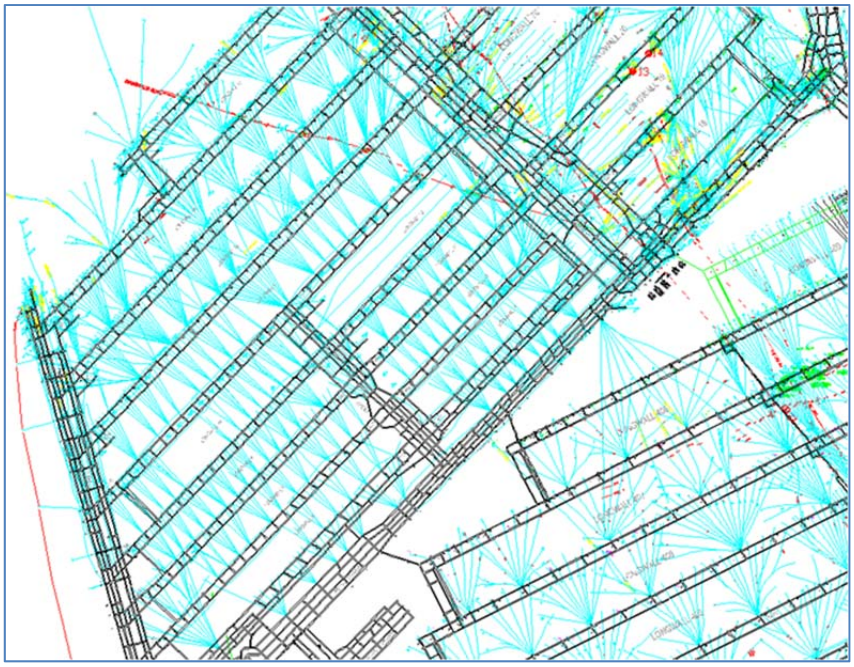

Figure 6 : Typical Layout of UIS Boreholes used in Bulli Seam Gas Drainage

3.4.2 Surface to In-seam (SIS) Gas Drainage

Surface to in-seam (SIS) gas drainage involves drilling boreholes from the surface to intersect, and extend along the coal seam for a long distance, typically greater than 1500 metres. Compared to UIS boreholes, SIS boreholes are longer, have a larger diameter, and are significantly more expensive to install. In coal mine applications, SIS gas drainage boreholes are typically installed well ahead of mining (>3-5 years) and are aligned parallel to planned mine workings. A cross-section of a typical SIS pre-drainage gas well, employing the medium radius drilling (MRD) technology is shown in Figure 7.

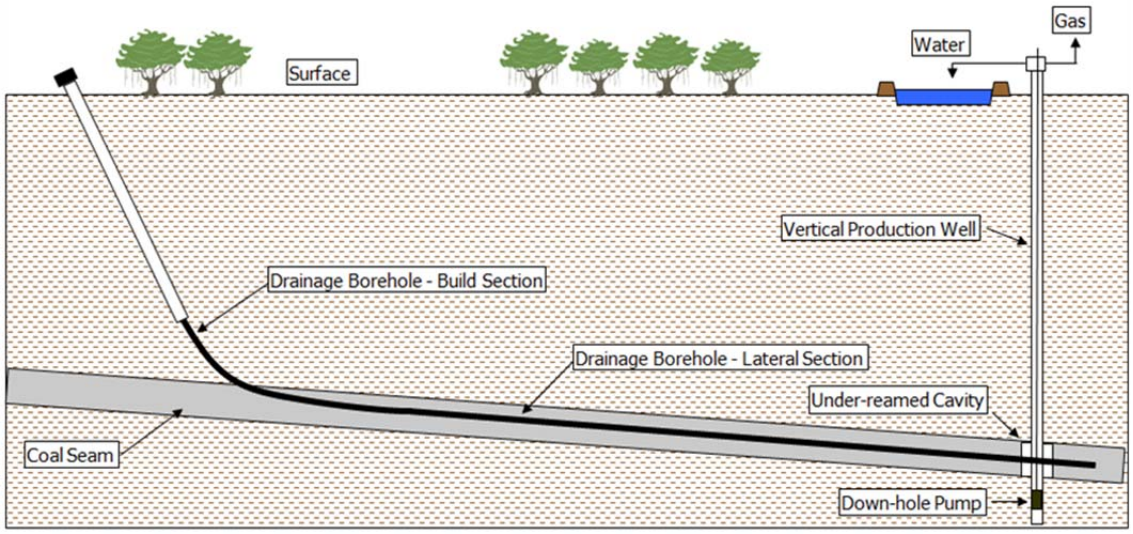

Figure 7 : Cross-section View of a Typical SIS Pre-drainage Gas Well Employing MRD Technology

3.4.3 Underground Goaf Gas Drainage

Various methods have been used in Bulli seam mines to drain gas from active and sealed longwall goaf areas (Black and Aziz, 2009). These underground based methods include:

a) Cross-measure boreholes – boreholes drilled above and/or below the working seam located along the length of the longwall panel;

b) Back-of-block drainage – boreholes drilled above the working section to connect into the goaf to remove accumulated high purity gas;

c) Goaf seal drainage – removal of gas from sealed goaf via pipes passing through seals; and

d) Horizontal directional drilling – long boreholes drilled above and/or below the working seam and oriented parallel to the longwall panel which connect to the forming goaf to drain the accumulating gas.

3.4.4 Surface Goaf Gas Drainage

Surface based drilling techniques have also been used to assist in extracting gas from the goaf during Bulli seam longwall mining operations. The two surface goaf drainage methods involve drilling either vertical goaf wells or Medium Radius Drilling (MRD) goaf wells (Black and Aziz, 2008, and Black and Aziz, 2009).

Vertical Goaf Wells

Vertical goaf wells are a common method used to extract gas from longwall goaf areas. To be effective in managing goaf gas emissions, the distance between goaf wells, although subject to local conditions, is typically 300m or less, with the wells spaced along the length of each longwall panel. Figure 8 shows a cross-section view of a simplified vertical goaf well layout relative to the retreating longwall.

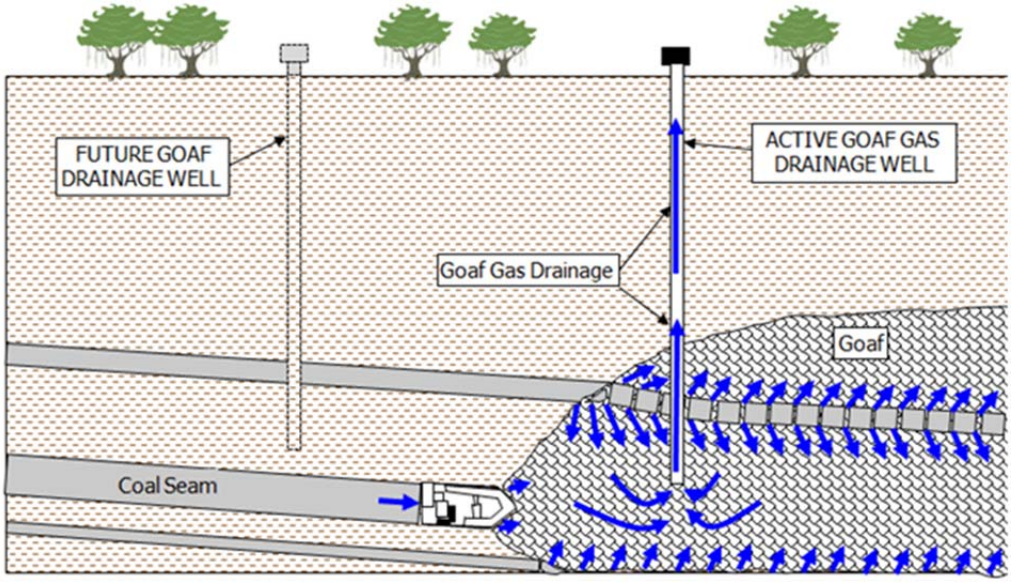

Figure 8 : Cross-section View of a Typical Vertical Goaf Drainage Well

MRD Goaf Wells

Use of the developing MRD technology represents a viable alternative to vertical boreholes for goaf gas extraction. This method involves drilling horizontal boreholes up to about 2500m in length above and/or below the target mining seam into the partial caving zone, prior to goaf formation. As the longwall retreats, the MRD drainage boreholes connect to the goaf and are used to draw gas to the surface using a suction plant, similar to that used with the vertical system. The significant potential advantages of the MRD goaf gas drainage method include:

a) The point of connection between the drainage borehole and the longwall face remains relatively consistent therefore the gas production rate is expected to be less variable than the vertical well alternative;

b) The effect on reducing gas emissions close to the longwall face will be maintained for the length of the borehole; and

c) Significantly less surface disturbance will be necessary as a single MRD surface installation has the potential to service two separate longwall panels and replace at least three vertical SGWs in each panel.

Figure 9 shows a cross-section view of a simplified MRD goaf well layout relative to the retreating longwall.

The MRD technology for goaf gas drainage as opposed to vertical goaf wells is currently being used by BHPBIC in West Cliff Area 5 and Appin Area 7, believed to be primarily due to surface access restrictions and/or a desire to reduce the surface footprint of gas extraction activities. However, in conjunction with the MRD goaf wells, BHPBIC continues to plan for a number of vertical goaf wells also. It is therefore unclear to IMC how effective the use of the MRD technology for goaf gas drainage is for the Bulli Seam operations.

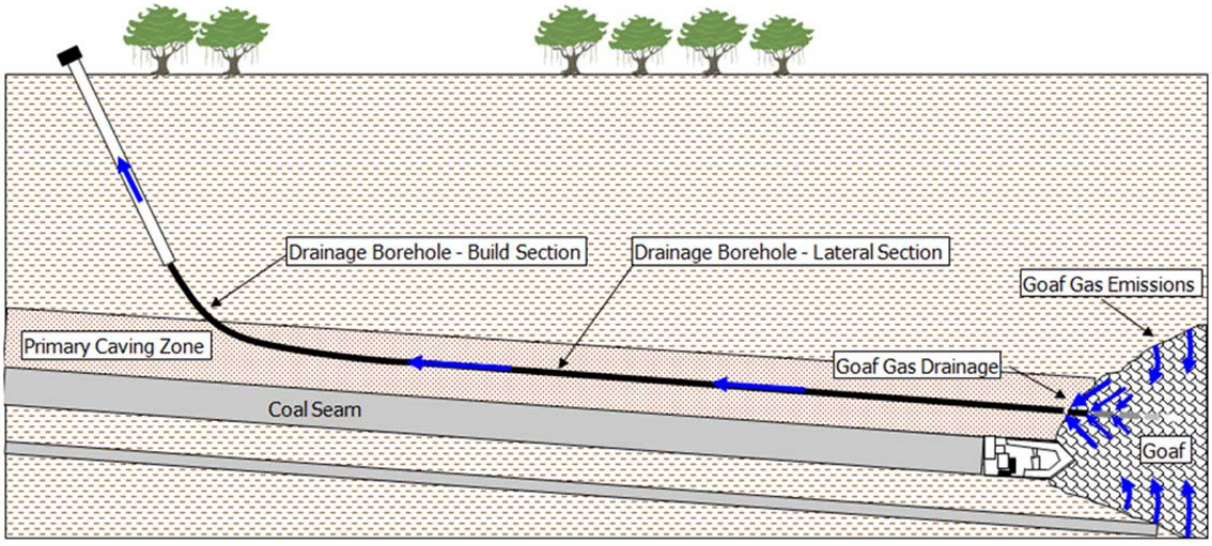

Figure 9 : Cross-section View of a Typical MRD Goaf Drainage Well

The MRD method for goaf gas drainage has also been used by Xstrata at their Blakefield South operations in the Hunter Valley of NSW (Justen, 2010). In this instance, the horizontal holes were used due to surface access limitations as well as the presence of the overlying South Bulga longwall workings, which make the establishment of vertical wells through the already caved ground difficult.

The MRD method for goaf gas drainage is also reportedly being trialed by Anglo Coal at their Grasstree and Moranbah North operations in the Bowen Basin of Queensland (Packham, 2011). In addition to addressing areas of difficult surface access, the horizontal holes at Grasstree are being trialed to enhance the connection between the vertical goaf wells and the gas desorption zone (i.e. increase effectiveness of the wells), which presumably will lead to a reduction in the number of vertical wells (they are on a 50 – 100m spacing currently), while at Moranbah North they are being trialed due to the difficult near surface drilling conditions that make the vertical wells quite expensive to construct.

4 POTENTIAL ISSUES AND OPTIONS – AREA 8 GAS DRAINAGE

This section discusses various options that may be used to drain gas from the Appin Area 8 coal reserves as well as install other necessary surface infrastructure with minimal impact on the Wilton Junction surface development.

4.1 Co-existence Zone – Appin Area 8 and Wilton Junction

Figure 10 shows the extent of the Wilton Junction development investigation area (including Bingarra Gorge) relative to the current proposed Appin Area 8 mining layout coinciding with the investigation area. It should be noted that additional longwall panels have been planned in the Area 8 domain to the northwest of the Nepean River that are not shown in Figure 10 (see Figure 1). Whilst underground mining is presently underway in Area 7, and development has commenced into Area 9, BHPBIC has indicated that the mining of the Area 8 domain will not commence for 10-15 years.

Figure 10 : Wilton Junction Development Area Relative to Proposed Appin Area 8 Mine Layout

4.2 Confirmation of Area 8 Mine Layout

Given that mining of Area 8 is not likely to commence for at least a decade or more, and then could commence in the area to the northwest of the Nepean River, it is unlikely that a great deal of exploration will be carried out in the Wilton Junction area in the short term (next 5 years). Therefore, in the absence of detailed resource data, the proposed layout of the longwall panels in Area 8 is considered indicative and it is likely that the mine layout will either be confirmed or change as more detailed information is gathered.

The following are among the many potentially significant factors that may impact the mine design.

- Gas content of the Bulli seam and adjacent coal seams and gas bearing strata.
- Composition of seam gas present in the Bulli seam and adjacent coal seams and gas bearing strata.
- Thickness of the Bulli seam.
- Permeability of the Bulli seam.
- Geological structures, such as faults and dykes.
- Magnitude and orientation of horizontal stress.
- Strike and dip of the coal seams.
- Stand-off distance from significant surface features e.g. rivers (Nepean River, Allens Creek), roads, rail, etc.

4.3 Area 8 Pre-drainage Options

As previously indicated in Figure 5, the Bulli seam gas content in Area 8 underlying Wilton Junction is similar to the content in the other mining domains and will likely require similar levels of gas drainage to support mining. The figure does show, however, that the gas content of the Bulli seam covering a large area underlying the Wilton Junction development is greater than 13m^3/t. Although requiring confirmation, if the composition of the seam gas is methane rich, then pre-drainage in this area will be required to reduce the gas content by approximately 4-5 m^3/t in order to place the area below the current outburst threshold limit. Additional gas content reduction will likely be required to reduce the rate and total amount of gas released into the mine working during mine operations. If the gas composition is carbon monoxide (CO) rich, then the gas drainage problem becomes compounded due to the greater difficulty in draining CO gas compared to methane. A high CO composition could severely restrict mine development in this area, regardless of Wilton Junction being developed or not.

4.3.1 Underground to In-seam Pre-drainage

The UIS method will continue to play a leading role in pre-draining the Bulli seam in Area 8. In addition to the conventional ‘fan’ drilling patterns, shown in Figure 6, UIS drilling is also required to drill boreholes parallel to the advancing development

roadways to check and confirm that the gas content has been successfully reduced below the outburst threshold limit.

UIS gas drainage boreholes are typically installed to pre-drain one gateroad in advance of current workings. A significant advantage of this method is that it is able to respond quickly to changes in mine layout thus avoiding unnecessary drilling, or incorrect placement of boreholes relative to mine workings. This method also provides a good geological (structural) investigative tool. A potentially significant negative factor, however, is that time available to achieve the required gas content reduction is typically in the order of 6-12 months. Should the characteristics of the Bulli seam be such that gas does not rapidly drain from the coal, more intensive UIS drilling may be required, as well as considering the use of alternative drilling methods that provide increased drainage time or drainage enhancement techniques that serve to stimulate the rate of gas emission from the coal, to effect adequate pre-drainage and prevent mining delays.

To assist in designing an appropriate pre-drainage strategy, it will be important to determine the degree of gas saturation and drainage characteristics of the Bulli seam within Area 8.

Based on the Appin Area 8 mine layout presented by BHPBIC in Section 2 – Project Description of the Bulli Seam Operations Environmental Assessment (BHPBIC, 2008), it may be possible to commence gas drainage in a number of the northeastern longwall panels using long UIS boreholes from drill sites located in existing mine workings (e.g. Area 9 and Tower colliery), as shown in Figure 11. Using current available drilling technology, it is possible for such UIS longholes to be drilled to a distance in the order of 1500-2000 metres.

Should the final design and mining schedule of Area 8 limit access to drill from mine workings in adjoining mining domains, it may be possible to drill longholes from the central and southern Main headings within Area 8, provided the sequence of Main headings development is kept in advance of gateroad development, as illustrated in Figure 12. The drainage time provided from this approach would practically be in the order of 12-24 months and potentially longer should the Main headings be developed further in advance of the gateroads.

Using presently available UIS drilling equipment to complete the long holes from central and southern Main headings may not provide for coverage of the entire length of the longer proposed longwall panels. However there has been increasing industry support for the development of larger capacity drill rigs suitable for use in underground coal mines. It is reasonable to expect that the development of such rigs could be achieved within 5-10 years and therefore could be utilised for the benefit of Appin Area 8.

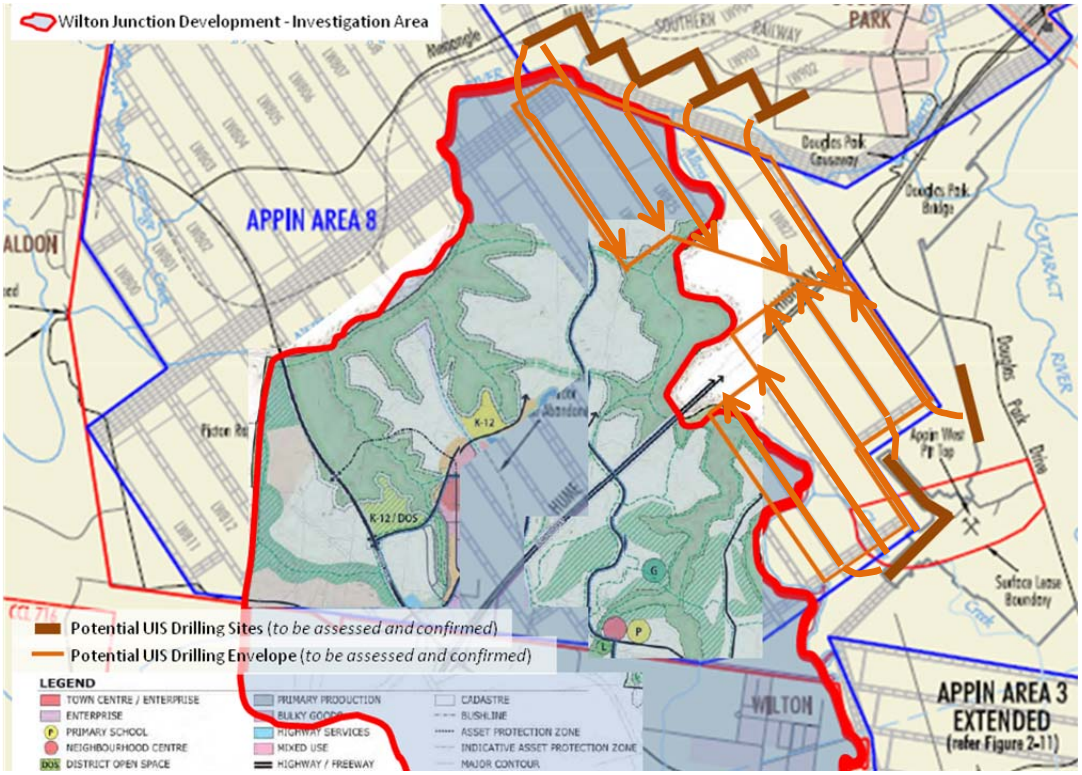

Figure 11 : UIS Longhole Pre-drainage of Area 8 Panels from Existing Adjacent Workings

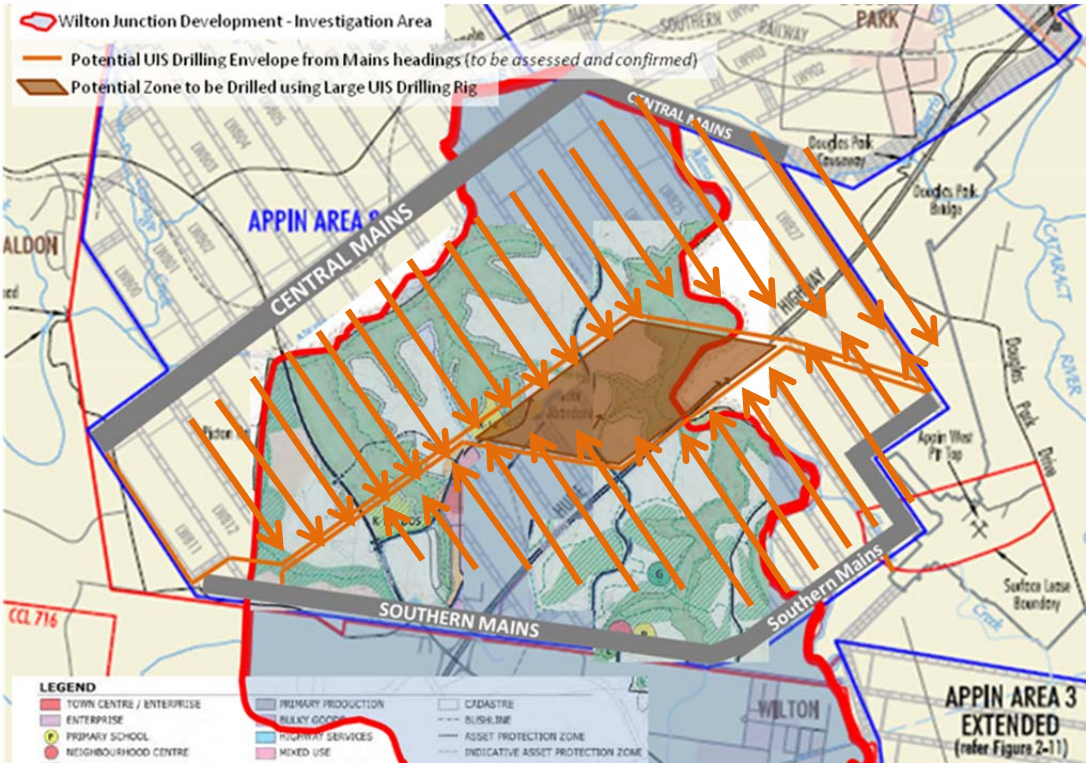

Figure 12 : UIS Longhole Pre-drainage Drilling from Central and Southern Main Headings

The development of high capacity underground drill rigs may also benefit underground goaf gas extraction, as discussed in Section 4.4.

Drilling long boreholes in-seam for gas drainage may also benefit the mine operator by providing valuable exploration data, such as recovering core samples for coal seam gas or coal quality testing, and the identification of potentially significant geological features, that can be used to update the mine plan and production schedules.

4.3.2 Surface to In-seam Pre-drainage

The potentially significant benefit of SIS pre-drainage is that the drilling can be carried out separate to, and many years in advance of, mine operations. The SIS pre-drainage method therefore has the potential to offer significantly longer drainage time than could be achieved using UIS.

To offset the high cost of SIS pre-drainage, these boreholes are ideally installed 5-10 years prior to mining in order to maximise the total potential gas extracted from each borehole, and thereby minimise the number of holes required.

The layout of the mine workings is therefore an important factor that must be considered in the design of an SIS pre-drainage drilling program. It is preferred that SIS boreholes be located separate to development roadways and are not intersected by mine workings until the coal in the area has been adequately pre-drained, with gas content being confirmed by UIS compliance drilling.

Figure 13 presents conceptual surface corridors that may be available to setup MRD drilling rigs to install SIS pre-drainage boreholes into the Bulli seam below Wilton Junction. The rigs used in coal mine SIS pre-drainage drilling are typically capable of drilling 1500-2000 metres, however, larger rigs are available that are capable of drilling longer boreholes.

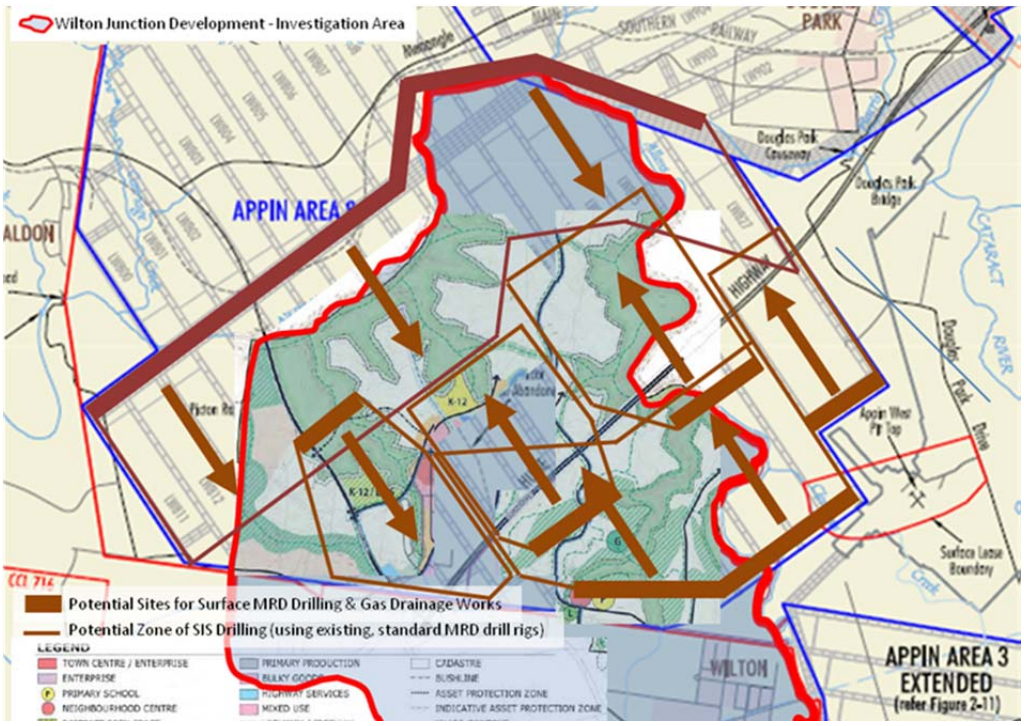

Figure 13 : Conceptual SIS Drilling Locations and Pre-drainage Zones

It has been previously reported that MRD drilling at BHPBIC sites is undertaken inside of a fenced compound that typically measures 50 metres x 40 metres, as illustrated in Figure 14 (Cardno, 2009) and shown in Figure 15 (Cardno, 2011).

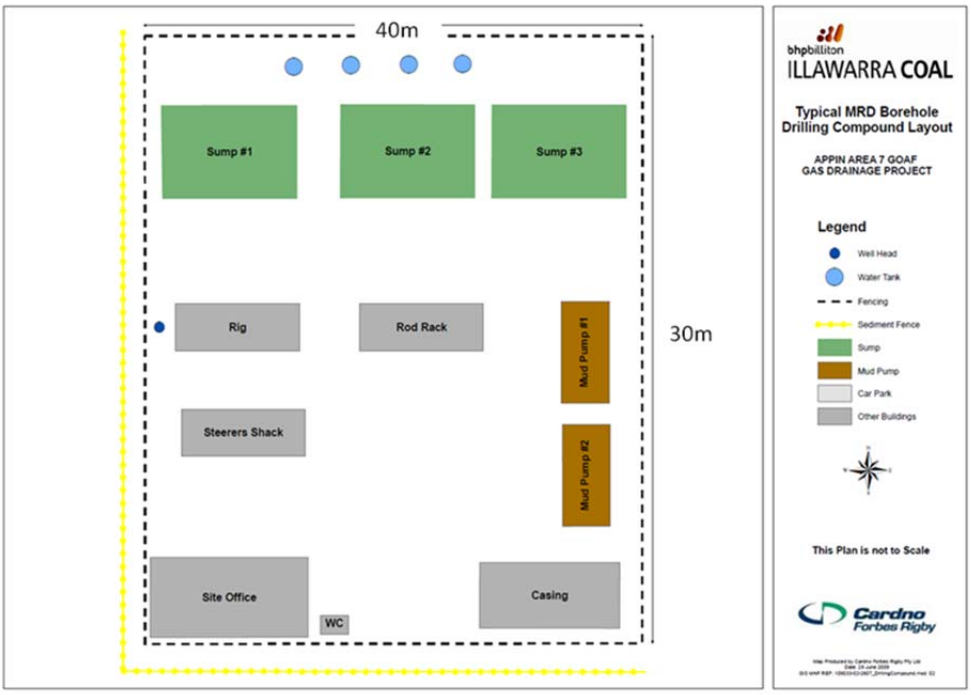

Figure 14 : Typical MRD Drilling Compound Layout
(Cardno, 2009)

Figure 15 : Actual MRD Drill Site at Appin
(Cardno, 2011)

4.4 Area 8 Goaf Drainage Options

It is reasonable to expect the size of the gas reservoir in Area 8 to be similar to Area 7 and Area 9, thus necessitating the continued use of goaf drainage to support safe and efficient longwall mining.

A number of areas exist on the surface overlying BHPBIC's and other's Bulli seam operations, including state conservation areas, Sydney water catchment structures, steep cliffs, etc. Such areas restrict surface access to drill and install equipment to aid the extraction of gas from the underlying workings. Therefore, goaf gas extraction has historically been achieved by predominantly underground methods. In 2006, surface-based goaf gas extraction commenced at West Cliff colliery using vertical gas wells (Meyer, 2006) and this method continues to be preferably employed by BHPBIC (and elsewhere in Australia) where surface access is available, primarily as surface based methods:

- are less labour intensive and generally more cost effective;
- are inherently safer because they remove workers from underground; and
- eliminate interaction with the underground mining operations.

4.4.1 Underground-based Goaf Drainage Methods

Section 3.4.3 lists four (4) underground-based methods that may be used to extract goaf gas. In Bulli seam operations, cross-measure drainage has been the dominant method. This method involves drilling a series of boreholes perpendicular to the length of each longwall panel from the Bulli seam maingate or tailgate to the Wongawilli seam. As the formation of the goaf causes fracturing of the surrounding strata ahead of the longwall face, the cross-measure boreholes are used to extract gas from the underlying coal seams.

Using UIS drill rigs to drill long goaf drainage boreholes is another method that has the potential to significantly increase the volume of goaf gas extracted from within the underground workings. Long boreholes may be drilled parallel to the longwall blocks, from drill sites located along each gateroad, into the caving zone above and/or below the working seam, as illustrated in Figure 16.

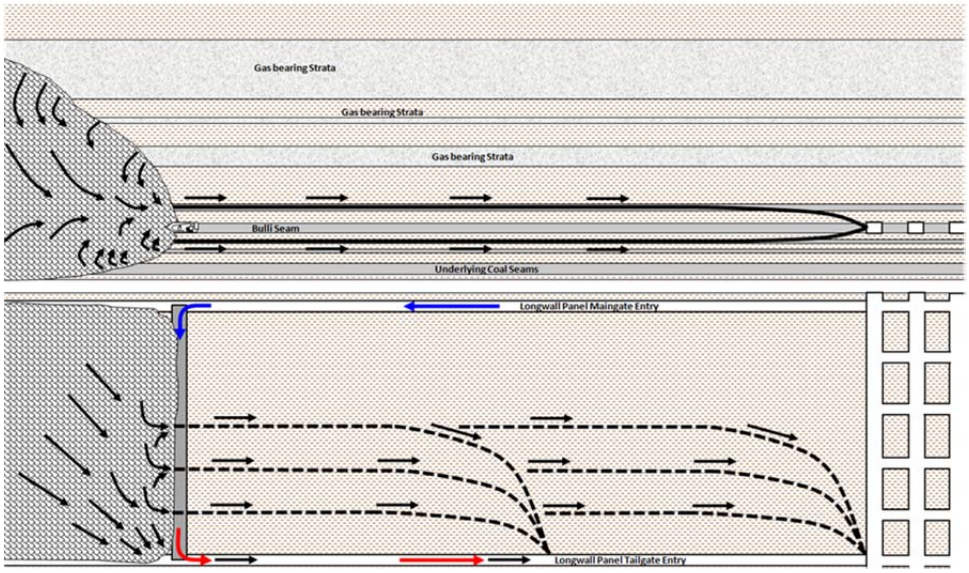

Figure 16 : Conceptual Layout of UIS Goaf Drainage Boreholes (longholes)

The application of this method is presently limited by the capacity of existing underground drill rigs. With increasing demand for the development of an MRD-style drill rig that is suitable, and approved, for use in underground mines, it is reasonable to expect that within 5-10 years there will be equipment available to drill longer, larger diameter boreholes, from within existing underground workings, to support high capacity goaf gas extraction.

An alternative drilling pattern, that may be more suited to a large capacity drill rig, features multiple long, larger diameter goaf drainage boreholes that are drilled from a single drilling site located in the Main headings, as illustrated in Figure 17.

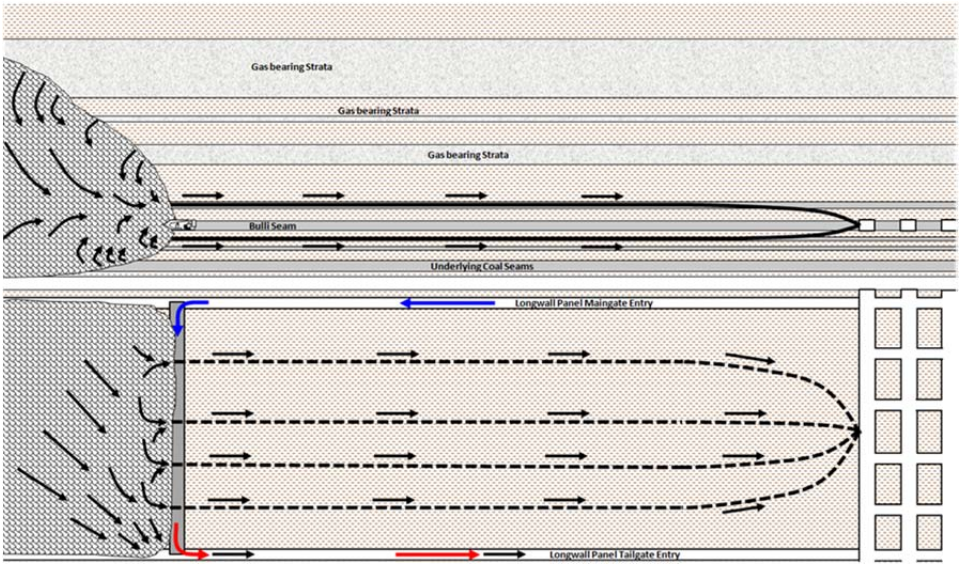

Figure 17 : Conceptual Layout of UIS Goaf Drainage Boreholes suited to Large Capacity Drill Rigs

4.4.2 Surface-based Goaf Drainage Methods

As discussed in Section 3.4.4, the two (2) drilling methods available to install boreholes for the purpose of extracting goaf gas from the surface include vertical goaf wells and MRD (horizontal) goaf wells.

Vertical Goaf Wells

Vertical goaf wells have the potential to be a very effective method to extract goaf gas to the surface. This method does have a large surface footprint, with the spacing between gas wells typically being 300 metres or less (depending on ground conditions). The area required at each drilling site typically measures 40 metres x 50 metres, as shown in Figure 18 (Cardno, 2009).

Figure 19 shows the 'bushland' areas (in brown) within the proposed Wilton Junction development, including the 50m wide fire barrier to be left around them. Although yet to be confirmed, these areas would likely be accessible to drill vertical goaf wells and install gas reticulation pipelines. Other than the corridor for the proposed Maldon to Dumbarton railway line, which may or may not be constructed before mining, and along Picton Road there appears to be limited "natural" access within the central section of the Wilton Junction master plan. Therefore, purpose

built open spaces will be required to be left and/or an alternative goaf drainage method is likely to be required as discussed below.

In areas where surface access is limited, it may be possible to drill multiple 'offset vertical' gas wells from a single drill site. In such areas, a drill rig capable of drilling angled boreholes would be required. Initially the borehole would be drilled at an angle and then steered into the vertical plane once the required offset distance had been achieved. The installation of two offset vertical goaf wells from a single drill site is illustrated in Figure 20. Similar offset wells could also be drilled from the one site in the perpendicular plane. Using this method, the vertical well sites required on surface could be located as much as 600m apart.

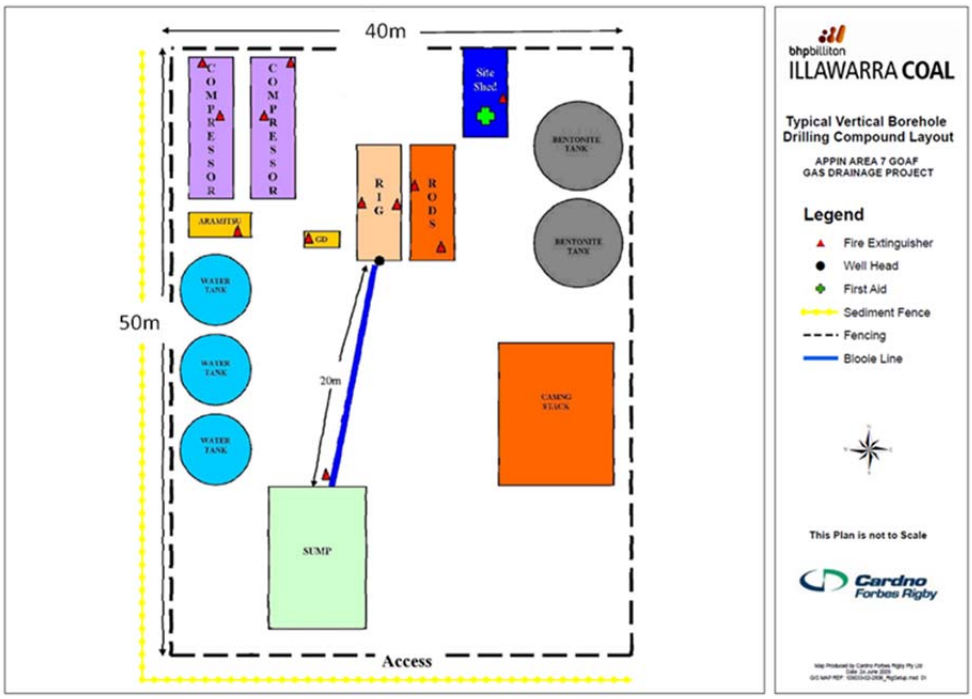

Figure 18 : Typical Vertical Goaf Drainage Well Drilling Compound Layout
(Cardno, 2009)

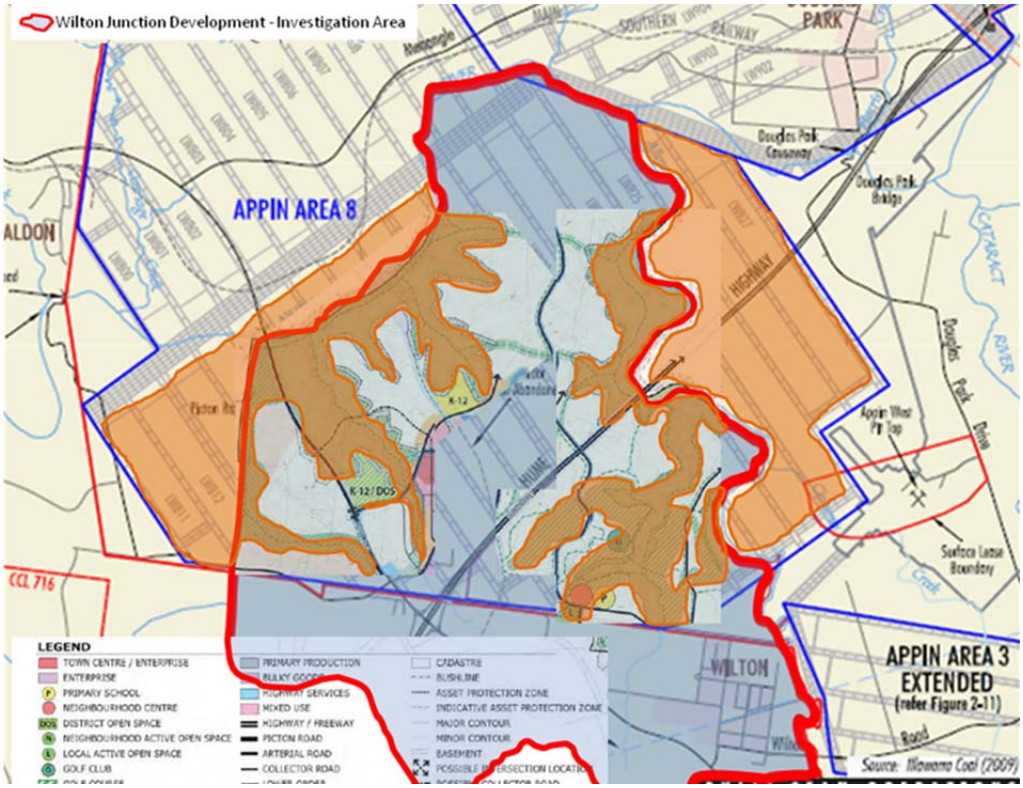

Figure 19 : Potential Areas for the Drilling of Vertical Goaf Drainage Wells

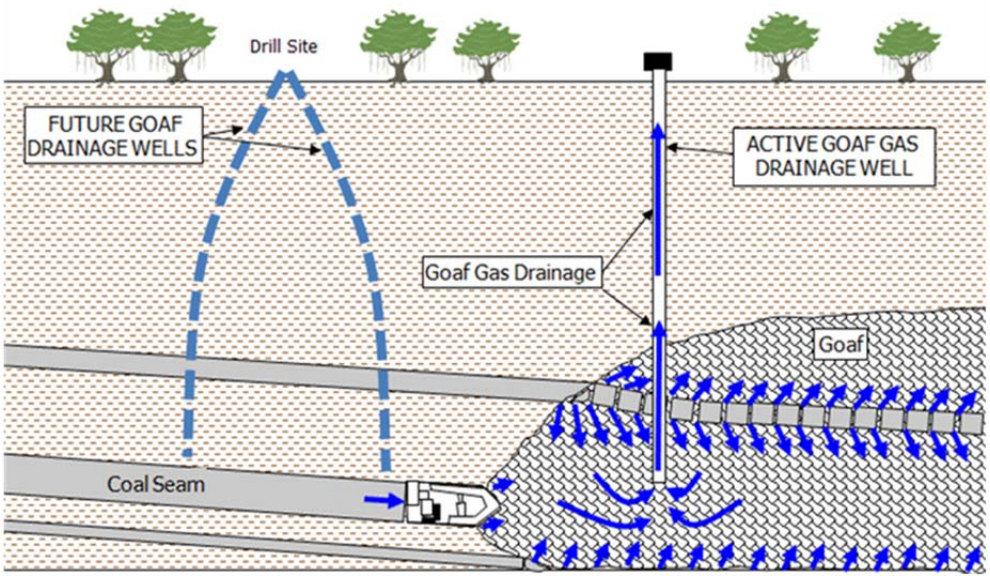

Figure 20 : Section View of Conceptual 'Offset Vertical' Goaf Drainage Wells Drilled from a Common Drill Site

MRD and ERD Goaf Wells

The use of the medium radius drilling (MRD) method to drill boreholes specifically for goaf gas extraction is a relatively new application of this technology (Black and Aziz, 2008). Typical surface drill rigs are capable of directionally drilling boreholes

around 2000m in length and greater than 300 mm in diameter, however, high capacity surface drill rigs are now available that have the capability to drill a 300mm diameter hole up to 4000 metres long (Justen, 2010). The use of similar, high capacity drill rigs, termed extended reach drilling (ERD), would enable the installation of goaf drainage boreholes from outside of the Wilton Junction development that would cover most of the proposed Area 8 mine workings located beneath the Wilton Junction development area, as shown in Figure 21.

In order to increase the suction and/or reduce the potential risk of an MRD/ERD goaf drainage borehole blocking and being unable to maintain the required goaf gas extraction rate, the early drilling designs have included a series of vertical goaf wells that are intersected by the MRD lateral borehole section as a contingency, as shown in Figure 22 (Justen, 2010). As experience grows and the use of MRD/ERD goaf wells becomes more common, it is possible that the inclusion of the vertical goaf wells in the drainage design may no longer be required.

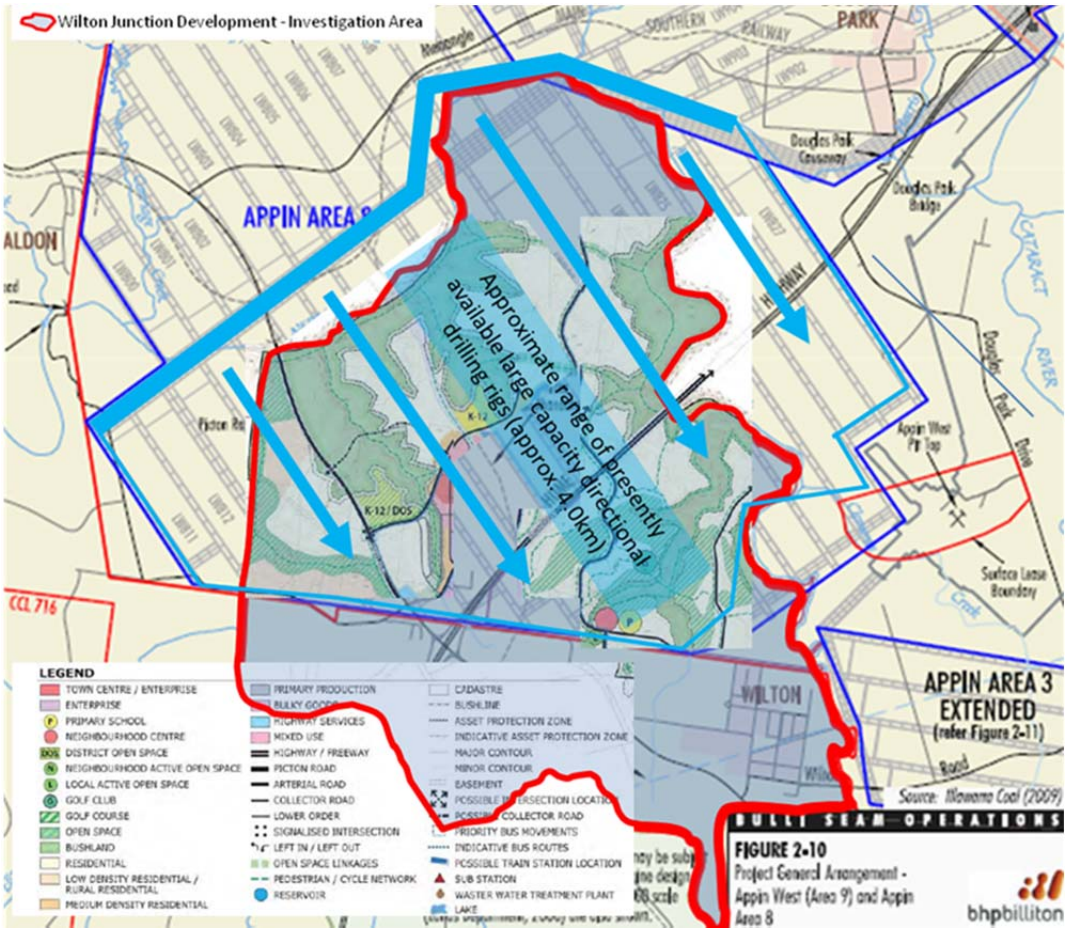

Figure 21 : Potential Corridor where ERD Goaf Drainage Wells may be Installed

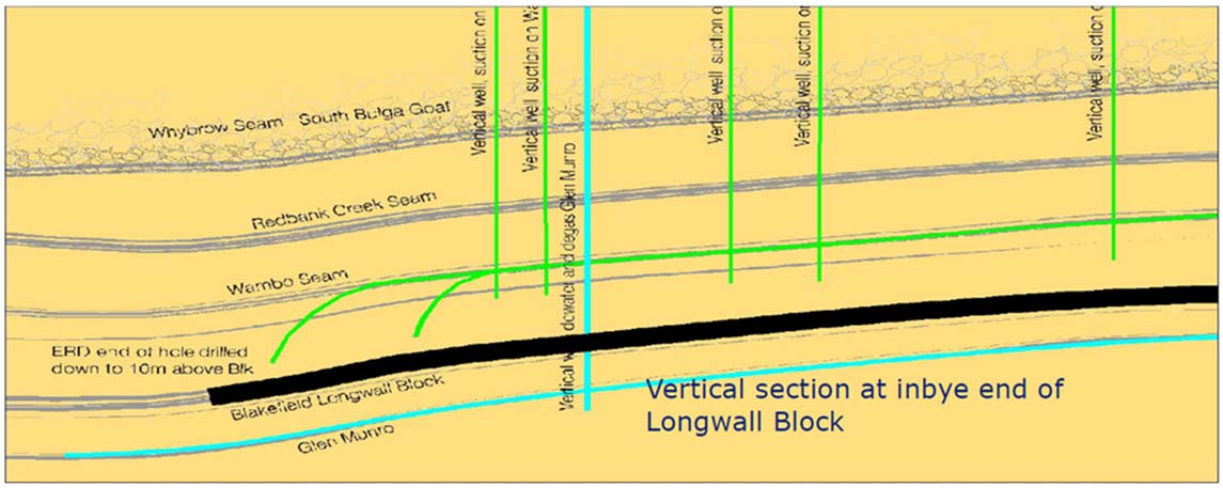

Figure 22 : Section View of MRD Drainage Well with Vertical Well Intersections
(Justen, 2010)

4.4.3 Comparative Costs of Goaf Drainage Methods

From the above discussion, it is apparent that there are alternative methods of goaf gas drainage for the area associated with Wilton Junction new town that would permit the coexistence of its development and underground mining by BHPBIC. Therefore, the decision on the most attractive method of goaf gas drainage for Wilton Junction needs to consider both the effectiveness of the method employed and the financial, social and environmental costs involved with implementing that method.

In order to gauge the comparative financial costs, IMC have held discussion with drilling contractors experienced in the various methods of goaf gas drainage discussed here. Based on those discussions, a comparative annual cost for each of the surface based methods as well as the conventional underground in seam (UIS) cross measure method have been estimated. The results are provided in Table 1, while Figure 23 provides particulars of the offset vertical and MRD/ERD well design.

As indicated on Table 1, the MRD, ERD and UIS cross-measure alternatives provide for roughly equal and potentially the least expensive methods for effecting goaf drainage, followed closely by straight vertical wells. The most expensive alternative appears to be the offset vertical wells, which are some 50% more costly (at maximum deviation) than the other alternatives.

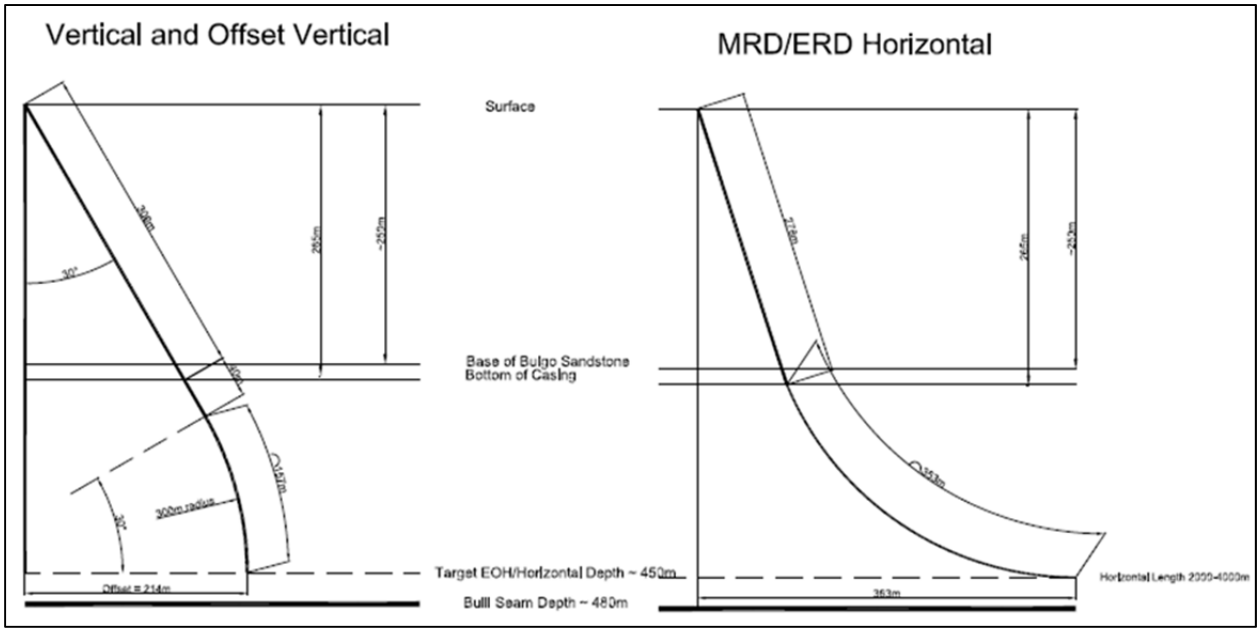

Figure 23 : Goaf Well Design Parameters for Comparative Costing

Table 1 : Comparative Cost of Goaf Drainage Alternatives

	Vertical Wells			Offset Vertical Wells			MRD Wells			ERD Wells			UIS (cross-measure) per Year		
	units	rate	cost	units	rate	cost	units	rate	cost	units	rate	cost	units	rate	cost
Mob/Demob	0.074	$240,000	$17,778	0.106	$240,000	$25,532	0.67	$480,000	$320,000	0.75	$480,000	$360,000	1	$100,000	$100,000
Drill Site Establishment	1	$50,000	$50,000	0.5	$50,000	$25,000	1	$100,000	$100,000	1	$100,000	$100,000	120	$10,000	$1,200,000
Drilling	23 shifts	$13,660	$314,180	33 shifts	$13,660	$450,780	76 shifts	$28,575	$2,171,700	136 shifts	$37,148	$5,052,060	28,800m	$140	$4,032,000
Casing	265m	$100	$26,500	300m	$100	$30,000	280m	$100	$28,000	280m	$100	$28,000	na		
Well Control Equipment	26 days	$1,830	$47,580	38 days	$1,830	$69,540	38 days	$1,830	$69,540	68 days	$1,830	$124,440	na		
Direction Drilling Services	na			14 shifts	$6,600	$92,400	56 shifts	$13,200	$739,200	116 shifts	$13,200	$1,531,200	na		
Total comparative cost per well			$456,038			$693,252			$3,428,440			$7,195,700			$5,332,000
Cost per m of longwall retreat			$2,280			$3,466			$1,714			$1,799			$1,777
Comparative cost per year			$6,840,567			$10,398,779			$5,142,660			$5,396,775			$5,332,000

Assumptions: Longwall retreat average 3000m per year
Vertical Wells - 200m spacing, average 450m deep, 26 days (including off days) per well to complete, 1 well per drill pad, 13.5 wells constructed per year per drill
Offset Vertical Wells - 200m target spacing, average 450m target depth at maximum offset (215m), 38 days (including off days) per well to complete, 2 wells per drill pad, 9.4 wells constructed per year pe
MRD Wells - 200mm diameter, 2000m horizontal length, 38 days to complete on 24/7 operations, 1.5 wells required per year on average
ERD Wells - 200mm diameter, 4000m horizontal length, 68 days to complete on 24/7 operations, 0.75 wells required per year on average
UIS - 4 x 60m deep holes on 25m set-up spacing, 240m drilled per set-up, 120 set-ups required per year
Average 1 mobilisation/demobilisation cost per year for vertical, offset vertical, and UIS operations

However, when we consider the effectiveness of the methods, there is evidence that the MRD method still requires some vertical wells in consort to effect the necessary suction and drainage volume, which would tend to balance or reverse the cost efficiency versus vertical wells, while the UIS method is used as a last resort due to increased safety risks for workers, higher drainage pipe costs, and generally poor effectiveness of the method resulting in increased delays to mining and higher mining costs.

4.5 Other Surface Facilities

4.5.1 Gas Extraction Facilities

With all surface-based gas drainage systems, there is a need to capture the gas at the well head and either safely release it into the atmosphere at the well head site by free venting (rarely used) or flaring, or transporting the gas elsewhere by pipelines for use in power generation.

The currently preferred option for BHPBIC in Area 7 is to extract the gas from individual vertical wells through connecting the well to a gas reticulation pipeline (Figure 24), which in turn is connected to a centrally located extraction plant, from where the gas from multiple wells is further transported via pipeline to the EDL power generation units located at the Appin West pit top. In this case, the pipelines (nominally 250mm in diameter from individual wells and up to 600mm in diameter for trunk lines) are placed in a trench and covered to prevent damage and allow access above the pipes.

For MRD holes, the extraction plant is connected directly to the well as shown in Figure 25.

As previously discussed, and depending on the location of the well head, the gas reticulation pipes can be located within the bushland and associated fire barrier corridors around the perimeter of the WJ development area. For internal sites, pipelines could be located along the road easements, as previously postulated by IMC and incorporated in the Wollondilly LEP for Bingarra Gorge development (Figure 26).

4.5.2 Ventilation Facilities

In addition to gas drainage wells, the mining of Appin Area 8 is likely to require the construction of mine ventilation facilities to provide the necessary air volumes for safe extraction. By design and to minimise costs, these are almost exclusively located to intersect the Main headings of the mine at either end of the longwall blocks in order that they can serve a number of panels. Given the proposed Main headings for Area 8 are located almost entirely outside of the Wilton Junction development area, there is not likely to be any impediment to their location or construction as a result of the development.

Figure 24 : Typical Connection to Vertical Drainage Wells
(Cardno, 2011)

Figure 25 : Gas Extraction Plant Connected to MRD Drainage Well
(Cardno, 2011)

Figure 26 : Proposed Bingara Gorge Gas Drainage Layout
(IMC, 2003)

4.6 Alternative Goaf Drainage Layouts for Wilton Junction

4.6.1 Vertical Wells

Based on the above discussion, and using the Bingara Gorge solution as a guide, a similar, indicative layout of drill sites and drainage pipelines for the Wilton Junction Master Plan (assuming a 200m vertical well spacing) is presented in Figure 27. This indicative layout assumes the use of the preferred and industry proven vertical wells (with offset technology as required) for goaf gas capture, and uses designated open spaces and perimeter bush land to locate the drill sites, with the network of pedestrian/cycle paths and road easements to locate the drainage lines. The drainage lines, in turn, connect back into the underground pipeline network in the Area 8 main headings for conveyance of the extracted gas to the Appin gas facilities.

It is understood that the perimeter bush land is to be placed into an environmental trust by the Landowners Group in order to preserve its ecological values. While some of the surface drill sites and gas drainage lines are proposed to be sited within these trust lands, these facilities would be accommodated and rehabilitated appropriately in order to preserve the ecological values in the long term.

There is an area in the north central portion of the Wilton Junction site where there are no currently planned open spaces in which to locate drill sites, and this results in

inadequate coverage of the vertical goaf wells. In this area, the Wilton Junction plan will need altering to include open space in order to manage the interaction issues. It should also be noted that the above design assumes a 200m well spacing. This well spacing may be inadequate, as evidenced by revised well requirements for the 704 panel in Area 7 and experience elsewhere in the Bowen Basin of Queensland. Should well spacing need to be decreased, then the number of drilling sites would likely need to increase and the lack of adequate coverage provided by the offset vertical method could be exasperated.

4.6.2 MRD Wells

As an alternative, a similar indicative layout for goaf gas drainage at Wilton Junction using industry trialed MRD technology and maximum 2200m horizontal hole lengths has been developed. The indicative MRD drainage layout is provided in Figure 28. For completeness, the layout has assumed the requirement of supplemental vertical wells on 600m spacing.

As shown, the use of MRD wells provides for a less intrusive method of gas drainage for Wilton Junction coexistence, with the MRD drilling sites located outside the development or along the northwestern and eastern perimeter. The number of vertical well drilling sites in the interior is markedly reduced.

The MRD drilling method requires 24 hours per day, 7 days per week drilling operations. Even located on the edges of the development, provision of adequate noise and lighting barriers to minimize the disturbance of Wilton Junction residents will be required.

4.6.3 Effect of Altered Mine Layout

As previously mentioned, it is quite possible that the final mining layout for Area 8 could be different to that projected currently. To gauge the effect on the indicative goaf drainage layouts presented above, Figure 29 presents the vertical drainage well target pattern assuming the mine layout is rotated 90 degrees to a similar orientation as historic mining.

As indicated, the spread of vertical well target locations is similar to the current orientation, and it is likely that the same or similar offset vertical well drilling sites as indicated for the current mine plan could be implemented for the rotated plan. Additionally as indicated in Figure 29, there are also natural corridors for locating the MRD drill sites along the eastern perimeter and along the Maldon to Dombarton rail corridor, which is assumed to be vacant. Should this not be the case, the drilling sites could be located along Picton Road as well.

What Figure 29 illustrates is that, using offset vertical and/or MRD drilling technology, surfaced based gas drainage can be carried out for a range of mine layouts by accommodating the drill sites and drainage pipelines along the Wilton Junction perimeter and within the bushland and open spaces elsewhere.

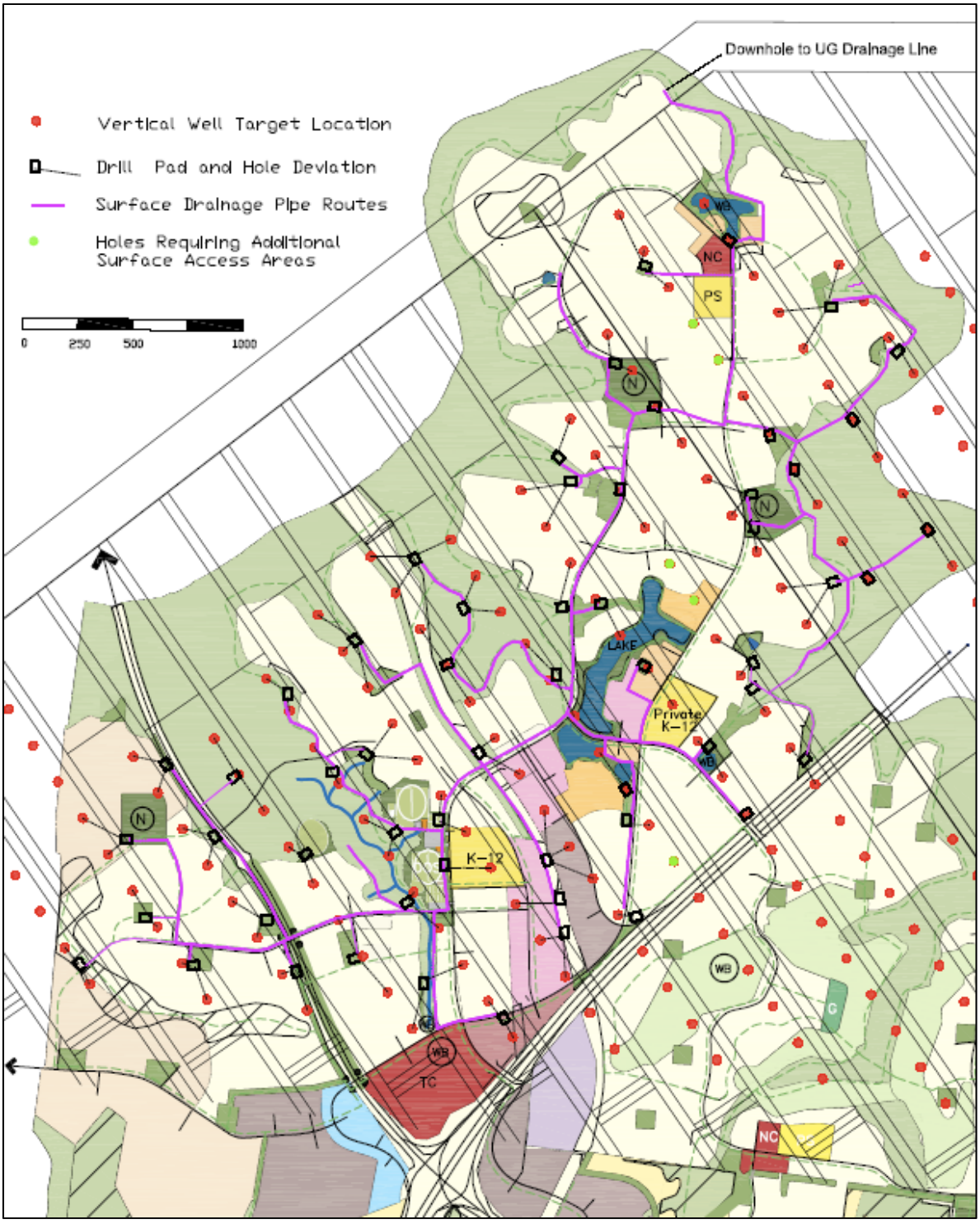

Figure 27 : Indicative Wilton Junction Goaf Drainage Layout using Vertical Wells

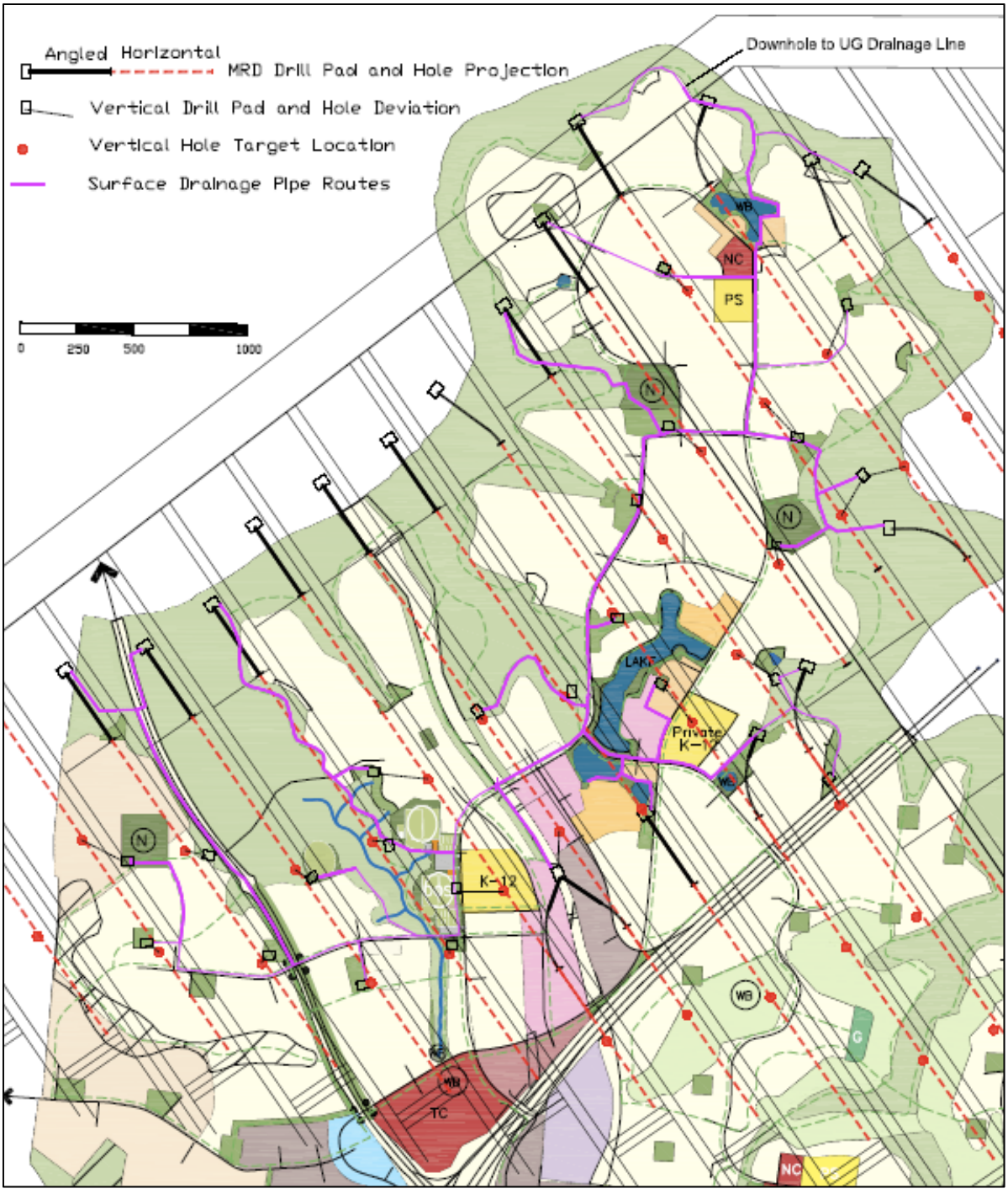

Figure 28 : Indicative Wilton Junction Goaf Drainage Layout using MRD Wells

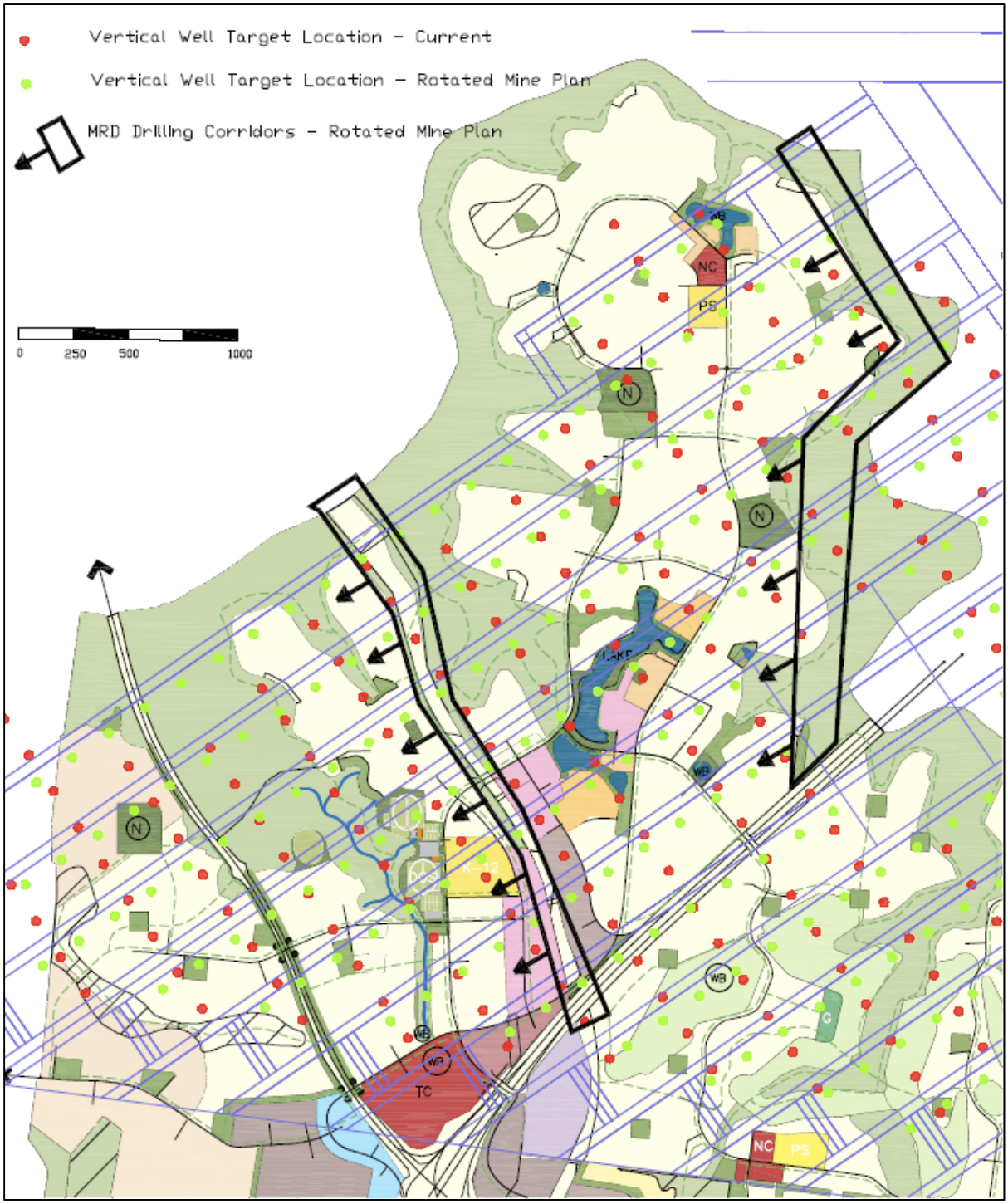

Figure 29 : Effect of Rotated Mine Layout on Goaf Drainage Options

5 PRACTICALITIES OF URBAN DEVELOPMENT AND MINING COEXISTENCE

5.1 Similar Situations

The coexistence of underground mining and urban development as proposed for Wilton Junction is not in itself unique.

There are many examples of undermining existing urban development, particularly in Eastern Europe and the United States, but also nearby Wilton Junction at Tahmoor. However, based on the available literature, none of these situations involved the coexistence of surface based gas drainage operations, whether due to the fact that the undermining pre-dated the use of these techniques, lower seam gas regimes precluded goaf drainage requirements, or as at Tahmoor, surface based gas drainage methods are not presently used.

5.2 Reducing Risk

The key to coexistence of Wilton Junction new town development and future underground mining by BHPBIC will be the ability to reduce risk to both parties.

In order to reduce risk, there needs to be open and meaningful discussions between the parties, and in particular BHPBIC's expected exploration and gas drainage requirements. This can be achieved through providing the latest Bulli seam geological modeling outcomes and long range operating projections, including expected gas drainage design to the Landowners Group. Through independent analysis of this data, the Landowners Group can better assess the likely mining and gas drainage options for Area 8 and the timing of those operations, and then develop a town plan that provides the required access areas for the mine's surface infrastructure and operational requirements.

6 REFERENCES

Black, D J and Aziz, N I, 2008. The evolution in coal mine gas extraction – a response to economic, environmental and community pressures, in *Proceedings of the 16th Coal Congress of Turkey*, Chamber of Mining Engineers of Turkey, Zonguldak, Turkey, 26-28 May, pp.149-156 [http://www.pacificmgm.com.au/index.php/publications].

Black, D J and Aziz, N I, 2009. Developments in coal mine methane drainage and utilisation in Australia, in *Proceedings of the Ninth International Mine Ventilation Congress*, Department of Mining Engineering, Indian School of Mines University, Dhanbad, India, 10-13 November, pp.445-460 [http://www.pacificmgm.com.au/index.php/publications].

BHP Billiton Illawarra Coal (BHPBIC), 2012a. Bulli Seam Operations – Mining Operations Plan (October 2012 – September 2019), pp.145.

BHP Billiton Illawarra Coal (BHPBIC), 2008. Bulli Seam Operations – Section 2 Project Description, pp.49.

BHP Billiton Illawarra Coal (BHPBIC), 2012b. Gas Drainage Management Plan - West Cliff Longwalls 36-37, pp.42.

BHP Billiton Illawarra Coal (BHPBIC), 2012c. Appendix A.1 – Gas Drainage Management Plan - West Cliff Longwalls 36-37

BHP Billiton Illawarra Coal (BHPBIC), 2013. Wilton Junction Proposal – Review of Coal Resources, p 30.

Cardno Forbes Rigby (Cardno), 2009. Environmental Assessment – Appin Area 7 Goaf Gas Drainage Project, report prepared for BHP Billiton Illawarra Coal, Job Number 109033-02 / Report 001 Rev1, p.134.

Elvy, B, 2012. Future of Coal Mining in the Illawarra, Presented at the ACARP Gas and Outburst Seminar, Wollongong. [http://www.uow.edu.au/eng/outburst/html/Research%20&%20Publication/outburst_pres.html]

Justen, M, 2010. Beltana Blakefield South Mine Ventilation System, presented at the ACARP Gas and Outburst Seminar, Wollongong. [http://www.uow.edu.au/eng/outburst/html/Research%20&%20Publication/outburst_pres.html]

Meyer, T, 2006. Surface goaf hole drainage trials at Illawarra Coal, in *Proceedings of the 7th Australasian Coal Operators' Conference COAL2006*, Australasian Institute of Mining and Metallurgy. Wollongong.

Packham, R, 2011. Advances in Gas Drainage and Gas Management Within AAMC, presented at Gas and Coal Outburst Committee Seminar. Wollongong

Wilton Junction Development Consortium (WJDC), 2013. Wilton Junction Co-existence of Coal Mining and Surface Development, p.72

IMC Mining Consultants Pty Ltd, 2003. Report No. IMC0959, Independent Opinion on Mining Issues at Wilton Park, p. 14