The environmental implications of extraction of coalbed methane

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ABSTRACT

The exploration for methane associated with coal seams and the subsequent development of the resource would be associated with environmental impacts on the land surface. The perceived environmental and social impacts of a typical exploration programme, the development of the resource and the long term presence of the infrastructure associated with wells are discussed. The most important environmental impact of gas production is associated with the storage and management of saline water pumped from the production wells. Reference is made to the legislative and regulatory framework within which the exploration, development and operational activities take place. The pro-active approach by one company involved in the exploration and development of Queensland's coalbed methane industry is discussed.

INTRODUCTION

The potential methane resources associated with coal seams in Queensland has attracted considerable interest and major exploration programmes to evaluate these resources have commenced. Exploration is concentrated in the Bowen Basin in Central Queensland and is taking place on rural land and in certain areas the exploration is in close proximity to large operating coal mines.

As the coal mining industry has been established in Central Queensland for several decades, the coalbed methane industry will need to accept and accommodate the perceptions of the existing population and particularly the rural population, where many of the land holders are neighbours of the coal mines in the region. From discussions with land holders in the region, few are strongly supportive of the mining industry, most can see the positive impacts of the industry as well as the negative aspects and are effectively mildly positive or neutral in their views towards the mining industry. Commonly held negative opinions on the coal mining industry include concerns that the industry can dominate the local area through its size and big spending, takes large areas of land from rural production regardless of the views of the land holder and employs a workforce with a totally different work ethic to most land owners.

An industry based on coalbed methane would be very different to the coal mining industry. These differences are outlined below:-

(a) An economic well field may be 10-20 times the area of a typical coal mining lease. However the actual area of land occupied by gas production, collection and compressing operations and taken out of rural production would be comparatively small. Further it would be anticipated that most of the land occupied by the industry would be under some long term lease arrangement with the land owner rather than through any land purchase.

(b) Commercial gas fields would generate employment particularly during the development phase. In the operational phase the industry would be a comparatively small employer and the skills required for the available positions would be markedly different from those currently in demand in the coal mining industry.

(c) The major environmental impact associated with the coal mining industry is related to land disturbance. While there is potential for water pollution to occur, discharges of poor quality water from a properly managed coal mine should be a comparatively rare event as mines should have areas for storage of poor quality water and mines have a buffer area between the operational pits and the mine boundary and any small flows usually disappear into the pervious sands in local watercourses. The major long term environmental issue for the coalbed methane industry would be related to water management with particular regard to the handling and management of saline water. As the area of land which is required for gas production is comparatively small and land ownership of that land would be expected to remain with the rural land owner, there would be no buffer area and effectively the environmental performance standard would be continually on public display.

An element of the successful development of the coalbed methane industry in the Bowen Basin would be the establishment of good long term relations with local land holders. This necessitates the establishment of trust between the land holder and the gas producer and the gas production operations being conducted at an acceptable standard to maintain that trust. The initial establishment of a good long term arrangement with a number of land holders may take time as the negative perceptions to mining and mining related activities would need to be overcome.

STATUTORY PROVISIONS

With regard to exploration and production operations, the major statute is the Petroleum Act administered by the Department of Resource Industries. The major provisions in the Petroleum Act with specific relevance to the environmental and land management relate to compensation to land owners adversely affected by operations on their land. The general philosophy within the Act is that the tenement holder should negotiate compensation arrangements with land owners and occupiers and that where agreement cannot be reached the Act specifies the procedures to be followed. The Act sets out reporting requirements on all aspects of land owner liaison and the grounds for compensation of land owners which include:-

(a) Deprivation of possession of the surface or of any part of the land surface.

(b) Damage to the surface and to any improvements as a result of exploration or development activities.

(c) Severance of the land from other land held by the owner or occupier.

(d) Provision of a surface right of way.

(e) All consequential damage.

It is apparent that these grounds for compensation effectively formalise the owner's common law rights.

Leases may be granted under the Petroleum Act for the purposes of gas extraction and development. Under other legislation, the State Development and Public Works Organisation Act, and government policies, all Statutory Authorities are required to take environmental factors into account in their decision making and granting of approvals and related activities. Thus while not specified in the Petroleum Act, the proposed environmental management programmes of a lease applicant would need to be considered by the Department of Resource Industries during the lease approval process. In practice this should normally involve the applicant demonstrating to the Department's satisfaction that the requirements of other relevant Departments have been met.

Coalbed methane extraction involves the establishment of production wells which have relatively short lives. During the production period, water is continuously extracted from the wells and storage and management of this water is required over the life of the well.

Water management would be a major environmental concern with coalbed methane development and the relevant Authorities would be the Queensland Water Resources Commission, which administers the Water Act, and the Department of Environment and Heritage which administers the Clean Waters Act and other pollution control and environmental management legislation.

The Water Resources Commission's authority is derived from legislation which vests ownership of the State's water in the Crown. Usually this authority is exercised through the granting of approvals to use water, construction of structures to contain water or divert water courses and through allocation of water to users where resources may be limited, for example, water for irrigation. Because of its broad authority, the Commission may take a direct interest in any matter which may affect the State's water resources. Thus in recent years through amendments to Act's administered by the Commission, the Commission has authority over tailings dams and any structure which may contain poor quality or polluted water.

Water generated as a result of methane production would be saline and would require storage and therefore the Commission would be involved. As the Commission is currently taking a major interest in water management on coal mines because of the potential impact of discharges of poor quality water into surface water resources, it would be expected that water management practices within the coalbed methane industry would be of considerable interest to the Commission.

The Department of Environment and Heritage administers specific pollution control legislation including the Clean Waters Act. Under this Act any regulated or storm water discharge of water should be licensed subject to conditions set by the Department. All environmental management and pollution control legislation in Queensland is currently being reviewed. While specific details on the new legislation are not available, from the perspective of the coalbed methane industry, it would be expected that the legislation would cover:-

(a) Provisions for the licensing, regulation and control of any discharge of water to a water course, and

(b) Provisions which give the Department general authority to review and approve water management proposals for any project which may cause water pollution.

Discharge of water generated by methane production would probably not be permitted and therefore would not be licensed. However as the operations may lead to water pollution, involvement of the Department of Environment and Heritage would be anticipated.

MAJOR ENVIRONMENTAL IMPACTS FROM COAL BED METHANE DEVELOPMENT

The exploration, development and operational phases of a well field each may have environmental impacts and these are discussed in turn.

Exploration

The potential environmental impacts associated with exploration activities should be relatively minor and should be avoided by common sense. Major concerns of the land owners usually relate to preservation of fences, respect for gates, minimising the spread of noxious weeds and prevention of unauthorised trespass.

Use of appropriate plant for the required tasks and competent operators should minimise adverse impacts to the land surface. With seismic lines, it is advisable to negotiate the location of the lines such that both the concerns of the land owner are taken into account and the aims of the exploration programme are met. With line marking and clearing, damage to the soil should be minimised and preferably roots of the vegetation left undisturbed in the soil. Lines on land with moderate slopes may pose an erosion risk and specific works may be required at the end of the seismic programme to prevent erosion.

With drilling, the location of drill sites should be arranged to minimise problems, for example avoiding water courses. The layout of drill sites should have regard to the natural drainage of the area and the catchments of ponds containing the drill lubricating fluids should be minimised to prevent flooding of ponds and the potential release of drilling fluids into water courses.

Development

The development of a well field would be associated with intense local activity with drilling, construction of water storages, construction of gas and water lines, construction of well head facilities and gas pumping stations, measures required to stimulate or commence gas production and other associated activities occurring concurrently and at several sites for the period of the field development. Activities during this phase would have the greatest potential for environmental impact.

From the perspective of the land owner, the location of all wells and all associated infrastructure on the property would be of interest and would need to be discussed in order to achieve the best location for the wells with the minimum disruption. However the major impact would be related to the continual activity which would be a major intrusion into their affairs and normal rural production including stock mustering may be disrupted over this period. Good planning and on site supervision would be required to minimise the disruption to the land owner.

The major potential environmental impact would be related to the generation of saline water. Across the Bowen Basin water in contact with coal seams and sedimentary rock above the seams has increased levels of salinity. Depending on location, salinity may be in the range 4000 - 10000 ppm. Sulphate ions are a major contributor to the observed salinity and as sulphate levels in natural surface waters are comparatively high, management of saline water would require detailed consideration.

Initially all water generated would need to be stored and the location and capacity of water storages would require detailed planning to ensure that sufficient storage capacity was available and suitably located to accommodate the water expected to be generated. Appropriate testing in the exploration phase of a project should provide information on the quantity and rate of water generation. Testing of the soils and sub-soils in the well field area would be required to ensure that appropriate materials are present for the construction of water storages. Certain subsoils in Central Queensland are sodic, dispersive and prone to piping. These soils may not be suitable for water storage construction unless appropriate construction techniques are employed.

As saline water would be continually generated, disposal of the contained water should be considered. The experience of the North American coalbed methane industry should be noted. However there are significant differences in operating conditions between North America and Central Queensland. In particular, North American mining legislation specifically prevents the storage of water on mine sites. There is no similar proscription in Queensland. Available information suggests that volumes and flow rates of water in the aquifers associated with coal seams in Queensland are lower than those in North America. The disposal method chosen would need to take Central Queensland conditions into account. Options available for disposal include the following:-

Discharge into Watercourses

As noted previously continuous direct discharge of water into local watercourses would be unacceptable. Depending on the location of the water storage in relation to local watercourses and their stream flows, discharge of water under particular circumstances may be permitted. For example discharge of water may be linked to the flow conditions in a particular watercourse. In that situation, when the flow conditions are sufficient to achieve acceptable dilution the discharge of a predefined quantity of water of a certain quality may be permitted.

While this may be theoretically possible, in practice it would be difficult to achieve. At best, discharge could only be regarded as a secondary water disposal option which could be exercised on occasions when conditions were favourable. This may arise when high stream flows coincided with periods when contained water had low to moderate salinity levels.

As good stream flows in all Central Queensland watercourses are infrequent events, it would be difficult to design a discharge system which would have any reasonable probability that discharges would actually be permitted. Extended dry periods are frequent events and during such periods evaporation would increase the salinity of any contained water. Any increase in salinity would in turn mean that higher stream flows would be required for discharge to be permitted. The higher the stream flow, the longer the return period for that stream flow and therefore the lower the probability that legal discharges could occur.

In summary direct uncontrolled discharge of saline water would not be permitted, but discharge of water may be permitted under certain situations. Legal discharges would be expected to be infrequent.

Reverse Osmosis and Injection of Waste Water into Aquifers

These methods are capital intensive and operating costs are also high and therefore these methods should be considered only in situations where other disposal options are not practical. The volumes of water generated in methane production in Central Queensland are expected to be comparatively low. Therefore there may not be the need for these or other techniques which have the capability to continuously reduce the volume of contained water. However if large volumes of water require disposal the use of capital intensive disposal options may be unavoidable.

Reverse osmosis has the advantage that the water produced may be directly used but the very saline waste material produced would require special handling and management. There should be no objections to the use of deep well injection techniques to dispose of water as it would involve the placement of saline water in an already saline environment. Should waste water injection into aquifers be required, it may be possible to dispose of water into exhausted wells by pumping through existing pipelines.

Evaporation

Provided the cost of land and the volumes of water for disposal are not excessive, evaporation should be the most cost effective disposal option for water disposal. In Central Queensland evaporation rates are approximately three times the rainfall rate and therefore there is considerable potential for disposal of water.

The use of the technique would involve an examination of the soils to ensure that a stable turkey's nest structure can be constructed, an analysis of the likely rate of waste water generation and an assessment of the impact on the environment of the release of any saline waters. The capacity of water storages would depend upon the operating design standard which in turn should be dependant upon the level of acceptable risk of failure or of overtopping of the containment structure. If the area is particularly sensitive to any salt water pollution a high standard may be required. However it would be more likely that diluted waste water would have little environmental impact. Therefore for each storage the general design parameters should be determined. As the bulk of the waste water is generated in the first two years of production for each well, that two year period represents the period of highest environmental risk. In situations where loss of diluted saline water may have little or no environmental impact, it may be an acceptable risk to have storages which may overtop with events with a relatively high return frequency, for example, one in five years. In other areas storages may need to be designed to retain all water from rainfall events with longer return periods. Actual performance criteria for waste water storages would need to be determined on a case by case basis.

The commissioning time may also influence design capacity. Over the period from April to November, approximately one to two metres of evaporation may occur with a relatively low probability of rainfall. Thus capacity for water storage for a well commissioned in April may be considerably smaller than for a well commissioned immediately prior to the commencement of the wet season.

A relatively simple water balance model could be developed for an area and from the model the capacity of water storages could be determined. The model could also be used to assess the likely environmental performance of an evaporation pond system.

In constructing water storages, consideration needs to be given to their eventual decommissioning. Topsoil from the storage area should be collected and either stockpiled or spread on to the land surface for later use. Some topsoil could be used in the storage construction, for example on the walls to reduce the need for maintenance.

Other Possible Disposal Methods

Local Authorities are continually seeking water to use for road construction. As the development of a well field would generate traffic which in turn would lead to increased road maintenance, the opportunities should arise for the disposal of some water.

Trees utilise considerable quantities of water through transpiration. It may be possible to propagate suitable species of salt tolerant trees. For example, River Red Gums, (Eucalyptus camaldulensis) occur in the Dawson and Fitzroy River systems and salt tolerant provinces of the species occur on the Murray River. It would be necessary to ensure that the root system of any vegetation did not adversely affect the dam structure and if this technique was to be tested, islands may need to be created within the evaporation pond. While use of trees to dispose of water has undoubted potential, the question of the loss of surface area for evaporation needs to be considered against the transpiration capacity of the vegetation. As trees would take several years to reach maturity and achieve their full potential in water disposal, the use of trees should only be considered in situations where centralised storages with comparatively long lives would be created.

In the development phase, clarified water is required for gas production and it is understood that clarified saline water may be used. Major causes of turbidity in water are related to the chemical properties of the water and the presence of dissolved salts in water is usually related to lower turbidity. In fresh water storages, suspended solids, very fine and colloidal material, transported to the storage by surface water run off are the major cause of turbidity. As water velocity falls when the water enters a storage, the suspended solids levels also fall and with reasonable retention times, most fine and colloidal material are precipitated on the floor of the storage. Mobilisation of the precipitated fines is usually associated with the gentle wave action which occurs at the edges of the water storage.

Mount Isa Mines Limited have developed a natural water treatment system for the supply of domestic water based on the prevention of wave action at the edges of the water storage. Essentially the treatment involves the retention of water in a storage where the water level within the storage is kept at a set design level. Because water level remains constant, healthy vegetation at the waters edge can be maintained and the presence of the vegetation can substantially reduce wave action.

The application of this system may have potential within the coalbed methane industry to utilise waste water for gas production. Whether or not the technique could be used would depend upon timing and logistics as establishment of the pond and the required vegetation would take time.

Operational Phase

If the development of the well field has been planned and the appropriate measures taken to minimise environmental impacts, environmental management over the operational phase should be relatively straight forward. Routine monitoring of the operation would be required to ensure that water and gas lines were in good order.

Only minimal disruption to the land holder would be expected and the land holder's main concern may relate to the total land temporarily taken out of production.

Depending on conditions it is likely that after approximately five years the capacity of the water storages would greatly exceed the actual requirements and the opportunity may arise for decommissioning certain storages. If the land holder wants the water storage retained, salt contaminated soil from the storage would need to be collected and disposed of accordance with the requirements of the local authority. If the dam is to be removed it may be possible to bury the salt contaminated soil as part of the rehabilitation process. To ensure that the land can be returned to useful production, topsoil would need to be applied to the recontoured land. Preferably the topsoil which was originally on the site should be used.

STRATEGY FOR PROJECT DEVELOPMENT

Mount Isa Mines Limited has commenced an extensive exploration and associated programme aimed at the development of coalbed methane resources. That Company recognised the importance of relations with land holders and considerable efforts have been made to establish good relations with land owners and occupiers.

To date the effort put into land holder liaison has had considerable benefits to the Company. Part of the approach has been to use the same personnel for all permitting. As a result relevant information on the individual land owners and their properties becomes known to the Company. As the exploration programme has developed, this information has assisted the exploration personnel through advice on potential problem areas and related matters and assisted in minimising impacts on the land and land holders. All drill holes have been located to avoid sensitive areas including cultivation and water courses and in instances where land owner assistance may be required, for example, in the location of explosives magazines, suitable sites have been identified.

From the land holder's perspective, the local population know those personnel and any problems which arise during operations are referred to those personnel for remedial action.

Should development of a well field occur, the point of contact with the Company for the land holder would be essential. In particular, even with complete and comprehensive planning some problems are bound to occur and in those situations if the relationship with the land holder are good there is a better probability that after the problems are resolved, relations with the land holder could be restored.