HAZARD AND RISK 26

26.1 INTRODUCTION

The management of risk is an integral part of the proposed expansion at Olympic Dam. BHP Billiton has detailed internal requirements for assessing and managing risk for all stages of the project and the EIS process is only one part of the broader project development process. Subsequent phases include feasibility studies, detailed design, construction and operation with risk assessments conducted at each stage. The risk assessments, conducted to date and reported in the Draft EIS, should be seen within this broader perspective. Further risk assessment work would be undertaken at later stages of the project in relation to decommissioning and closure.

The preceding Draft EIS chapters have assessed the impact of known and identified issues. The risk assessment, on the other hand, has considered unplanned events or conditions and then made a judgement on the magnitude of the potential consequences and the chance (or frequency) that the events or conditions might occur. This is a standard approach and provides a good assessment of the 'size' of each risk so that risks can be ranked against each other and also against a pre-determined set of criteria.

The EIS risk assessment process has considered a large number of project components, some of which are now no longer part of the final project scope or have been modified considerably as a result of impact and risk assessment findings (see Chapter 1, Introduction, Section 1.6.2 and Figure 1.11 for details of this iterative process). However, the risk assessments for those components remain within the body of work and highlight the completeness of the process undertaken.

The risk assessment work described in this chapter is largely based on a semi-quantitative approach, which involves assessing risks from a non numeric perspective or through informed discussion. The approach depends upon the knowledge and experience of participants and is typically quite conservative. A quantitative risk assessment (based on historical statistical analysis) has been undertaken for particular transport risks and is addressed in Chapter 22, Health and Safety.

The risk assessments focused entirely on the health, safety, societal and environmental risks, excluding an evaluation of financial risk and exposure of BHP Billiton.

Using recognised standards, risks have been defined as tolerable and intolerable. Intolerable risks require mandatory mitigation or control within the Draft EIS process, while tolerable risks are those that require further mitigation and control through the BHP Billiton management systems.

This chapter describes the risk assessment process and main outcomes. Key project risks are also identified.

26.2 ASSESSMENT METHODS

26.2.1 OVERVIEW

The basis of the risk assessment work was a series of risk workshops that were facilitated by a consultant from Arup Pty Ltd (Arup) who has more than 20 years' experience in risk management. Using a single facilitator provided a high degree of consistency across all of the workshops. Twenty-two risk workshops were conducted over a period of approximately two years and resulted in 4,967 risk events and risk situations being identified and ranked (see Appendix C for a summary of the process and Olympic Dam Development Risk Assessment – Arup 2008 (Arup 2008) for details).

At the completion of the risk workshops, a cross check was undertaken to ensure that the risk events associated with the impact assessments had been considered. The aim was to ensure that unplanned events that could influence the level or security of the predicted residual impacts had been covered in the main risk workshops.

While all risks have been captured within the broader Olympic Dam Expansion Project Risk Register, the list of potential risks was summarised and prioritised to provide a list of the key project risks. Control and management measures for these risks were then captured within the Environmental Management Programs (EM Programs).

The main aims of the risk assessment work were as follows:

- Identification of intolerable risks – Wherever the base risk level of an event or condition was assessed as intolerable, additional mitigation or control measures were required. This process continued until the residual risk was reduced to a level that was acceptable.
- Development of a consolidated project risk register – Tolerable risks were transferred to the risk register, to be followed-up during the subsequent project development phase.
- Identification of key project risks - Prioritised key project risks required further attention with the aim of reducing the level of risk in accordance with the principle 'as low as reasonably practicable' (ALARP). Controls for these risk items are included in the individual EM Programs.

26.2.2 DEVELOPMENT OF RISK ASSESSMENT TOOLS

The most important tools for a risk assessment are reference tables that provide a consistent platform for establishing the frequency and consequence of each unplanned event or situation.

Risk criteria reference tables were developed for frequency and consequence based on information from various key standards and specifications and taking into account recognised protocols. The tables were developed following an extensive literature review of the applicable standards and specifications, as listed below:

- HB 141:2004 – Risk Financing Guidelines
- HB 436:2004 – Risk Management Guideline – Companion to AS/NZS 4360:2004
- HB 240:2004 – Guideline to Managing Risk in Outsourcing
- HB 203:2006 – Environmental Risk Management – Principles and Process
- HB 105:1998 Risk Management – Companion to AS 2885 Pipelines – Gas and Liquid Petroleum
- Victoria Work cover Guidance Note 14 – Major Facilities Regulations – Safety Assessment
- HAZPAK – A Practical Guide to Risk Assessment
- Practical Application of Environmental Risk Management of the Gorgon Project
- The National Minerals Industry Safety and Health Risk Assessment Guideline (Joy and Griffiths 2007)
- Australian Standard AS 2885 – Pipelines – Gas and Liquid Petroleum
- The BHP Billiton proprietary risk management standard
- Hazardous Industry Planning Advisory Paper No 4
- Guidelines for Design and Maintenance of Overhead Distribution and Transmission Lines (1999) (HB C(b)1 Technical Guideline of the Electricity Supply Association of Australia ESAA)
- Hazard Identification and Analysis/Qualitative Risk Assessment Approach (BHP Billiton, HSEC toolkit No T05, Revision 2.0 2003).

Regular risk assessment does not usually take into account the effects of multiple risk events on the same receptor. For example, there may be a number of risks that a construction worker could be exposed to, and these are usually considered in isolation. However, the actual risk is a combination of the risks from all of the independent events.

To make allowance for this in the EIS risk assessment, a level of conservatism was designed into the assessment process, through the risk matrix, which rated individual risks higher than would normally be the case. This conservatively took into account the effects of multiple risks.

An additional consideration was the potential synergistic effects of multiple risk events, where the combined risk of two or more independent events may be more than the sum of the individual risks. These situations are difficult to predict, however, the interactive nature of the risk workshops encouraged discussion on such situations and where identified, risks were ranked appropriately. The conservatism built into the process for multiple risk events also provided another level of assurance.

Frequency table

For the purposes of the Draft EIS, 'frequency' is defined as how often an event is likely to occur. The frequency table provided in Table 26.1 describes six frequency levels, which are ranked according to the estimated incidence rate (number per unit time). The table also describes the probability (i.e. per cent), and the regularity of an event occurring.

Several documents were researched for the preparation of the frequency table, including standard specifications and industry-wide accepted criteria. The following six criteria were used to define the frequency of an event occurring:

- expected to happen – describes an event (or a series of events) that may occur many times during the project (a frequency of more than once per month)
- almost certain – describes an event (or series of events) that is (are) expected to occur in most circumstances (a frequency of once per year)
- likely – describes an event (or events) that will probably occur in most circumstances (a frequency of once every 10 years)
- possible – describes an event (or series of events) that might occur (a frequency of once every 100 years)

Table 26.1 Frequency reference table

Descriptor	Level	General description[1]	Chance per annum[2]	Project basis (construction phase[3])	Frequency[4]	
Expected to Happen	A	This event will occur – known to always occur in similar situations – Expected to occur several (many) times each year	99.9%	Many times during project	1/month	More than 10 times per annum
Almost certain	B	This event is expected to occur in most circumstances – Expected to occur at least once each year	>90%	At least once during project	1/year	One or more times per annum
Likely	C	This event may occur in some circumstances – May occur during any given year	10%	At least once in every 10 projects	1/10 years	Once every 2 to 10 years
Possible	D	This event might occur at some time – Not likely to occur in any given year, but is possible	1%	At least once in every 100 projects	1/100 years	Once every 11 to 100 years
Unlikely	E	This event could occur at some time – Very unlikely to occur in any given year	0.10%	At least once in every 1,000 projects	1/1,000 years	Once every 101 to 1,000 years
Rare	F	This event may only occur in very exceptional circumstances – Examples of this have occurred historically, but is not anticipated	<0.1%	At least once in every 10,000 projects	<1/1,000 years	Less than once every 1,000 years

[1] The intention is to describe the probability or frequency of an event on an annualised basis such that the impacts or exposure (risks) faced by society and the environment are recorded as those present during any given year of the life-of-mine, including the construction phase.
[2] The probability of an occurrence in any given year either during the construction or operation phase as appropriate.
[3] Relates to the number of occurrences during the construction phase.
[4] The frequency of an occurrence (or return period when considering natural events) during either the construction or operation phase as appropriate.

- unlikely – describes an event (or events) that could occur at some time (a frequency of once every 1,000 years)
- rare – describes an event (or series of events) that may only occur in exceptional circumstances (a frequency of less than one every 10,000 years).

Consequence table

For the purposes of the Draft EIS, 'consequence' is defined as the magnitude of an event that could occur as a result of a failure. An event may have multiple consequences, which would affect different receptors. Accordingly, the information used to prepare the consequence table considered the following:

- various standards and qualifications
- relevant environmental impact statements and public consultation
- specialist and expert judgement.

Given the complex nature of the project, it was decided that the risk assessment would be conducted for each of the following consequence factors:

- occupational health and safety
- social factors and cultural heritage
- flora and fauna
- soil and land
- water quality
- air quality.

The consequence table is presented in Table 26.2, and provides a qualitative description of the magnitude of a potential event affecting each of the elements.

The six categories of consequences were ranked as follows:

- minimal – denoting an insignificant or trivial effect as a result of an event occurring
- minor – denoting small effects following the occurrence of an event or series of events
- moderate – defined as a noticeable event or a series of events that can still be rectified in the long term
- serious – denoting a severe event or series of events that would lead to fatalities, irreversible disabilities and/or events with wide-spread distribution
- major – describing key events leading to fatalities, breakdown of social order, loss of abundance and/or loss of species, and widespread contamination resulting in the reduction of air and water qualities
- catastrophic – describing disastrous events that would lead to multiple fatalities, complete breakdown of social order, local extinction of population and widespread contamination that cannot be immediately remediated.

Category	Health and safety		Social/cultural heritage	Flora and fauna				Soil and land			Water quality	Air quality
				Listed flora and fauna		General flora and fauna						
	Injury and/or fatality	Radiation exposure		Effect on fauna behaviour	Effect on listed species viability	Effect on fauna behaviour	Effect on community	Contamination	Recharge	Habitat	Groundwater, surface water and marine water	
Minimal	No injury to the public Minor operator injuries requiring on-site treatment with immediate release		No impact or minor medium-term social impacts on local population Mostly reparable	Insignificant effect	Insignificant effect	Local short-term behavioural effect	Local short-term decrease in abundance of some species without reduction in local community viability	Insignificant effect	Insignificant effect	Insignificant effect	Minimal contamination or change with no significant loss of quality	Insignificant effect
Minor	Moderate level of injuries to the public requiring off-site (doctor) medical treatment Injuries to one or more operators requiring off-site medical attention including moderate reversible disability	Radiation worker >10 mSv / year but <20 mSv in 5 year period	Ongoing social issues Damage to items of cultural significance	Local short-term behavioural effect	Local short-term decrease in abundance with no lasting effects on local population	Local long-term behavioural effect that does not unduly affect the ecology of the species	Local long-term decrease in abundance of some species resulting in little or no change to community structure	Local contamination that can be immediately remediated	Local minor change in recharge patterns within sub-catchments	Disturbance of well-represented landform habitats	Local minor short-term reduction or change in water quality Local contamination or change that can be immediately remediated	Local short-term and minor exceedance of air quality standard
Moderate	Significant level of injuries to the public requiring hospitalisation Moderate irreversible disability or moderate impairment to one or more operators	Public / other >1 mSv / year but <5 mSv in 5 year period Radiation worker >20 mSv / year but <100 mSv in 5 year period	On going serious social issues Significant damage to structures / items of cultural significance	Local long-term behavioural effect that does not unduly affect the ecology of the species	Local long-term decrease in abundance without reduction in local population viability	Local long-term behavioural effect that significantly affects the ecology of the species	Regional long-term decrease in abundance of some species and/or local loss of some species resulting in some change to the community structure	Local contamination that can be remediated in the long term	Local major change in recharge patterns within sub-catchments	Local loss of well represented landform habitats	Local minor long-term or widespread minor short-term, or local major short-term reduction or change in water quality Local contamination or change that can be remediated in the long term	Local minor long-term or widespread minor short-term, or local major short-term exceedance of air quality standard
Serious	Irreversible disability or impairment or serious injuries requiring long-term hospitalisation to one or more members of public Single operator fatality or multiple serious injuries	Public / other >5 mSv in 5 year period Radiation worker >100 mSv in 5 year period	Very serious widespread social impacts Irreparable damage to highly valued items	Local long-term behavioural effect that significantly affects the ecology of the species	Regional long-term decrease in abundance and/or local loss resulting in some reduction in regional population viability		Regional long-term decrease in abundance of numerous species and/or some loss of species diversity resulting in significant changes to community structure	Local contamination that cannot be remediated in the long term	Widespread major changes in recharge patterns within sub-catchments	Local loss of a unique landform habitat	Widespread (regional) major short-term reduction or change in water quality Local contamination or change that cannot be remediated in the long term	Widespread (regional) major short-term exceedance of air quality standard
Major	Single fatality of a member of public Several operator fatalities		Breakdown of social order Irreparable damage to highly valued items of cultural significance		Regional long-term decrease in abundance and/or local loss resulting in significant reduction in regional viabiility of the species		Regional long-term loss of numerous species resulting in the dominance of only a few species	Widespread contamination that can be remediated in the long term	Regional minor changes in recharge patterns		Regional long-term reduction or change in water quality Widespread contamination or change that can be remediated in the long term	Regional long-term exceedance of air quality standard
Catastrophic	Several fatalities of members of public Multiple operator fatalities		Complete breakdown of social order Irreparable damage to highly valued items of great cultural significance		Regional extinction of the species			Widespread contamination that cannot be immediately remediated	Regional major changes in recharge patterns		Widespread contamination or change that cannot be immediately remediated	

Table 26.2 Consequences look-up table

Risk matrix

Based on the frequency and consequence ratings assigned to each hazard item, a risk level was assigned using the risk matrix, as shown in Table 26.3. The risk matrix indicates the risk level attributed to any combination of frequency and consequence.

26.2.3 PROJECT COMPONENTS ASSESSED

To ensure that all aspects of the project were assessed, the risk assessment workshops for the proposed expansion were divided into project component areas, namely:

- transport
- water supply
- contractor village
- construction phase
- rehabilitation and decommissioning
- township construction
- concentrator, tailings and refining
- smelting and refining
- hydrometallurgy
- energy
- mining
- landing facility
- concentrate transport
- sulphur handling.

Where necessary, more specific risk workshops were held under the broader project component headings listed above.

26.2.4 WORKSHOP STRUCTURE AND RESULTING RISK REGISTERS

Workshop participants included experts in risk assessment, rail, transport, logistics, radiation, health, safety, ecology, water treatment, infrastructure, design, construction and social planning. The workshops also included specialists in mining, extractive metallurgy and mineral processing.

The focus of the workshops was to identify and quantify the risk events that have an impact on a receptor and the workshop participants were encouraged to apply 'free thinking' to test the credibility of a potential threat or a consequence.

Aspects considered within the hazard identification stage included:

- potential hazard sources
- sporadic emissions and the risks they posed to health, society and environment
- major accidents related to fixed installations and storage facilities
- transporting goods, including dangerous goods
- wastes and associated technology.

The workshop discussion aimed to establish a base risk profile for each subject area in the Draft EIS, including:

- type of hazard
- fault or failure mechanism in relation to each identified hazard
- risk event, impact or consequence triggered by the failure
- risk level.

Limitations were established for each subject area during each workshop. For example, in the transport workshop, it was necessary to delineate where BHP Billiton's ownership in the logistics chain began and ended.

The risk workshops resulted in the development of registers. The registers include lists of potential hazardous events or situations and an assessment of the relative risk associated with that event or situation. The decisions taken by the workshop participants were recorded in real time with the use of a computer and data projector, which enabled the participants to correct and confirm the interpretation and recording at the workshop. The existing mitigation or control measures were also considered during the workshops and these included:

- standard procedures and management systems mandated by BHP Billiton (and other relevant parties)
- known contracting procedures
- known or expected design criteria
- any other actions that are planned to be included in the delivery of the project.

Table 26.3 Risk matrix

			Consequences					
			1	2	3	4	5	6
			Minimal	Minor	Moderate	Serious	Major	Catastrophic
Frequency	A	10/yr	H	E	E	E	E	E
	B	1/yr	H	H	E	E	E	E
	C	1/10yrs	M	H	E	E	E	E
	D	1/100yrs	L	M	H	E	E	E
	E	1/1000yrs	L	L	M	H	E	E
	F	>1/1000yrs	L	L	L	M	H	E

E = extreme H = high M = moderate L = low

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Where necessary, or where there was an opportunity to reduce the risk, additional mitigation measures were discussed and included on the risk register.

Given the nature of the process, there was much repetition of particular risk events or risk situations and, for practical purposes, a consolidated risk register was developed. For example, the risk of soil contamination from an accidental spill was identified in a number of the workshops. In the cases of repetition, a single entry was placed in the consolidated risk register to represent all the occurrences. Where the level of risk varied between risk workshops, the highest (or worst case) level of risk was transferred to the risk register. Attention was paid to ensuring that no loss in causal factors occurred.

26.3 RISK ASSESSMENT OUTCOMES AND MANAGEMENT

26.3.1 RISK ASSESSMENT SUMMARY

There were 22 workshops conducted over a two-year period, resulting in the assessment of 4,967 risk events or risk situations. Of these, there were:

- 40 'extreme' risks
- 872 'high' risks
- 1,340 'medium' risks
- 2,715 'low' risks.

Almost half of the risks identified were associated with occupational health and safety and social issues. Public safety issues were addressed under these headings.

Extreme risks were defined as 'intolerable' and required mandatory mitigation or control within the Draft EIS process. High, medium and low risks were defined as 'tolerable' in accordance with Australian risk standards and require further mitigation and control through the BHP Billiton management systems. All risks have been transferred to the Olympic Dam Expansion Project Risk Register.

In the governments' EIS guidelines, specific risk events and situations were outlined. Each of these risks has been formally assessed, although many of them do not rank high in the process (e.g. earthquakes and unplanned explosions). Those that do are identified in the key risk tables presented in this chapter.

26.3.2 EXTREME RISKS

Of the total risk events or situations assessed, 40 were rated as extreme. Each of these was subsequently reviewed with BHP Billiton personnel, and eleven design changes were made or mitigation measures added. When reassessed this resulted in all 40 risks being reduced to a tolerable level (i.e. a high risk or lower). Even though there were 40 items recorded, the repetitiveness of risks identified across the workshops resulted in only 11 unique extreme events or situations. The mitigation measures were:

- a traffic management plan to ensure that delays to road users is minimised
- level crossings along the rail spur are to be signalised
- the desalination plant intake and outfall pipes are to be buried for their length on land
- the water supply pipeline is not to be located within the Santos facility boundary and the desalination plant outfall pipe is not to be located on the Santos Port Bonython jetty
- in the brownfields expansion work, exclusion zones would need to be established and effective barriers would need to be installed to control risks from work at heights
- the final decommissioning of the metallurgical plant and associated infrastructure is to use rail to transport the material away from Olympic Dam rather than road to minimise truck movements
- improved design is required for the ventilation systems in the expanded smelter
- barriers are to be installed along the tailings cells and balance ponds access roads to prevent vehicles from accidentally leaving the road. Tether points and harnesses are to be provided for use by operators in tailings cells and balance pond areas
- contracts for a third party power plant are to be entered into in time to meet energy demand, otherwise the on-site gas-fired power plant is to be constructed (if not already constructed)
- dust suppression capabilities to be installed on ore conveyor stacker to control dust
- increased surveillance during underwater blasting for desalination plant intake and outfall pipe installations.

The project therefore has no intolerable risks as identified by the risk assessment process.

26.3.3 KEY PROJECT RISKS

The key project risks are those requiring immediate control through management systems. For the purpose of providing a consolidated list of the key environmental and social risks in this chapter, key risks have been defined as those risks or situations that rated 'high' on one or more of the consequences (social, flora, fauna, physical, water and air). All other risks, while not shown in this chapter, are provided in Arup (2008) and have been transferred to the BHP Billiton Olympic Dam Expansion Project Risk Register.

The key environmental and social risks for the Draft EIS as established through the risk assessment process are listed in Table 26.4 and have been incorporated into the EM Programs. By doing so, monitoring programs can be established to assess ongoing performance and help predict whether risk events are becoming more likely. The list of key risks in Table 26.4 also identifies the particular EM Programs that addresses the risk. The EM Programs identification numbers shown relate to the following (see Chapter 24, Environmental Management Framework for a further description of EM Programs):

- ID 1. Use of natural resources
  - ID 1.1 Land disturbance
  - ID 1.2 Marine disturbance
  - ID 1.3 Spread of pest plants and animals
  - ID 1.4 Aquifer level drawdown
- ID 2. Storage, transport and handling of hazardous material
  - ID 2.1 Chemical/hydrocarbon spillage
  - ID 2.2 Radioactive process material spillage
  - ID 2.3 Transport of radioactive material
- ID 3. Operation of industrial systems
  - ID 3.1 Fugitive particulate emissions
  - ID 3.2 Noise emissions
  - ID 3.3 Point-source emissions
  - ID 3.4 Saline aerosol emissions (existing operation only)
  - ID 3.5 Radioactive emissions
  - ID 3.6 Greenhouse gas emissions
- ID 4. Generation of industrial waste
  - ID 4.1 Marine discharge
  - ID 4.2 Containment of tailings and mine rock
  - ID 4.3 Major storage seepage
  - ID 4.4 Stormwater discharge
  - ID 4.5 Fauna interaction with the operation
  - ID 4.6 Waste disposal
  - ID 4.7 Radioactive waste
- ID 5. Employment and accommodation of people
  - ID 5.1 Community interactions
  - ID 5.2 Workplace interactions.

A separate process was undertaken to identify the key project occupational health and safety risks from the risk assessment. This involved reviewing the consolidated risk registers for health and safety and identifying those that were new to Olympic Dam or had been assessed as having a high consequence (e.g. serious injury or fatality).

The health and safety risks would be managed and controlled under the existing BHP Billiton Fatal Risk Control Protocols. BHP Billiton has also undertaken an additional independent safety risk review based on Major Hazard Accident Events.

The key health and safety-related risks identified in the Draft EIS risk assessment process are listed in Table 26.5.

26.3.4 ECONOMIC IMPACT OF MAJOR HAZARDS

BHP Billiton's risk assessment and assurance function oversees the business and financial risks associated with major hazards, and facilitates insurance to mitigate the impacts of such hazards.

The potential costs of major hazards, such as major natural catastrophes, business disruptions or major incidents, associated with operations at Olympic Dam or off-site infrastructure, could be significant to BHP Billiton or one or more affected parties. In some cases these costs may exceed US$1 billion. To provide assurance for all potentially affected parties (e.g. shareholders, governments, employees and other businesses) BHP Billiton has insurance arrangements in place to meet external liabilities borne by third parties.

The potential cost of specific events is subject to many variables that are assessed for each of BHP Billiton's operational assets. A qualified Loss Control Engineer visits each operation to understand the potential hazards, their potential consequences and the residual risks from control measures.

An assessment of financial risk of major hazards was undertaken by:

- establishing a list of major project hazards that could have an economic impact to a third party
- establishing a consequence ranking for third-party economic impact (where low = <$10m; moderate = $10m to $100m; high = >$100m)
- utilising the frequency look-up table (see Table 26.1)
- assessing each major project hazard against consequence and frequency to determine a risk level.

The assessment identified 27 risk events or risk situations that could have a significant economic impact to a third party. Of these, there were:

- no 'extreme' risks
- five 'high' risks
- six 'medium' risks
- 16 'low' risks.

The risks that rated as 'high' are discussed below. All other economic risks have been transferred to the BHP Billiton Olympic Dam Expansion Project Risk Register.

The grounding or loss of a sea going vessel in a shipping channel

The grounding or loss of a sea going vessel in a shipping channel could lead to delays or restrictions in third-party shipping through loss of access. The risk assessment established that the likelihood of a such an event is low, however, blocking a shipping channel could have significant financial implications to other users.

Excessive energy demands

If operational power demands temporarily exceed predicted demand then market conditions would dictate the price of electricity. This may lead to elevated prices in parts of the energy supply network. This is considered to be a low likelihood event.

Excessive labour demands

The demand for labour during the construction of the proposed expansion is expected to be high, although training and development programs would reduce the impact (see Chapter 19, Social Environment). A potential risk, considered to be of a low likelihood, is that labour requirements exceed predicted levels, which would increase the labour drawdown from the region and lead to reductions in the supply of services for other users. However, it is anticipated that supply would ultimately respond to demand.

Impacts on gas supply

An incident on the proposed Olympic Dam gas supply pipeline could impact the Moomba to Adelaide gas pipeline, leading to disruptions and impacts on third party users in the state. The proposed Olympic Dam pipeline lies in close proximity to the main pipeline for a limited length, however the likelihood of an incident is considered to be low given the implementation of proposed design and safety measures.

Changing the broader economic situation

While not specifically a hazard, the impact of commencing, but then slowing down or deferring the Olympic Dam expansion, could have broad financial impacts for third parties. Although the likelihood is low, the possible economic flow-on effects to third parties could be significant. The changing global economic situation is beyond the control of BHP Billiton.

Other hazards identified in the economic risk assessment but ranked as either a low or moderate event include; the potential impact of the desalination plant on the aquaculture and fisheries industries; third party economic impacts from an adverse effect on the environment as a result of a product spill (via a train derailment or sinking of sea going vessel); temporary loss of employment for some of the workforce and demand for third party support services as a result of an operational failure at Olympic Dam; inappropriate ballast water management; and transport disruptions affecting the delivery of goods or services.

26.4 CONCLUSION

The risk assessment workshops aimed to identify the hazards that could occur during the construction, operation and decommissioning phases of the proposed expansion, the faults or failures that would result in an event, and determine the likelihood and consequence of these events. This information was used to determine the level of risk.

Registers were completed during each of the risk workshops, to record the potential frequency and consequence of the risk event against relevant published criteria adopted for the EIS.

A total of 4,967 hazards were identified in the workshops, including those that were considered not to be credible. The key environmental and health and safety risks have been consolidated into the lists provided in Table 26.4 and Table 26.5. Economic risks as a result of a major hazard have also been identified and discussed in Section 26.3.4. All risks that were categorised as extreme have been subsequently reduced through design modification or the adoption of specific mitigations measures. The resulting key project risks will be monitored through the Olympic Dam Environmental Management Program (see Chapter 24, Environmental Management Framework) or the BHP Billiton Olympic Dam Expansion Project Risk Register.

Table 26.4 Key environment and community project risks

Topic	Residual impact from chapter	Project component	Event	Cause	Relevant EMP ID
Air quality	Predicted ground level dust concentrations	Mine and RSF	Excessive dust from routine mining blasting operations	Failure of dust control mechanisms	3.1
				Inappropriate blast design	3.1
			Excessive dust generation from ore stockpile	Ore from mine is too dry, resulting in dusting	3.1
			Excessive dust from crushing operations	Failure of ventilation systems and dust control system	3.1
			Excessive dust from operations on RSF	Failure of dust control mechanisms	3.1
		Port of Darwin	Spillage during movement of material to and from stockpile at Darwin	Failure of conveyor system and/or product enclosure system	2.3
		Metallurgical plant	Excessive exhaust dust from uranium calcination and packing	Failure of off-gas cleaning equipment	3.3
			Excessive dust from ore handling and ore processing operation	Failure of ventilation systems and dust control system	3.1, 3.3
			Release of concentrate in the feed preparation area of the smelter	Failure of the concentrate pneumatic system	3.3
		Roxby Downs	Excessive dust from mining operations	Change in meteorological conditions, including wind or inaccurate modelling	3.1
Air quality	Predicted ground level concentrations of other airborne emissions	CCGT power station	Emissions exceeding expectations	Failure of emission control systems	3.3
		Desalination plant	Routine operation of sludge and evaporation basins	Development of anaerobic conditions	3.3
		Refinery	Emissions of gases and dusts from refinery slimes treatment	Operator error or failure of ventilation system	3.3
			Emissions of dust from uranium calciner	Failure of dust cleaning and control systems	3.3
		Smelting	High concentration SO_2 gas emission	Leak or failure in gas handling system	3.3
			Uncontrolled release from smelter dust recycle system	Failure of control systems	3.1
			Uncontrolled release of dust and gases from anode furnace and slag furnace	Failure of gas control system	3.1, 3.3
Groundwater	Contamination from ponds and lagoons	Desalination plant	Routine operation of sludge/ evaporation basins	Seepage	4.3
	Potential impacts to third parties	Groundwater extraction	Excessive drawdown of potentiometric heads	Actual drawdown differs from results of modelling	1.4
				Inter-aquifer contamination (change of pressure between aquifers and water flows in different directions)	1.4
	Seepage to groundwater from the TSF and/ or RSF	Tailings storage facility	Decrease in vertical permeabiity of Arcoona quartzite increases lateral flow	Chemical reaction from seepage changes hydro-geological characteristics of shallow aquifer	4.3
			Increased lateral penetrability through Andamooka limestone	Chemical reaction from seepage changes hydro-geological characteristics	4.3
			Increased seepage from balancing pond	Failure of the base system	4.3
			Acid seepage through base of tailings	Failure to neutralise the seepage water through the ground	4.3
			Increased seepage from TSF	Excessively high rainfall leading to failure to manage water balance	4.3
			Seepage from existing evaporation ponds	Excessively high rainfall leading to failure to manage water balance	4.3
			Uncontrolled release from TSF, balancing ponds or existing evaporation ponds	Failure of containment system and/or liquor transfer pipelines	4.3

Table 26.4 Key environment and community project risks (cont'd)

Topic	Residual impact from chapter	Project component	Event	Cause	Relevant EMP ID
	Changes to groundwater levels	Saline aquifer	Excessive drawdown of potentiometric heads	Incorrect modelling of the impact of drawing water from aquifer	1.4
	Changes to groundwater levels	Mine and RSF	Routine mining operations	Pit cuts aquifer (drawdown aquifer)	1.4
Marine environment	Inadequate dispersion of the return water and predicted maximum salinity exceeded	Desalination plant	Return water discharge does not meet parameters derived from modelling	Actual dilution outcomes differ from modelling results	4.1
			Increase in salinity levels in shallow water	Significant failure of pipe near water line (in shallow water)	4.1
	Effects on marine ecology from construction activities	Desalination plant	Spill of fuel or chemicals into Spencer Gulf	Equipment failure and operator error	2.1
			Chemical and/or fuel spillage on-site	Lack of care during plant removal phase or loss of containment	2.1
	Stratification and deoxygenation	Desalination plant	Excessive silt plume during construction of inlet and discharge pipes	Actual silt behaviour differs from modelling results or excessive sediment generation	1.2, 4.1
Social	Social character and well-being	Road transport	Delays to public road users on public highway	Transport of over dimension loads along public highway	5.1
		Landing facility and access road	Concern by local residents	Construction noise exceeds expected levels	5.1
		Roxby Downs and Hiltaba Village	Public concern	Expansion of town and new construction village	5.1
Soil	Soil contamination	Metallurgical plant	Chemical and/or fuel spillage on-site	Lack of care during plant removal phase or loss of containment	2.1
			Seepage of pregnant liquor from storage ponds	Failure of containment systems	4.3
		Rail transport	Spillage of toxic or flammable materials during rail transport between Port Adelaide and Olympic Dam	Failure of ISO transport containers	2.1
				Excessive impact due to heavy shunting	2.1
			Spillage of sulphur during rail transport between Port Adelaide and Olympic Dam	Bottom dumping wagons fail or leak during transport	2.1
			Commodity loss in rural or agricultural area from rail transport between Olympic Dam and Port Adelaide	Failure of commodity containment systems	2.1
		CCGT power station	Loss of control of inert/ or recyclable waste during decommissioning	Failure of contractor management systems	4.6
		Port of Darwin	Loss of integrity of concentrate storage	Cyclonic rain storm	2.3
		Smelting	Spillage of concentrate in corridor between greenfield and brownfield sites	Failure of material transfer systems (pipes)	2.2
			Spillage of molten sulphur in corridor between greenfield and brownfield sites	Failure of material transfer systems (pipes)	2.1
			Loss of containment of acid between new acid plant and existing facilities	Failure of acid pipelines	2.1
		Wharf activities	Spillage of sulphur	Overfill of rail wagon	2.1
	Fossils	Hiltaba Village	Collecting and fossicking	Inadequate resident awareness and/ or failure to provide adequate alternative recreational activities	5.1

Table 26.4 Key environment and community project risks (cont'd)

Topic	Residual impact from chapter	Project component	Event	Cause	Relevant EMP ID
Surface water Terrestrial ecology	Drainage patterns	TSF	Water infiltration into TSF following decommissioning	Failure to rehabilitate TSF successfully	4.2
		CCGT power station	Unwanted release of wastewater from water treatment facilities during operations	Failure of containment systems	4.6
	Discharge of chemicals	Whole project	Fuel/oil/chemical spills during construction and decommissioning	Loss of containment or operator error	2.1
	Potential ecological effects on groundwater dependent ecosystems	Gas pipeline	Destruction of mound springs and/or surrounding areas	Inadvertent clearing of ground in the area of mound springs	1.1
	Recreational activities around Roxby Downs	Hiltaba Village and Roxby Downs	Indiscriminate off-road driving	Inadequate resident awareness, inadequate education and training of workers, and/or failure to provide adequate alternative activities; failure of management systems	1.1, 5.1
			Collecting and fossicking	Inadequate resident awareness and/ or failure to provide adequate recreational alternatives	5.1
		Linear infrastructure	Indiscriminate off-road driving leading to damage of Aboriginal heritage sites	Inadequate education and training of workers; failure of management systems	1.1, 5.1
	Tailings storage facility and wildlife	TSF	Excessive numbers of wading birds visiting beach and liquor area of TSF	Pond area grows due to imbalance in process or design	4.5
			Large flock of wading birds is affected by TSF liquor	Large flock of wading birds visits liquor ponds	4.5
			Increased visitation by fauna to TSF and balancing pond	Failure to limit fauna access to acidic liquor ponds	4.5
	Threatened ecological communities	All operations	Construction workforce impacts GAB springs	Failure to manage construction workers and camp sites	1.1
	Vertebrate animal species	Hiltaba Village	Inadequate waste management practices	Lack of procedures, lack of proper facilities, lack of waste management initiatives	4.6
	Weeds	Desalination plant	Weed infestation (marine and terrestrial)	Decontamination procedure fails	1.3
		Energy supply; linear infrastructure; Roxby Downs	Weed infestation	Decontamination procedure fails	1.3
Visual amenity	Waste	Roxby Downs	Inadequate waste management practices	Lack of procedures, lack of proper facilities, lack of waste management initiatives	4.6
Environmental and public radiation exposure	Impacts to the public	Roxby Downs	Increased radiation levels in Roxby Downs and environment	Change in meteorological conditions including wind	3.5
			Increased ionising radiation levels in Roxby Downs	Actual dust and radon patterns differ from modelling results leading to increased intensity and area of exposure	3.5

Table 26.5 Key project occupational health and safety risks

Project component	Project phase	Event	Cause
Transport	Operations	Collision between Olympic Dam supply train and member of public	Inadequate warning of oncoming train or inattention
		Release of toxic materials during road or rail transport	Failure of containment systems or vehicle accident
Desalination plant	Operations	Diver or maintenance crew impacted during cleaning and maintenance of intake/outfall structure	Blockage during intake/outfall cleaning process
		Chlorine gas leak	Rupture or equipment failure leading to chlorine gas leak
		Drowning of diver	Diver error or systems failure
Hiltaba Village	Construction	Violent acts in Hiltaba Village and/or Roxby Downs	Anti-social behaviour or pre-meditated behaviour of transient workforce (due to alcohol or drugs)
Whole of project	Construction	Trench collapse during excavation	Inappropriate trench shoring or benching or ineffective construction management controls
		Incidents involving lifting equipment (collapse, overload, contact with overhead services) during greenfield site construction	Not following safe work procedures
		Unauthorised entry by construction workers into operations area	Failure of management and control procedures
		Interaction between construction and operations work areas resulting in such events as falling objects	Construction workers working in vicinity of operations personnel with different safety systems
	All phases	Accidents involving surface mobile equipment (including collisions, run over and rollover)	Increased number of vehicles being used for all phases of the project
		Aircraft accident	Systems failure
	Operations	Vehicle accidents	Increase in number of vehicles for residents and workers in Roxby Downs and/or failure to follow road safety rules
		Hazardous materials interactions	Failure to identify susceptible workers and/or undesired exposure to hazardous substances
		Electrocution	Electrocution due to live wire, operator error or systems failure
Smelter	Operations	Increased fugitive emissions into smelter building	Failure of gas handling systems to control emissions from increased smelter throughput
		Explosion leading to fatality	Hydrocarbon leak in vicinity of oxygen production area
		Asphyxiation	Major leak of nitrogen in confined space in oxygen production area
TRS	Operations	Operator falls into acidic tailings liquor	Failure of barriers and failure of safe work procedures
Mining	Operations	Accidents during open pit blasting	Uncontrolled detonation of a loaded blast pattern, misfire, personnel inside blast perimeter, flyrock beyond safe zone or explosion at batch plant or magazine
		Failure of pit walls	Incorrect design
		Mining vehicle accidents	Failure of traffic management plan
CCGT and gas pipeline	Operations	Gas leak leading to fire or explosion	Gas leak in plant
Concentrate export	Operations	Accident to technicians while monitoring radiation levels of rail trucks	Failure of safety systems and operating procedures
Port of Darwin and Olympic Dam	Operations	Interaction between rail truck and worker during loading or unloading	Operator fails to follow procedure or unauthorised entry
		Concentrate stockpile slumping	Engulfment of personnel or equipment
Shipping	Operations	Ship collision or grounding	Loss of control of vessel or operator error