Appendix 16

Hazard and Risks

South East Open Cut Project

&

Modification to the

Existing ACP Consent

AECOM

Prepared for:

Ashton Coal Operations Pty Ltd

Camberwell, NSW

Ashton Coal Project
Proposed South East Open Cut
Preliminary Hazard Analysis

AECOM

30 July 2009

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Distribution

Ashton Coal Operations Pty Ltd
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EXECUTIVE SUMMARY

Introduction, Objectives & Scope

Ashton Coal Operations Pty Ltd (ACOL) proposes to develop an open cut coal mine known as the South East Open Cut (SEOC), located on the southern side of the New England Highway at Camberwell, NSW. As part of the project development, ACOL are required to conduct an Environmental Assessment (EA), which must address potential hazards at the proposed site, in accordance with the Director General's Requirements (DGRs). ACOL has commissioned AECOM Environmental to conduct a preliminary hazard analysis of the proposed SEOC, the objective of which is to demonstrate that the proposed mine will not adversely affect the surrounding land uses. The scope of work is for the assessment of hazards associated with the SEOC Ashton Coal mine only.

This document addresses the DGRS dot point 5, issued by the NSW Department of Planning in a letter dated 20 May 2009 (Ref. SO3/00074-28).

Methodology

The methodology selected for the study was that recommended by the NSW Department of Planning (DoP) in the Multi Level Risk Assessment – level 2 (Ref.1). The analysis identified the hazards, assessed the hazard consequences and determined whether these would impact beyond the site boundary. Where no impact was identified, no further assessment was conducted. For those incidents identified to have an offsite impact, further risk assessment was conducted and risk reduction measures recommended.

Brief Description of the Proposed Project

The open cut mining operation consists of a number of steps that involve the removal of overburden, the extraction of the coal and the replacement of the overburden and rehabilitation of the mined area. **Table 1** lists the operations that are conducted as part of the open cut mining procedure.

TABLE 1
LIST OF OPERATIONS AT THE PROPOSED SEOC

Operation	Operation
1. Surveying	2. Topsoil Stripping
3.Drill Pad Preparation	4. Drilling
5. Blasting	6. Excavator and truck operations
7. Coal Ripping	8. Coal Mining (excavators/trucks)
10. Coal Preparation Plant	11. Backfill (spoil)
11. Grading	12. Re-Topsoil
13. Re-Vegetation	

In addition to the mine, a pit-top service area will be constructed consisting of a number of buildings and support operations, these include:

- Admin office and bathhouse;
- Crib and muster facilities;
- Workshop and store;
- Fuel farm and compound; and
- Sewage treatment plant and raw water storage.

These facilities are located in a dedicated services area on the south east side of the mine.

Hazard Identification and Consequence Analysis

A detailed hazard identification and analysis was conducted and the following hazards were identified to have a potential to impact offsite. These were carried forward for consequence analysis.

- Front End Loaders(FEL), Dozer, Truck, Mix Truck fuel leak and fire;
- Mix truck fire;
- Explosion on the shotfirers vehicle;
- Premature explosion of the ANFO mix on the mix truck;
- Diesel fuel storage fire
- Lubricating oil storage fire; and
- Magazine explosion.

Acceptable levels of heat radiation from fires and overpressure from explosions were selected from the DoP consequence impact criteria document "Hazardous Industry Planning Advisory Paper No.4, Risk Criteria for Land Use Safety Planning" (Ref.3). This document published the following acceptable impact criteria at the site boundary:

- Heat Radiation – 4.7kW/m^2; and
- Explosion Overpressure – 7kPa.

Where incident impacts do not exceed these criteria, the operation would be classified as acceptable under the provisions of State Environmental Planning Policy No.33, Hazardous and Offensive Developments.

A quantitative consequence analysis was conducted for each of the incidents identified above. The results of the analysis, shown in **Table 2**, determined heat radiation impact and explosion overpressures distance to permissible impact levels as published by the DoP (Ref.3).

TABLE 2
SUMMARY RESULTS OF CONSEQUENCE ANALYSIS

Fire Incident	Heat Radiation Distance to 4.7kW/m^2
FEL, dozer, truck fire	14.2m
Mix truck fire	24.4m
Diesel storage bund fire	31.1m
Lube oil storage bund fire	19.9m
Explosion Incident	**Explosion Overpressure Distance to 7kPa**
Shotfirers vehicle – detonators and cords explosion	44m
Mix truck ANFO explosion	34m
Magazine explosion	119m

A review of the site layout indicates that the mine will be constructed with a 100m buffer zone between the operational area within the pit and the site boundary. The pit-top services area will also be constructed with a buffer zone of 50m (min.) between the fuel/oil storages and the boundary of the services area.

Conclusions & Recommendations

As a result of the analysis conducted in this study, the following conclusions are made :

- The impact of the consequences of all identified hazards in the surface mine and pit top facilities, with the exception of the magazine explosion, do not have the potential to impact offsite due to the application of a 100m buffer zone around the open cut workings and a 50m set back of the fuel/oil storages from the pit-top services facilities from the site boundary.

- In the event the portable explosives magazine was placed on the edge of the 100m buffer zone, and an explosion occurred in the magazine, there would be an offsite overpressure in excess of 7kPa for 20m beyond the site boundary.

Notwithstanding the majority of analysis results indicating no off-site impact, a number of risk reduction recommendations have been made to enhance the hazard mitigation and site emergency response. These are detailed below

Whilst it was identified that the majority of hazardous incidents have no offsite impact, the following recommendations are made in relation to risk reduction to ensure the ALARP (as low as reasonably practicable) principle is applied.

1. It is recommended that the incidents listed in **Appendix A**, and detailed above be included in the site Emergency Response Plan, along with other incidents identified to have onsite impact to mine equipment and personnel.

2. It is recommended that during the regular emergency response drills, conducted as part of the Mine Rescue Team (MRT) exercises, the hazards listed in **Appendix A** be included in the drill exercises to ensure MRT readiness.

3. As the study indicated that fire in vehicles was a potential major hazard on site, and that fire growth has the potential to result in serious damage to vehicles, it is recommended that all vehicles on site be fitted with at least one dry powder type extinguisher. Larger vehicles should carry at least one 9kg dry powder extinguisher and smaller vehicles at least one 4.5kg dry powder extinguisher.

4. It is recommended that portable magazines located in the pit be located no closer than 150m to the site boundary.

5. It was identified that the storage of diesel in quantities exceeding 100,000L will require notification of the diesel storage, and other dangerous goods storages on site, to WorkCover, NSW, in accordance with the Occupational Health and Safety Regulation (Ref.4), Section 6a and Schedule 5. It is recommended that ACOL prepare a dangerous goods notification form, in accordance with the Regulation (Ref.4) and submit the forms to WorkCover NSW.

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ABBREVIATIONS

Abbreviation	Description
ACOL	Ashton Coal Operations Limited
ANFO	Ammonium Nitrate Fuel Oil
AS	Australian Standards
CHPP	Coal Handling and Preparation Plant
DoP	Department of Planning
FEL	Front End Loader
HIPAP	Hazardous Industry Planning Advisory Paper
kg	Kilograms
kg/m^2s	kilograms per metre squared seconds
kg/m^3	kilograms per cubic metre
kPa	kilo Pascals
kV	kilo Volts
kW/m^2	kilo Watts per square metre
L	Litres
m	Metres
m/s^2	metres per second
mm	Millimetres
MRT	Mine Rescue Team
OH&S	Occupational Health and Safety
PHA	Preliminary Hazard Analysis
QRA	Quantitative Risk Assessment
ROM	Run of Mine
SEOC	South East Open Cut
SEP	Surface Emissive Power
SSC	Spread Sheet Calculator
TNT	Tri-Nitro Toluene

1.0 INTRODUCTION

1.1 Background

Ashton Coal Operations Pty Ltd (ACOL) operates an open cut and underground coal mine facility near the village of Camberwell, which is about 14kms north west of Singleton in the Hunter Valley region of NSW. To provide a continuum of open cut operations, ACOL proposes to develop a section of the coal field known as the South East Open Cut (SEOC) coal mine, located about 2.5kms south east of the existing coal preparation plant. To ensure the hazards associated with the proposed mine expansion has been adequately addressed in the proposed design and operational philosophy, ACOL engaged AECOM Environmental to conduct a preliminary hazard analysis of the proposed SEOC.

This document details AECOM's analysis of the hazards associated with the operation of the proposed ACOL SEOC mine.

1.2 Objectives

The objectives of the study are to:

- conduct a PHA of the proposed SEOC Project in accordance with NSW Department of Planning Multi Level Risk Assessment (Ref.1) and Hazardous Industry Planning Advisory paper No.6 (Ref.2); and
- report on the findings of the PHA study.

1.3 Scope of Work

The scope of work was for a PHA of the ACOL Project – SEOC mine. The study scope was for an assessment of the offsite impacts from operations at the proposed SEOC expansion included the following operations:

- open cut operations in the SEOC area; and
- pit top facilities for the administration, maintenance and support of open cut coal mining.

The scope included the assessment of hazardous materials storage and use at the mine sites and the potential for impact on sensitive land uses adjacent to mine property.

2.0 METHODOLOGY

2.1 General Approach

The DoP Multi Level Risk Assessment (Ref.1) approach was used for this study. The approach considered the development in context of its location and its technical and safety management control. The Multi Level Risk Assessment Guidelines are intended to assist industry, consultants and the consent authorities to carry out and evaluate risk assessments at an appropriate level for the facility being studied.

The Multi Level Risk Assessment approach is summarised in **Figure 2.1**. There are three levels of assessment, depending on the outcome of preliminary screening. These are:

- **Level 1 – Qualitative Analysis**, primarily based on the hazard identification techniques and qualitative risk assessment of consequences, frequency and risk;
- **Level 2 – Partially Quantitative Analysis**, using hazard identification and the focused quantification of key potential offsite risks; and
- **Level 3 – Quantitative Risk Analysis (QRA)**, based on the full detailed quantification of risks, consistent with Hazardous Industry Planning Advisory paper No.6 – Guidelines for Hazard Analysis.

Since the facility is a new coal mine located in a rural area and the site operations areas are some considerable distance from residential areas, the most appropriate approach is Level 2 for this analysis.

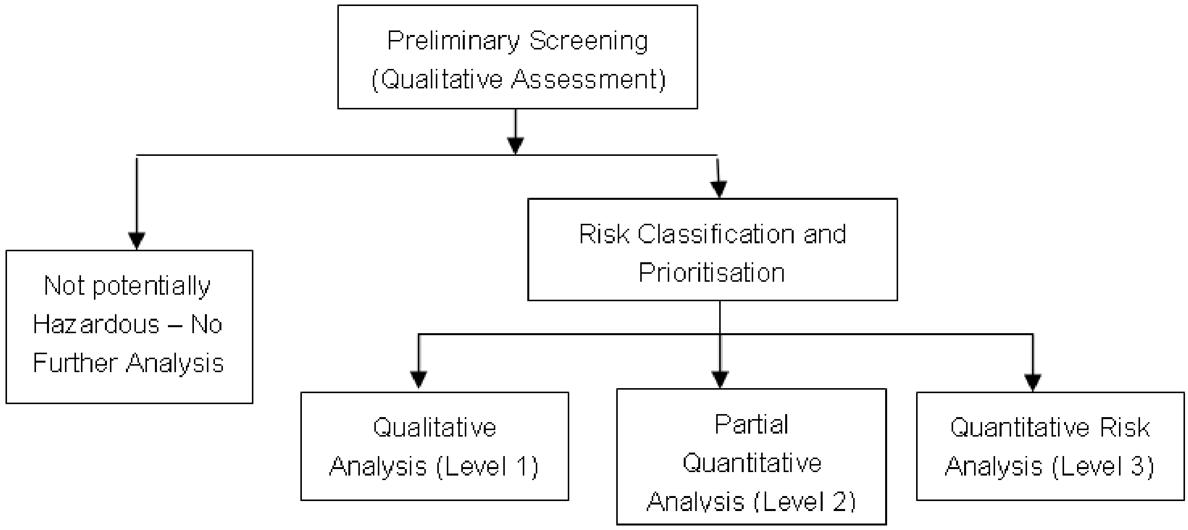

FIGURE 2.1
THE MULTI LEVEL RISK ASSESSMENT APPROACH

2.2 Detailed Approach

2.2.1 Hazard Analysis

A detailed hazard identification was conducted for all site operations described in **Section 3**. Where an incident was identified to have potential off site impact, it was included in the recorded hazard identification word diagram (**Appendix A**). The hazard identification word diagram lists incident type, causes, consequences and safeguards. This was performed using the word diagram format suggested in HIPAP No.6 (Ref.2). Each postulated hazardous incident was assessed qualitatively in light of proposed safeguards (technical and management controls). Where a potential offsite impact was identified, the incident was carried into the main report for further analysis. Where the qualitative review in the main report determined that the safeguards were adequate to control the hazard, or that the consequence would obviously have no offsite impact, no further analysis was performed.

2.2.2 Consequence Analysis

For those incidents qualitatively identified in the hazard analysis to have a potential offsite impact, a detailed consequence analysis was conducted. The analysis modelled the various postulated hazardous incidents and determined impact distances from the incident source. The results were compared to the criteria listed in HIPAP No.4 (Ref.3). Where an incident was identified to result in offsite effect, it was carried forward for frequency analysis. Where an incident was identified to have an offsite effect, and a simple solution was evident (i.e. move the proposed equipment further away from the site boundary), the solution was recommended and no further analysis was performed.

2.2.3 Frequency Analysis

In the event a simple solution for managing consequence impacts was not evident, each incident identified to have potential offsite impact would be subjected to a frequency analysis. The analysis considered the initiating event and probability of failure of the safeguards (both hardware and software).

2.2.4 Risk Assessment & Reduction

As the selected approach for this analysis was a Level 2 assessment (Ref.1), where incidents were identified to impact offsite and where a consequence and frequency analysis was conducted, the consequence and frequency analysis for each incident would be combined and compared to the risk criteria published in HIPAP No.4 (Ref.3). Where the criteria were exceeded, a review of the major risk contributors would be performed. Recommendations would then be made regarding risk reduction measures.

3.0 BRIEF DESCRIPTION OF PROPOSED SEOC OPERATIONS

3.1 Site Location and Surrounding Land Uses

The ACOL Project (SEOC) is located 14 km north west of Singleton in the Hunter Valley region of NSW. The SEOC will be located approximately 2.5km south east of the ACP coal processing plant. The village of Camberwell is located approximately 400m to the north of the SEOC. The regional location of ACOL and the SEOC are shown by **Figure 3.1**. An aerial photograph with an overlay of the mine facilities is shown in **Figure 3.2** and the SEOC layout in relation to the surrounding land uses, and the effective boundary for hazard analysis, is shown in **Figure 3.3**.

The area where the proposed mine will operate is currently zoned 1(a) (Rural Zone) which has one of its objectives "*to allow mining where environmental impacts do not exceed acceptable limits and the land is satisfactorily rehabilitated after mining*".

The mine site will be located on the south western side of the New England Highway. The area is rural in nature with a number of farms located around the proposed mine area. The closest occupied farm buildings (i.e. rural residential farm house and dairy) are located about 250m to the west of the open pit area boundary (property No. 130, **Figure 3.3**). The closest residences in the Camberwell area, to the open cut pit boundary are located across the New England 250m from the northern end of the SEOC out of pit emplacement. The closest point on the Pacific Highway is located about 250m from the northern end of the open cut pit. It can be seen on **Figure 3.3** that the environmental bund will be located between the pit and the New England Highway.

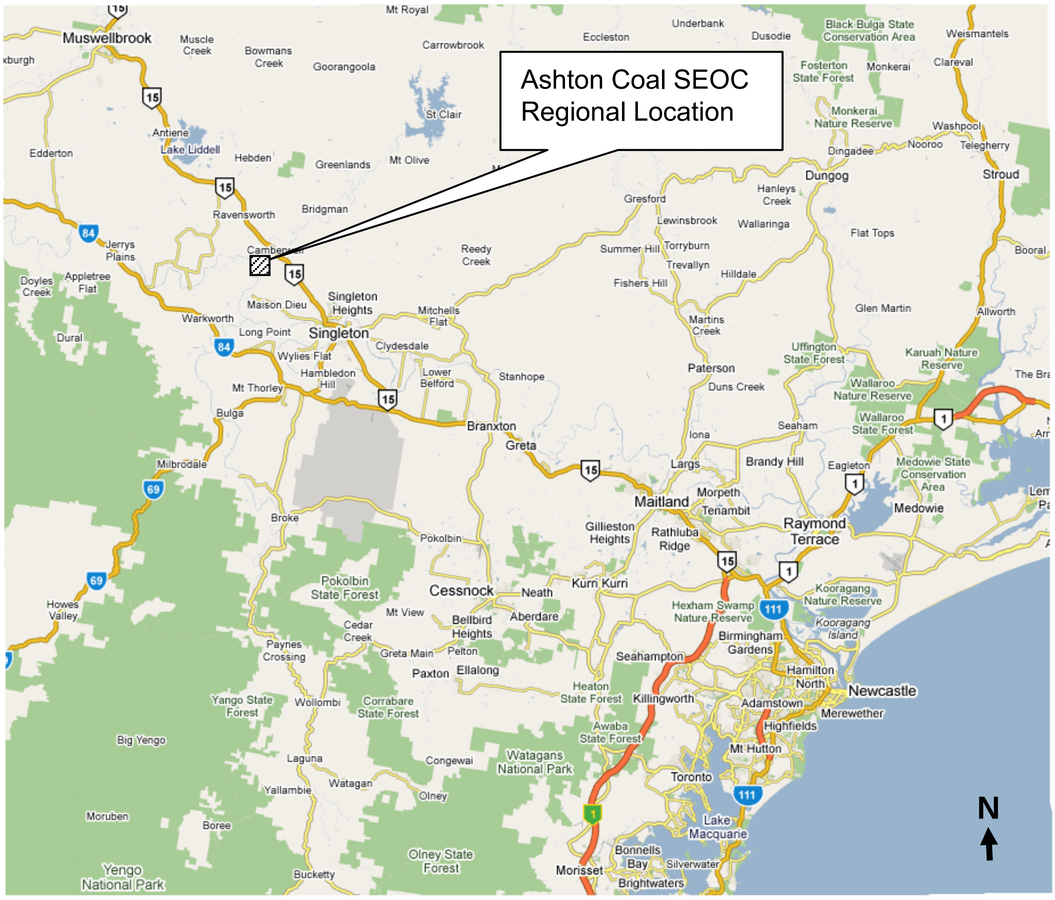

FIGURE 3.1
REGIONAL LOCATION OF THE ASHTON COAL PROJECT SEOC

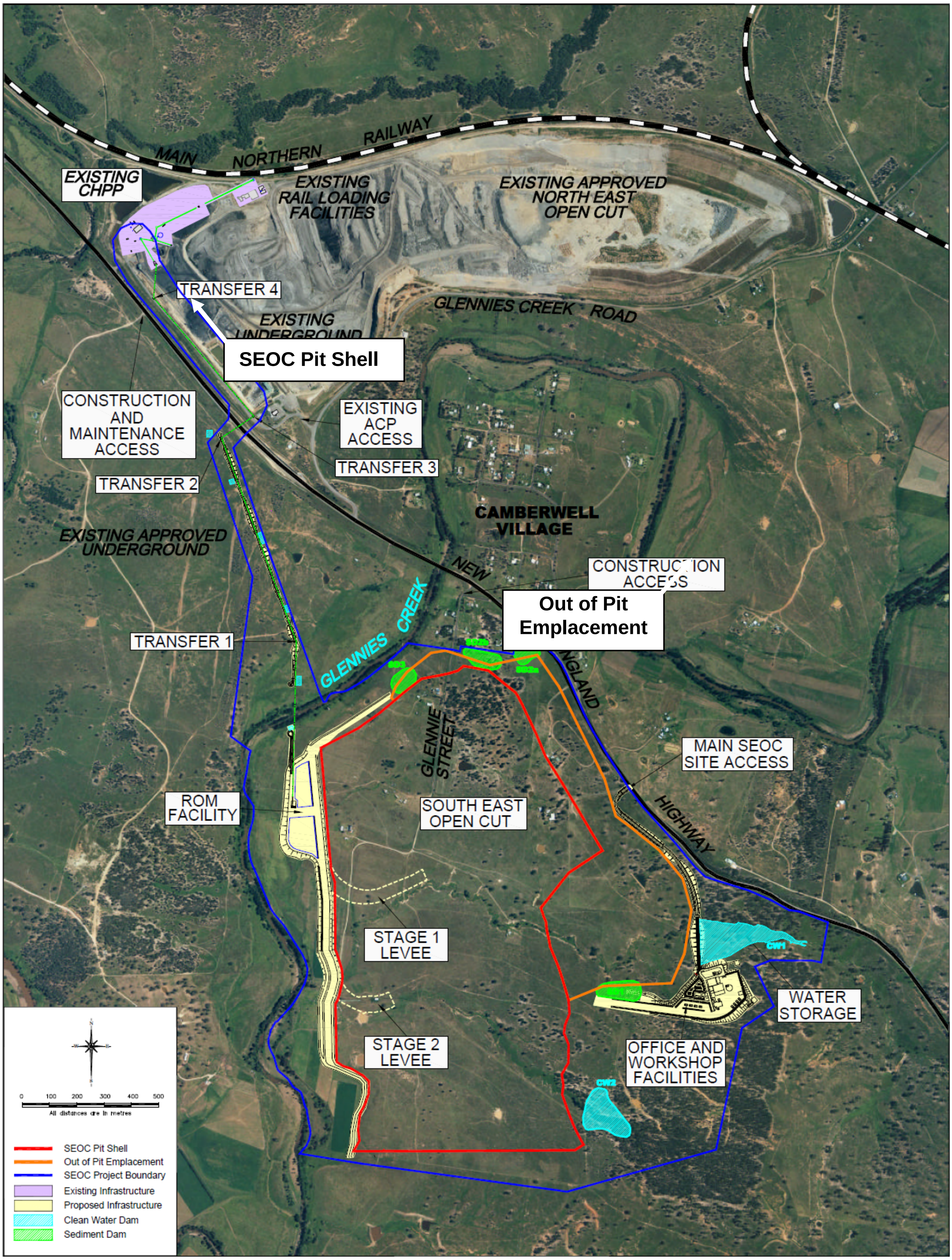

FIGURE 3.2
AERIAL PHOTOGRAPH WITH AN OVERLAY OF THE SEOC

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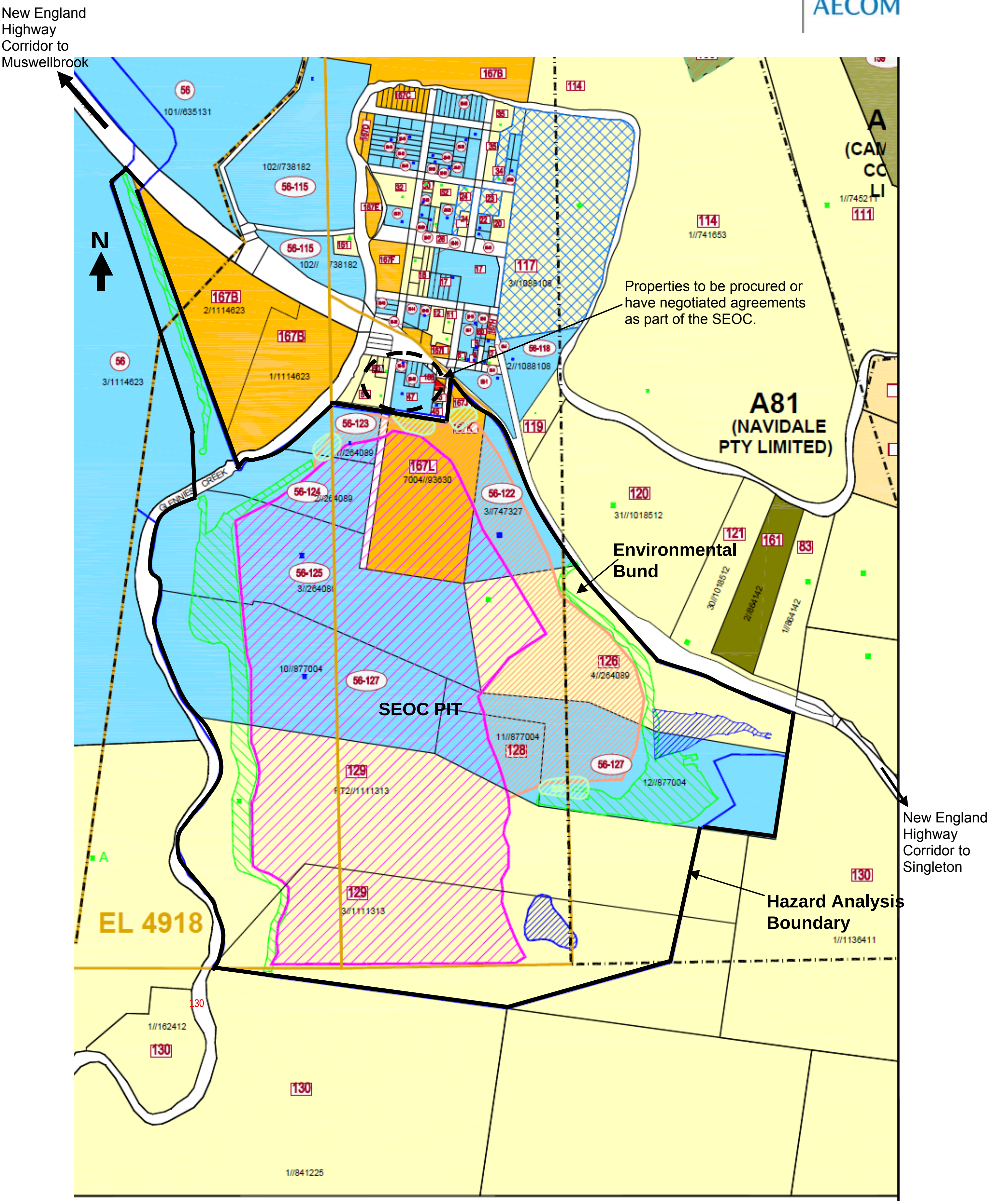

FIGURE 3.3
MINE LOCATION IN RELATION TO THE SURROUNDING LAND OWNERSHIP OF THE PROJECT AREA

3.2 Proposed Project Description Overview

The proposed SEOC will consist of the following components:

- One open cut pit, the SEOC producing up to 3.6Mtpa of ROM coal;
- An environmental bund and out of pit emplacement constructed along the portion of the pit adjacent to the New England Highway;
- Increase in the extraction rate of the approved underground coal mine from 2.95Mtpa ROM coal to 5.0Mtpa ROM coal;
- Increase in throughput of the Coal Handling & Preparation Plant (CHPP) and rail loading facilities to cater for an additional 2.3Mtpa of product coals;
- Crushers and conveyors to transport the ROM coal to existing CHPP over Glennies Creek and the New England Highway, with light vehicle access along the conveyor route (excluding creek and highway crossing);
- New workshop, bathhouse and administration buildings located east of the SEOC and south of the New England Highway;
- Site services and infrastructure such as power supply, water supply, access roads and dewatering network;
- Water storage dam between the facilities and New England Highway;
- Diversion of 132kV and 66kV power lines owned by Energy Australia; and
- Closure of Roads and Camberwell Common.

The mining method used for extraction of coal from the SEOC would be primarily truck and excavator. Mining will commence from the north and progress to the south. Initial overburden displaced will be used to construct the environmental bund and out of pit emplacement at the northern end of the pit. Overburden will then be backfilled into the SEOC and the land rehabilitated.

3.3 Open Cut Mining Description

In order to ensure all potential hazards with offsite impact have been identified, it is important to fully understand the operations at the proposed SEOC. The description below details the open cut mine operation. The hazard analysis was based on this description of operations. **Table 3.1** lists the basic operations in open cut mining.

TABLE 3.1
LIST OF OPERATIONS AT THE PROPOSED SEOC

Operation	Operation
1. Surveying	2. Topsoil Stripping
3.Drill Pad Preparation	4. Drilling
5. Blasting	6. Excavator and truck operations
7. Coal Ripping	8. Coal Mining (excavators/trucks)
10. Coal Preparation Plant	11. Backfill (spoil)
11. Grading	12. Re-Topsoil
13. Re-Vegetation	

Each operation in **Table 3.1** is explained briefly in the section below. **Figure 3.4** may be used to assist in understanding some of the terminology used in the description.

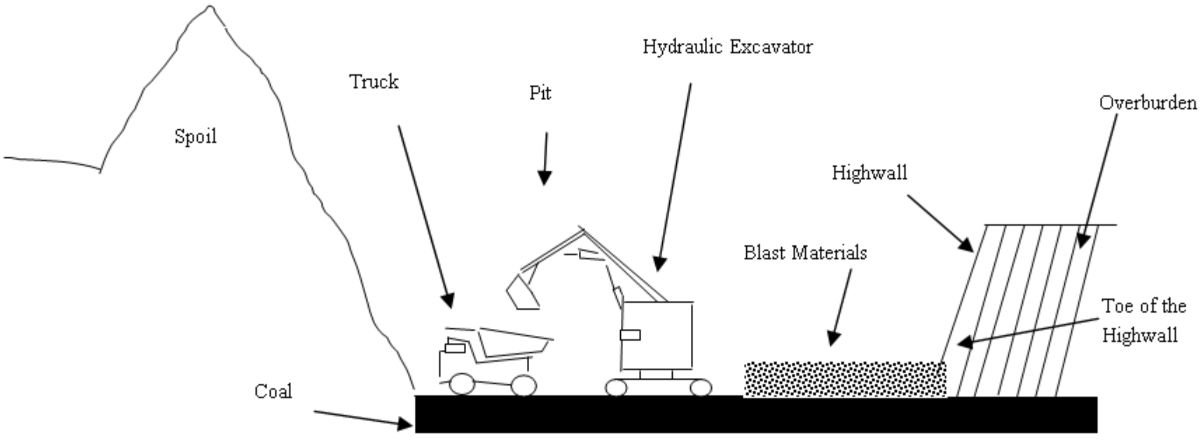

FIGURE 3.4
DIAGRAMMATIC SECTION OF AN OPEN CUR MINE OPERATION

3.3.1 Surveying

Mine surveyors are used to establish levels on site and to ensure the operations are conducted at the correct locations. Surveyors access all parts of the surface operations using “light” vehicles (e.g. four wheel drive, utilities, etc.). Surveyors access high hazard areas such as the top and toe of the high wall and interact regularly with heavy vehicle traffic around the mine.

3.3.2 Topsoil Stripping

Once the appropriate area for mining has been established, the topsoil is removed using bull dozers, front end loaders (FEL) and haulage trucks. The topsoil is then stockpiled for later use in regeneration of mined areas. The topsoil removal area is accessed by a number of “light” vehicles, including surveyors and supervisors.

3.3.3 Drill Pad Preparation

Once the topsoil removal is complete, preparation for drilling is performed. This involves the clearing of areas using a bull dozer (dozer). Areas are levelled by the dozer to permit the drill machine to access for drilling. In some cases, drill pad preparation is performed adjacent to an area that has already been blasted. In this case there is a potential for the dozer to stray into the area that has been blasted and contact holes that have misfired. However, to limit this potential, a berm is placed between the blast and non-blast areas.

3.3.4 Drilling

Once the drill pad has been prepared, the drilling machine is used to drill holes at set depths and patterns. The drill machine is a vehicle that is powered by a diesel engine and hydraulic systems. The diesel engine drives hydraulic pumps, which are used to operate the two drills and drive the tracks on the drill. The drill operates up and down the drill pad until the drill hole pattern has been established.

3.3.5 Blasting

The blasting is performed using a mix of ammonium nitrate and fuel oil (ANFO). The ammonium nitrate is stored in silos and is delivered to the silo by a truck fitted with pneumatic transfer equipment. Diesel is delivered by a road tanker and the fuel is transferred to storage tanks using a truck mounted pump.

Prior to charging the holes with ANFO, it is necessary to prime the holes with detonators and primer. These are stored in a portable magazine and are collected by the blast personnel on a daily basis. Detonators and primer for a single day operation only is taken to the blast site. In the event of left over materials, these are taken back to the magazine at the end of the day. Detonators and primer are not stored at the blast area. The detonators and primer are first prepared on the surface, next to the blast hole, and then lowered into the hole. The blast charge (ANFO) is then loaded.

A mix truck is used to collect the ammonium nitrate and diesel fuel, which is stored in dedicated tanks on the mix truck. The truck is then taken to the blast area in readiness for charging the holes. The truck drives alongside each hole and a truck mounted mix pump prepares the ANFO mix and charges the hole. The hole is then stemmed, which involves filling the hole with a material to prevent the blast from directly ejecting from the hole rather than breaking up the surrounding rock.

Once all holes have been charged and stemmed, the primer chords are tied-in and the main chord laid out. A blast zone is established and all personnel moved out of the zone to ensure blast waves and fly rock does not impact people close to the blast area. Once safety checks have been completed the blast is initiated and the ANFO exploded.

A safety check is then performed to ensure all holes have initiated and that no misfires have occurred. Once this has been completed the area is declared safe for access.

3.3.6 Excavator & Truck Operations

Once the overburden has been loosened by blasting, a large hydraulic excavator will extract the loosened material and load it to trucks. **Figure 3.5** illustrates the truck-hydraulic excavator operation. The loaded trucks will transport the material to the area surrounding the pit for the construction of the environmental bund wall. Initial extraction will be used for this purpose with the remaining overburden used to backfill the SEOC.

Operations at the hydraulic excavator may require a dozer to push the overburden or coal towards the excavator bucket. This introduces inherent hazards of collision between the end dump trucks, excavator and dozer.

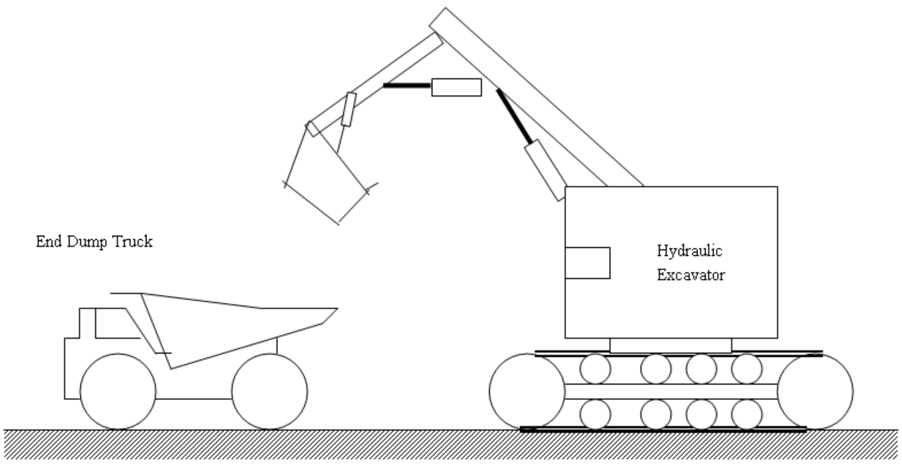

FIGURE 3.5
HYDRAULIC EXCAVATOR AND END DUMP TRUCK SCHEMATIC

3.3.7 Coal Ripping

Once the overburden has been removed (i.e. the material covering the coal), coal is ripped using a dozer. This is performed to loosen the coal in preparation for coal mining using the hydraulic excavator.

3.3.8 Coal Mining (Excavation/Trucks)

The coal that has been ripped is then removed using the hydraulic excavator-end dump truck operation. A large dozer is used to assist the excavator and clean up around the coal loading area and under the excavator itself. The dozer is also used to trim the pit in the toe area, maintaining a stable highwall.

Problems may occur when the dozer and excavator interact, resulting in collisions between these two pieces of machinery. In some cases, dozers working close to the high wall edge or toe may fall from the wall or be struck by falling rocks or covered by a slippage from the highwall.

Loaded trucks transport the coal to the dump station where the coal is transferred via conveyor to the CHPP.

3.3.9 Backfill Spoil

Once the mining operation is complete, the area will be remediated. The spoil, removed as part of the process of exposing the coal, will be transferred to the pit by truck and backfilled into the excavation area.

3.3.10 Grading, Re-Topsoil and Re-Vegetation

Once backfilled, the pit will be graded to accept a topsoil cover. Graders will be used to provide a level surface for the spreading of the topsoil. The topsoil removed from the mine area, in the early stages of the development, will be replaced over the graded backfill and the area re-vegetated to rehabilitate the mine.

3.3.11 Pit Top Facilities

Figure 3.6 shows the layout of the pit-top facilities. The pit-top facilities will consist of the following components:

- Administration Office;
- Bath House;
- Workshop;
- Store (building);
- Fuel farm;
- Sewage Treatment Plant;
- Truck wash areas; and
- Raw water storage tanks.

The office, stores and workshops area will also contain fuel and oil storages for supporting the mine earthmoving equipment. Earthmoving equipment will be fuelled from three 110,000L diesel fuel tanks located in a bunded area directly to the north of the workshop facilities. Refilling or earthmoving equipment, and other vehicles, will typically occur via a fuel truck that will deliver the fuel to the equipment within the operational area of the pit. Earthmoving equipment will also be maintained in the mine workshops. This will require oil changes and the storage of new and used oils. These oils will be stored in 200L drums in the compound area to the north of the workshop.

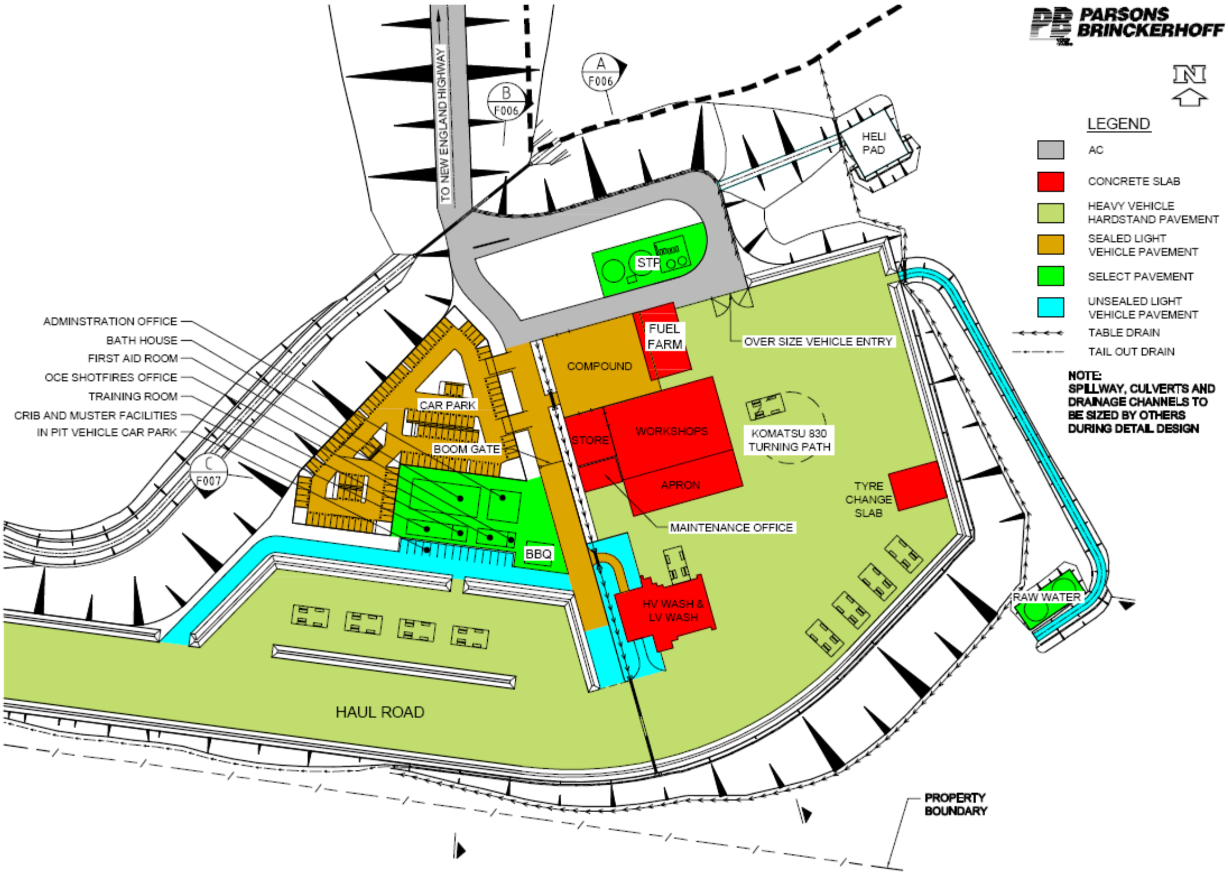

FIGURE 3.6
LAYOUT OF THE PIT-TOP FACILITIES

4.0 HAZARD IDENTIFICATION

4.1 Hazard Identification and Screening

A review of the mine layout and pit-top facilities are shown in **Figures 3.2 & 3.6** respectively. The following operations were reviewed:

Open-Cut Mining

- Surveying;
- Topsoil Stripping;
- Drill Pad Preparation;
- Drilling;
- Blasting (overburden); and
- Truck and Shovel Operations (overburden and coal).

Pit Top Facilities

- Offices, Stores and Workshops;
- Sewage treatment plant; and
- Hazardous/Dangerous Goods Storage, handling and use (e.g. explosives).

A hazard identification table was developed for the proposed SEOC, this table is presented at **Appendix A.** As a result of the hazard analysis study, a number of incidents were identified with the potential to impact offsite, these are:

Open-Cut Mining

- Topsoil Stripping Operations - Hydraulic oil or fuel spill under the equipment, ignition of fuel resulting in fire;
- Drill Pad Preparation, Overburden & Coal Mining, Truck, Shovel & Dozer Operations - Hydraulic oil or fuel spill under the equipment, ignition of fuel resulting in fire;
- Mix truck accident leading to rollover, fuel spill, ignition and pool fire.
- Detonators, primer and charge cord initiated in shotfirers vehicle resulting in localised explosion;
- ANFO mixing in the pump and pipework on the mix truck initiates and leads to an explosion;
- Blast pattern explosion leading to flyrock;
- Refuelling of earthmoving equipment, spill and environmental impact and/or fire;

Pit Top Facilities

- Surge Bin – Dust explosion;
- Hazardous/Dangerous Goods Storage and Handling
  - Diesel fuel storage fire;
  - Ammonium Nitrate storage explosion;
  - Magazine explosion

Each incident has been reviewed in detail in **Section 4.2**.

4.2 Details of Dangerous Goods Stored and Handled at the Mine

4.2.1 Diesel Storage

Diesel will be stored in three 110,000 litre tanks located in a bunded area adjacent to the workshop facilities. The diesel storage will be designed and operated in accordance with the NSW Occupational Health and Safety (Dangerous Goods Amendment) Regulation - 2005 (Ref.4) and AS1940-2004 (Ref.5).

Diesel fuel will be delivered to the tanks by a diesel road tanker. Fuel will be transferred by a truck mounted pump. Vehicles will be fuelled from a fuelling point using a fuel bowser arrangement, the fuel delivery tanker (refilling equipment around the site) will use a transfer hose and pump located within the bunded area. All fuel delivery and filling points will be bunded.

Figure 3.5 shows the location of the diesel storage facilities

The storage of diesel in quantities exceeding 100,000L will require notification of the diesel storage, and other dangerous goods storages on site, to WorkCover, NSW, in accordance with the Occupational Helath and Safety Regulation (Ref.4), Section 6a and Schedule 5. **It is recommended that ACOL prepare a dangerous goods notification form, in accordance with the Regulation (Ref.4) and submit the forms to workcover NSW**.

4.2.2 Explosives Storage

Explosives will be stored in a portable magazine that will be located close to the blast area. The magazine will store a maximum of around 500kg of detonators and blast cord. The magazine will be designed and operated in accordance with the regulatory requirements (NSW DG Regs and NSW Mineral Resources Regs).

As the magazine is a portable unit, its location will change throughout the mine operation. Hence, the location has not been shown on the site layout figures.

4.2.3 Ammonium Nitrate Storage

Ammonium nitrate will be stored in portable silos located near the blast zone. Silos will be positioned outside the blast zone but close enough to provide ready access for mix trucks. The silos are steel hoppers and are about 2m in diameter and 4m high. The base of the hopper is about 3m above the ground and is located on steel legs or stanchions.

Ammonium Nitrate is delivered by truck and is conveyed into the hopper/silos using a pneumatic conveying system. Mix truck tanks are filled from the silos by gravity. As the silos are portable units their location has not been shown on site layout figures.

4.2.4 Lubricating Oil Storage

Lubricating oil will be required for the operation of heavy earth moving equipment and vehicles at the site. Oil will be stored in a range of containers (drums) from 205 litres to 5 litres. The drums will be located in a dedicated storage area in the pit-top area compound. The drums will be located in a bunded area that will comply with AS1940 (Ref.5).

4.3 Detailed Hazard Analysis

4.3.1 Front End Loader/Excavator Fuel/Hydraulic Line Failure - Pool Fire

In the event of failure of a hydraulic line or fuel line in equipment, there is a potential for fuel/oil to leak under the vehicle causing a pool. Fuel/oil may also spray near the engine exhaust and ignite leading to a spray/pool fire under the vehicle. This would result in heat radiation impact to the area surrounding the vehicle.

Equipment operating towards the centre of the area to be cleared for open-cut mining would be far enough away from the site boundary so that heat radiation would not impact off site. However, as vehicles work close to the edge of the area being cleared, they approach the site boundary and incidents in this area may result in heat radiation offsite. This incident has been carried forward for consequence analysis.

4.3.2 Dozer/Truck/Shovel Fuel/Hydraulic Line Failure - Pool Fire

This incident would be similar to **Section 4.3.2** above. Where dozers/trucks/shovels operate towards the centre of the pit or deep in the pit, in the latter stages of open-cut mining, heat radiation would not impact off-site. However, in the early stages of operations where the equipment may be located towards the edge of the pit and where the pit is not deep, there is a potential for heat to radiate off-site. This incident has been carried forward for consequence analysis.

4.3.3 Mix Truck Accident – Rollover and Fire

The mix truck is used to carry ammonium nitrate and diesel fuel to the drill pad (blast area) for ANFO mixing and charging of holes. In the event of an accident involving collision or roll over there is a potential to pierce the diesel fuel tank on the truck leading to a pool of diesel fuel around the truck. Ignition of the fuel (e.g. from hot exhaust or collision) would result in a pool fire radiating heat into the surrounding area.

Incidents of this type occurring in the open-cut pit would not result in impact off-site due to the heat radiation containment by the pit walls. However, in the early stages of open-cut mining there is a potential for mix trucks to operate nearer site boundaries.

A collision involving a mix truck and another vehicle, resulting in diesel tank damage, would also result in Ammonium Nitrate tank damage and spill. This material would burn along with the diesel, however, as it is not tightly confined (e.g. in a blast hole) and as there is little chance of high energy impact, there is a negligible potential for explosion, and fire would be the main result.

Hence, fire incidents from mix truck accidents and fuel fires have been carried forward for consequence analysis to determine the potential for heat radiation impact off-site.

4.3.4 Detonators/Explosives Initiate in the Shot Firers Vehicle

During the blast program, the shotfirer collects detonators, primer and charge cord from the explosives magazine on a daily basis. The ‘explosives’ are taken to the blast pad and the holes primed ready for the ANFO charge. In the event of an accident involving a shotfirers vehicle, there is a potential for detonators and charge cord to be initiated resulting in explosion. Vehicle accidents may occur as a result of collision or rollover, other initiating events may result from human error.

Incidents of this type occurring in the open-cut pit would not result in impact off-site due to the blast containment by the pit walls. However, in the early stages of open-cut mining there is a potential for shotfirers to operate nearer site boundaries.

This incident has been carried forward for consequence analysis to determine the potential for overpressure impact offsite.

4.3.5 ANFO Mixing and Premature Explosion

Diesel fuel and ammonium nitrate is mixed using a truck mounted pump. The ANFO is charged to the blast hole using pipework from the pump to the top of the hole. In the event of a pump failure (e.g. shaft, bearings, impeller, etc.) there is a potential for heat to be generated and the ANFO to be initiated, resulting in explosion on the mix truck.

Incidents of this type occurring in the open-cut pit would not result in impact off-site due to the blast containment by the pit walls. However, in the early stages of open-cut mining there is a potential for mix trucks to operate nearer site boundaries.

This incident has been carried forward for consequence analysis to determine the potential for blast overpressure to project off-site.

4.3.6 Fuel Deliveries to Equipment in the Pit

Fuel will be delivered to earthmoving equipment and vehicles in the pit via a tanker that will load fuel at the main storage tanks and deliver the fuel to the vehicle, transferring the fuel via a truck mounted pumps. The vehicles will be fuelled using a transfer hose and fuel tank filling nozzle.

During refuelling of vehicles, there is a potential for a hose leak/failure leading to the release of diesel fuel. This could have an immediate impact to the environment surrounding the spill area. However, the spill would be limited as the tanker driver and vehicle operator would both be in attendance at the fuel transfer operation. Hence, a spill would be immediately isolated and the spill quantity minimised. The result would a minor spill surrounding the fuelling area. This would result in localised impact only and could be cleaned up without impact to the wider environment. Hence, this incident has not bee carried forward fir further analysis.

In the unlikely event of a fuel spill and ignition, a pool fire would result. This could cause heat radiation impact to project towards and beyond site boundaries where the refuelling occurs close to the edge of the pit (i.e. during early stages of operation). Hence, this incident has been carried forward for further analysis.

4.3.7 Diesel Fuel Storage Fire

Diesel fuel is stored on site for fuelling trucks, vehicles and heavy earthmoving equipment. It is also stored for the manufacture of ANFO at the blast pad area.

Diesel fuel is stored in tanks in a bunded area adjacent to the main workshop and compound. In the event of a tank leak and fuel ignition (e.g. from hot work or maintenance), a bund fire would occur, radiating heat into the surrounding area.

Diesel fuel is delivered to site by road tanker and transferred to the tanks using a truck mounted pump. The diesel delivery tanker will park in a bunded area that will drain back to the main storage tank bund. Any leaks from tanker incidents (e.g. delivery hose failure) will drain back to the storage bund area. In the event of ignition of the leak, a bund fire would result. This would lead to the same incident as detailed for the full bund fire above.

This incident has been carried forward for consequence analysis to determine whether the tank location is sufficient distance from the site boundary to ensure heat radiation does not impact off-site.

4.3.8 Lube Oil Storage Fire

Lube oil is stored in a dedicated, bunded storage area in the pit-top compound. In the event of an oil leak there is a potential for ignition of the oil resulting in a fire within the bunded area. Heat radiation could impact offsite causing potential fire growth beyond the site boundary.

Whilst it is recognised that lube oil has a high flash point, and ignition/fire is highly unlikely, a fire in such storages cannot be fully discounted. Hence, this incident has been carried forward for consequence analysis to determine whether the lube oil storage location is sufficient distance from the site boundary to ensure heat radiation does not impact off-site.

4.3.9 Ammonium Nitrate Storage Explosion

Ammonium Nitrate, whilst having the potential to explode in specific situations (e.g. when confined and impacted by fire), is not readily ignited nor does it burn. The storage hopper and support legs (stanchions) are steel and there are no combustibles close to storage silo locations. Furthermore, there are no ignition sources (e.g. electrical instruments, etc.) in the hoppers.

Under these circumstances there is no potential for fire in the hopper area and hence, no potential for explosion. This incident has not been carried forward for further analysis.

4.3.10 Explosion in Explosives Magazine

The explosives magazine will be designed in accordance with the appropriate codes, standards and regulations. The magazine will be a portable unit that will be located in the vicinity of the high wall, but a sufficient distance so as not to be impacted by blasting in the pit.

During the blast program, the shotfirer collects detonators, primer and charge cord from the explosives magazine on a daily basis. During access to the magazine there is a potential for the shotfirer to accidentally initiate explosives in the magazine, albeit extremely unlikely. A major explosion in the magazine would generate an overpressure wave that may project off-site.

This incident has been carried forward for consequence analysis

4.3.11 Blasting and Flyrock

Controlled blasting is conducted as part of the preparation of the overburden prior to removal for access to the coal. As noted in **Section 3.3.5**, the explosive (ANFO) is deposited within the blast hole and stemmed to prevent the explosive force discharging upwards and/or outwards. Hence, there will be little explosive percussive force as a result of the blasting. However, the explosive force dislodges rock and debris that is expelled from the blast area as projectiles known as flyrock.

Flyrock has the potential to impact areas well beyond the immediate blast zone causing damage, injury and potential fatalities. To manage this, ACOL will implement an exclusion zone surrounding the blast operation. Personnel will be evacuated from the exclusion zone and where roads are located within the zone, traffic will be prevented from entering until the blast operation is complete.

Exclusion zones are a commonly implemented safety feature in the mining industry and are effectively applied to manage the potential for impact of flyrock from blast operations. It is understood that an exclusion zone of This has been applied at the current operations and has proven to be effective in managing the flyrock risk.

As the same exclusion zone, to that currently used, will be applied to the SEOC operation, and as the risk of flyrock impact is effectively managed at the existing operation, this incident has not been carried forward for further analysis as it is considered that the risk of impact from flyrock will be negligible as long as the flyrock management exclusion zone is applied.

4.4 Summary of Hazardous Incidents Carried Forward for Consequence Analysis

The following incidents have been carried forward for consequence analysis:

- FEL, Excavator, Dozer, Truck, Mix Truck fuel leak and fire;
- Mix truck accident and fire;
- Earthmoving equipment refuelling fire;
- Explosion on the shotfirers vehicle;
- Premature explosion of the ANFO mix on the mix truck;
- Refuelling of equipment in the pit;
- Diesel fuel storage fire
- Lubricating oil storage fire; and
- Magazine explosion.

5.0 CONSEQUENCE ANALYSIS

5.1 Consequence Criteria

The severity of incident consequences has a bearing on the magnitude of impact to people, plant/buildings and the environment. High heat radiation or explosion overpressure can result in fatality or incident growth to facilities adjacent to the incident. In planning assessments, it is important to understand the severity of consequence impacts, from incidents at a facility, so that effective safeguards can be implemented to ensure the risks to adjacent properties to the facility are managed accordingly.

A number of regulators throughout the world have stipulated maximum permissible heat radiation and explosion overpressure impacts at site boundaries as a result of incidents at potentially hazardous facilities. In NSW, the Department of Planning has issued a hazardous industry planning advisory paper (HIPAP) listing acceptable consequence and risk criteria (Ref.3). This document indicates the following acceptable consequence impact criteria for heat radiation and explosion overpressure at the boundary of a potentially hazardous facility:

- Heat Radiation – 4.7kW/m^2
- Explosion Overpressure – 7kPa

These values have been used to determine whether impacts from postulated incidents at the mine will be acceptable at the site boundary and whether further analysis or risk reduction is required.

5.2 Summary of Consequence Analysis Results

A detailed consequence analysis was conducted for each of the hazardous incidents carried forward from the hazard analysis, **Section 4**. The detailed analysis is conducted in **Appendix B**. **Table 5.1** summarises the results of the consequence analysis.

TABLE 5.1
SUMMARY RESULTS OF CONSEQUENCE ANALYSIS

Fire Incident	Heat Radiation Distance to 4.7kW/m^2
FEL, excavator, dozer, truck fire	14.2m
Mix truck accident and fire	24.4m
Earthmoving equipment refuelling	4.8m
Diesel storage bund fire	31.1m
Lube oil storage bund fire	19.9m
Explosion Incident	**Explosion Overpressure Distance to 7kPa**
Shotfirers vehicle – detonators and cords explosion	44m
Mix truck ANFO explosion	34m
Magazine explosion	119m

5.2.1 Assessment of Consequence Analysis Results

Figures 5.1 & **5.2** show the various consequence impact contours on a site map and a services layout diagram of the SEOC Project. The contours are shown as examples of the various locations of trucks, mix trucks, shotfirers vehicles and magazines during the daily site operations. This map, and indicated contours, may be used in conjunction with the discussion below to understand the impact associated with the various hazards.

5.2.2 FEL/Excavator/Dozer/Truck Fires

The consequence analysis, for the worst case scenario for fires associated with scrapers, dozers and trucks (see **Appendix B, Section B1.1**), estimated the heat radiation impact distance to 4.7kW/m^2 to be 14.2m. The site will be established with a minimum 100m buffer zone between the pit area and the site boundary, with the exception of the south west corner of the site, where the boundary will be about 50m from the pit area. Any fire incidents associated with FEL, excavators, dozers and trucks will be within the pit area and not in the 100m buffer zone or closer than 50m on the south west corner of the site.. As the maximum impact distance is 14.2m, there will be no offsite impact from this incident.

This incident has not been carried forward for further analysis.

5.2.3 Mix Truck Accident and Fires

Mix trucks will operate between the diesel storage and the pit. Mix trucks will travel on roads around the site and the closest a mix truck will come to the site boundary is at the south western corner of the pit, 50m from the boundary.

In the worst case fire scenario (see **Appendix B**, **Section B1.2**), involving a mix truck, the distance to a heat radiation level of 4.7kW/m^2 is 24.4m. This is well within the 50m closest distance to the site boundary for a mix truck. There will be no offsite impact from this incident.

This incident has not been carried forward for further analysis.

5.2.4 Earthmoving Equipment Refuelling Fire

Earthmoving equipment will be refuelled from a tanker vehicle that will circulate around the mine and fuel vehicles as required. In the event of an incident where a fuel hose breaks or an operator drops a hose whilst fuelling, there is a potential for a spill around the localised area of the failed or dropped hose. The operator or equipment driver would then respond and shut down the fuel transfer.

In a postulated incident fire (see **Appendix B, Section B1.5**), involving a refuelling truck, the distance to a heat radiation level of 4.7kW/m^2 is 4.8m. This is well within the 50m closest distance to the site boundary for a refuelling truck. There will be no offsite impact from this incident.

This incident has not been carried forward for further analysis.

5.2.5 Diesel Bund Storage Fire

The diesel storage tanks and bund are located on the eastern side of the pit-top facilities. The distance to the closest boundary (north) from these tanks is 50m. The worst case fire scenario is a full diesel bund fire (see **Appendix B, Section B1.3**). The distance to a heat radiation of 4.7kW/m^2 from this fire would be 31.1m. This is well within the 50m distance to the site boundary. There would be no offsite impact from this incident.

This incident has not been carried forward for further analysis.

5.2.6 Lube Oil Storage Bund Fire

The lube oil storage area is located on the northern side of the pit-top facilities compound. The distance to the closest boundary (north) from this storage area is 50m. The worst case fire scenario is a full lube oil bund fire (see **Appendix B, Section B1.4**). The distance to a heat radiation of 4.7kW/m^2 from this fire would be 19.9m. This is well within the 50m distance to the site boundary. There would be no offsite impact from this incident.

This incident has not been carried forward for further analysis.

5.2.7 Shorfirers Vehicle Explosion

Shotfirers vehicles will travel from the pit area to the magazine to load the detonators and cords for a specific blast pattern only. Large quantities of explosives will not be carried in the shotfirers vehicle. The magazine will be placed within the pit outline and well clear of site boundaries. Hence, the shotfirers vehicle will not travel any closer than 50m to the site boundary (i.e. the south west corner of the site).

In the worst case incident (see **Appendix B, Section B2.2**), explosion of all detonators, primer and cords on the shotfirers vehicle, the distance to an explosion overpressure of 7kPa is 44m. This is within the 50m distance to the closest site boundary (i.e. the south west corner of the site) and hence there will be no overpressure impact offsite.

This incident has not been carried forward for further analysis.

5.2.8 Mix Truck ANFO Explosion

Mix trucks loading holes will operate within the pit area only. This area is well inside the pit and does not encroach on the 100m buffer zone or closer than the 50m in the south west corner of the site. In the worst case incident (see Appendix B, Section B2.3), an explosion of ANFO in the mix pump and lines, the distance to an overpressure of 7kPa is 34m. This is well clear of the closest site boundary to the pit (i.e. 50m in the south west corner) and, hence, there is no impact offsite.

This incident has not been carried forward for further analysis.

5.2.9 Magazine Explosion

As indicated in **Section 3.3.4**, the explosives (detonators, primer and cords) magazine will be located in the pit area. There will be a general buffer distance of at least 100m between the magazine and the site boundary, with the exception of the south west corner of the pit, which will be within 50m of the site boundary. In the worst case scenario (see **Appendix B, Section B2.4**), a full magazine explosion, the distance to an explosion overpressure of 7kPa is 119m. In the event the magazine was placed on the edge of the pit outline (i.e. on the south west corner of the pit), the overpressure impact of 7kPa would extend offsite by about 70m.

It is noted that the explosion overpressure calculations performed in this study were conservative and explosions involving detonators and cords would be expected to have an explosive power much less than TNT, the representative explosive used in this study.

Nonetheless, to ensure blast overpressure is not projected offsite, in the unlikely event of magazine explosion, **it is recommended that magazines be located at least 150m from the site boundary. This should be included as part of the safety management systems developed for the site**.

Based on the separation afforded by the 150m buffer zone, this incident has not been carried forward for further analysis.

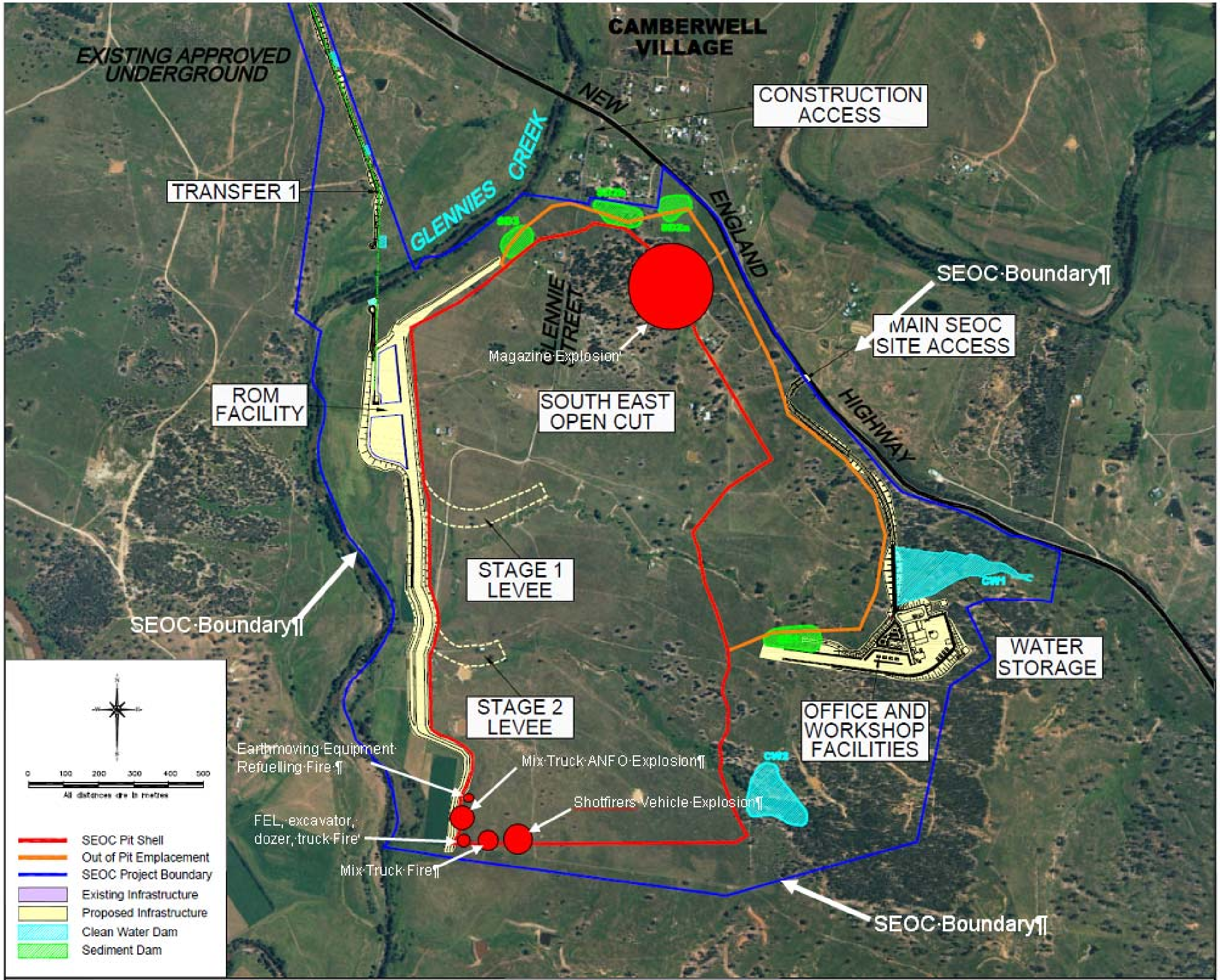

FIGURE 5.1
HAZARDOUS INCIDENTS - CONSEQUENCE CONTOURS
ASHTON COAL SEOC SITE MAP

FIGURE 5.2
HAZARDOUS INCIDENTS - CONSEQUENCE CONTOURS
PIT TOP SERVICES AREA

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

As a result of the analysis conducted in this study, the following conclusions are made :

- The impact of the consequences of all identified hazards in the surface mine and pit top facilities, with the exception of the magazine explosion, do not have the potential to impact offsite due to the general application of a minimum 100m buffer zone around the open cut workings and the closest site boundary being 50m from the edge of the pit.

- In the event the portable explosives magazine was placed in the south west corner of the pit, and an explosion occurred in the magazine, there would be an offsite overpressure in excess of 7kPa for 70m beyond the site boundary.

Notwithstanding the majority of analysis results indicating no off-site impact, a number of risk reduction recommendations have been made to enhance the hazard mitigation and site emergency response. These are detailed in **Section 6.2**.

6.2 Recommendations

Whilst it was identified that the majority of hazardous incidents have no offsite impact, the following recommendations are made in relation to risk reduction to ensure the ALARP (as low as reasonably practicable) principle is applied.

1. It is recommended that the incidents listed in **Appendix A**, and detailed in **Section 4.3**, be included in the site Emergency Response Plan, along with other incidents identified to have onsite impact to mine equipment and personnel.

2. It is recommended that during the regular emergency response drills, conducted as part of the Mine Rescue Team (MRT) exercises, the hazards listed in **Appendix A** be included in the drill exercises to ensure MRT readiness.

3. As the study indicated that fire in vehicles was a potential major hazard on site, and that fire growth has the potential to result in serious damage to vehicles, it is recommended that all vehicles on site be fitted with at least one dry powder type extinguisher. Larger vehicles should carry at least one 9kg dry powder extinguisher and smaller vehicles at least one 4.5kg dry powder extinguisher.

4. It is recommended that portable magazines located in the pit be located no closer than 150m to the site boundary.

7.0 REFERENCES

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APPENDIX A

HAZARD IDENTIFICATION TABLE

HAZARD IDENTIFICATION – ASHTON COAL MINE			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
1. Surveying – No identified hazards with offsite impact, surveyors operate in vehicles around the mine and may be involved in minor vehicle accidents or may fall from high walls or benches. OH&S issues only.			
2. TOPSOIL STRIPPING			
2.1 FEL collides with other vehicles in topsoil strip area or FEL driver loses control & rolls FEL	- Driver (human) error - Equipment failure - Unauthorised vehicles access topsoil removal area	- Vehicle damage - Lost Time Injury	- Compulsory for seat belts to be worn in all earthworks vehicles - Drivers have clear view from vehicle cab - Restriction on vehicle access to topsoil striping area - Vehicles in constant radio contact (vehicle to vehicle and vehicle to control centre) **Onsite impact only. Incident not carried forward for detailed hazard analysis**
2.2 Hydraulic line failure or fuel line leak on scraper leading to spray of oil/fuel onto engine exhaust, ignition and fire	Equipment failure (hydraulic hose or fuel line)	Fuel/oil pool under vehicle leading to pool fire Heat radiation into the area immediately surrounding the vehicle fire	- Vehicle inspection at the beginning of each shift/operation - Regular vehicle maintenance (including hose change out schedule) - Localised fire only, no major heat radiation impacts beyond the vehicle incident - Environmental bund protects against radiation beyond the immediate pit area **Potential for fire to occur close to the site boundary, incident carried forward for further analysis.**

HAZARD IDENTIFICATION – ASHTON COAL MINE			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
3. DRILL PAD PREPARATION, OVERBURDEN & COAL MINING, TRUCK/SHOVEL OPERATIONS			
3.1 Hydraulic line failure or fuel line leak on dozer, truck or shovel leading to spray of oil/fuel onto engine exhaust, ignition and fire	Incident impact is the same as 2.2 above		
4. Blasting			
4.1 Detonators/explosives initiate in the shot firers vehicle	- Vehicle accident - Unstable detonators/explosives - Human error	Localised explosion in the immediate vicinity of the shot firers vehicle	- Dedicated vehicle used for transport of detonators and explosives - Detonators and explosives separated in the shot firers vehicle - Only licensed shot firer permitted to handle explosives - Environmental bund protects against explosion overpressure beyond the immediate pit area **Shotfirers vehicle may be close to the site boundary, incident carried forward for further analysis**
4.2 Detonator initiates in the hole after hole is primed	- Unstable detonators - Lightning strike	- Minor explosion in the blast hole - Material exhausted from the hole in a vertical direction	- Explosion is relatively small - Explosion is not directed towards the site boundary - Environmental bund protects against explosion overpressure beyond the immediate pit area **No offsite impact. Not carried forward for detailed hazard analysis**

HAZARD IDENTIFICATION – ASHTON COAL MINE			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
4.3 Mix truck fire	Mix truck accident leading to roll over, fuel spill and fire	Heat radiation to the surrounding area, potential to project offsite if mix truck is close to site boundary	- Speed limit for vehicles on site (40 kph) - Closest location to the site boundary for mix trucks is 50.m (i.e. south west corner of the site) - Environmental bund protects against radiation beyond the immediate pit area **Mix truck may be close to the boundary, incident carried forward for further analysis**
4.4 ANFO explosion in a hole after loading	ANFO is loaded to a "hot hole" (i.e. a hole that is heated by burning coal in the seam)	- Premature blast and unplanned explosion - Material exhausted from the hole in a vertical direction	Explosion is projected in a vertical direction and hence there is no impact towards the site boundary Environmental bund protects against explosion overpressure beyond the immediate pit area **Not carried forward for detailed hazard analysis**
4.5 ANFO detonates in the mix pump and delivery lines during hole loading	Equipment (pump) failure resulting in pump overheating and initiation of ANFO	- Explosion in the pump/lines on the mix truck - Blast wave and fire in the immediate vicinity of the mix truck	- Regular pump maintenance - Only small quantity of ANFO involved in the explosion - Closest location to the site boundary for mix trucks is 75.m (i.e. buffer zone for the pit to site boundary) - Environmental bund protects against explosion overpressure beyond the immediate pit area **Mix truck may be close to the boundary, incident carried forward for further analysis**

HAZARD IDENTIFICATION – ASHTON COAL MINE			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
4.6 Flyrock	Blast pattern is initiated for blasting of overburden or coal	Potential for fly rock to impact offsite areas	- Blast zone is established based on experience with set blast patterns - Where blast is closer to site boundary, traffic control on local roads and rail lines is maintained (i.e. vehicles/trains prevented from passing through the blast zone during the blast) - Where blast is close to site boundary and adjacent properties, blast zone is established so that buildings on properties are not impacted **It is considered that there will be effective management control of the blast site and flyrock impact potential, however, a review of these has been conducted in the hazard analysis.**
5. Fuelling of Earthmoving Equipment in the Pit			
5.1 Fuel spill during refilling of vehicles	Failed hose, operator error	- Environmental impact - Ignition and pool fire	- Operators present during fuelling operation (can initiate emergency response) - Spill equipment available on the fuelling truck (tanker) - Fire fighting equipment available on earthmoving equipment (extinguishers) - Fuelling of vehicles conducted remote from site boundaries and other equipment (minimal impact to surrounding areas or potential for incident growth to other equipment).

HAZARD IDENTIFICATION – ASHTON COAL MINE			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
6. PIT TOP FACILITIES			
6.1 Fire in buildings, workshop, bathhouse, truck wash, compound.	- Electrical faults - Rubbish fires - Kitchen fires	Localised heat radiation in the immediate vicinity of the building/structure	- Buildings located no closer than 50m from the boundary - Building maintenance - Buildings constructed to Australian Standards & Building Code of Australia - Fire fighting equipment installed in buildings - Mine Rescue Team on site and familiar with fire fighting operations **No potential for impact offsite due to distance between building and site boundary. Not carried forward for detailed hazard analysis**
6.2 Chemical spill in the Sewage Treatment Plant	- Leaking tanks; - Pipework failure	Potential spill to the environment	- Regular maintenance and inspection (daily) of equipment - Mine Rescue Team on site and familiar with spill containment operations - Localised spill, plant is bunded, no spill beyond plant boundaries **No potential for impact off-site in sensitive adjacent land uses Not carried forward for detailed hazard analysis**
7. Hazardous and Dangerous Goods Storages			
7.1 Explosion in the explosives magazine	- Unstable detonators/explosives - Detonators/explosives handling errors when	Potential for blast wave to project offsite	- Limited quantity of explosives stored in the magazine (≈ 500kg) - Magazine is designed and maintained in accordance with NSW Explosives Regulations and NSW Dept. of

HAZARD IDENTIFICATION – ASHTON COAL MINE			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
	collecting/returning materials		Mineral Resources Regulations - Magazine is located well clear of site boundaries - Magazine design is such that a large quantity of the explosive force would be absorbed in destruction of the magazine - Environmental bund protects against explosion overpressure beyond the immediate pit area **Potential for larger explosion and impact beyond the mine area, incident carried forward for further analysis**
7.2 Bund fire at the diesel storage tanks (trucks and ANFO)	- Tank leak and ignition of diesel fuel - Maintenance on tanks (e.g. welding, cutting, grinding, etc.)	Potential for heat radiation offsite	- Diesel storage is bunded in accordance with the NSW Dangerous Goods Regulations and AS1940-1993 - Regular inspections and maintenance of diesel storage tanks and bunds - Work in diesel area will be conducted under hot-work permit - Mine Rescue Team on site with fire fighting capabilities **Potential for larger fire and impact beyond the pit-top facility area, incident carried forward for further analysis**
7.3 Diesel fuel fire adjacent to the diesel fuel storage tanks	Delivery vehicle spill and ignition of fuel leading to pool fire	Potential for heat radiation offsite	- Operator in attendance during fill operations - Operator has access to first attack fire fighting equipment - Mine Rescue Team on site (i.e. back up fire fighting capabilities) **Potential for larger fire and impact beyond the pit-top facility area, incident carried forward for further**

HAZARD IDENTIFICATION – ASHTON COAL MINE			
Incident	**Cause**	**Consequence**	**Safeguards (Prevention, Protection, Detection)**
			analysis
7.4 Chemical spill from chemical storages	- Leaking drum/container - Dropped container during handling (i.e. transfer from delivery vehicle to storage)	Spill to drains and environment	- Minor quantities stored only – minimal spill quantity - Storages comply with the requirements of the OH&S Dangerous Goods regulation – 2005 - Storages comply with the relevant Australian Standards - Storages are bunded **Negligible likelihood of spill beyond the immediate area of the storage, incident not carried forward for further analysis**
7.5 Oil spill, ignition and fire in the oil storage area	- Leaking drum/container - Dropped container during handling (i.e. transfer from delivery vehicle to storage) - Ignition from hot work	Potential for heat radiation offsite	- Oil has a high flash point and dose not ignite readily - Fire fighting facilities provided on site (hydrant, hose reels, extinguishers) - Operator in attendance during oil handling operations - Work in the oil storage area would be conducted under work permit conditions - Mine Rescue Team on site with fire fighting capabilities **Potential for full bund fire and impact beyond the pit-top facility area, incident carried forward for further analysis**

APPENDIX B

CONSEQUENCE ANALYSIS

B1. HEAT RADIATION ANALYSIS

B1.1 FEL/Excavator/Dozer/Truck Fires

Scrapers/dozers/trucks and heavy earth moving equipment carry diesel fuel in truck mounted tanks. The largest tank is on the end dump truck and carries a maximum of about 3000 litres of fuel. Assuming, conservatively, that the fuel tank had just been filled the total leak would be 3000 litres. A leak through a fuel line or hole in the tank would result in fuel spilled on soil, which would not spread as far as fuel spilled on concrete, as the soil would absorb some of the spilled diesel. However, to ensure results are conservative, fuel spread on concrete has been assumed.

Pool Fire Diameter

In the worst case scenario, a failure of a fuel line after the fuel booster pump would result in the highest volume leak. Assuming, conservatively, that the fuel booster pump delivers about 1litre of fuel per second, the leak from the line would be 0.001 m^3/second. This value has been used to determine the equilibrium pool diameter under the vehicle.

The fuel burn down rate from a burning diesel pool is 0.005m/minute or 8.3x10-5 m/s (Ref.6).

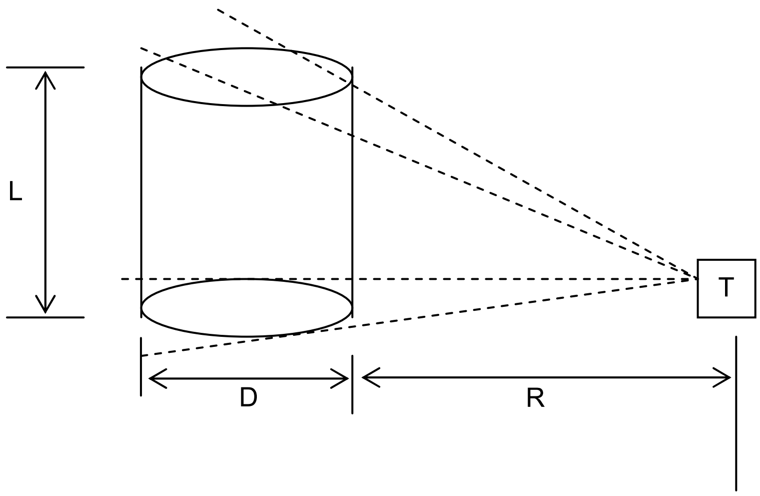
The volume of fuel consumed is therefore: $\pi/4(D^2) \times 8.3\times10^{-5}$

The equilibrium pool diameter is calculated by equating the volume fuel fed to the fire and the volume of fuel consumed:

$0.001 = \pi/4(D^2) \times 8.3\times10^{-5}$

D = 3.9m

The flame burns in the shape of a cylinder tilted in the direction of the wind. **Figure B1.1** shows a diagram of a pool fire impacting a target as a distance from the flame.



Where: L = Flame length
D = pool diameter
R = distance to target
T = Target

FIGURE B1.1
VIEW FACTOR METHOD FOR HEAT RADIATION CALCULATIONS

Flame Height (L)

The flame height of a pool fire is given by the following correlation of Thomas (Ref.7):

$$L = 42D\left(\frac{m}{\rho_o\sqrt{gD}}\right)^{0.61}$$ -----------------(**B1.1**)

where: L= mean flame height (m)
D= pool diameter (m)
ρ_o= ambient air density (typically 1.2 kg/m^3)
m= mass burning rate (kg/m^{2}s) = 0.0667, based on 5mm/min burn down rate (Ref.6)
g= acceleration due to gravity (9.81 m/s^2)

Hence, flame height for the diesel truck fire is:

L = 42 x 3.9 (0.0667/(1.2(9.81x 3.9)$^{0.5}$))$^{0.61}$ = 9.2m

To estimate the heat radiation impact at specific distances, the view factor method has been applied, which uses the heat radiation from the surfaces of the flame and applies a correction factor for flame shape and target distance/location.

The heat radiation at a specific distance from the flame can be estimated from the formula:

Ir = Ie x F x τ -------(**B1.2**)

Where: I_r = Target Heat (kW/m^2).
I_e= Flame Heat (kW/m^2) or surface emissive power (SEP).
τ = Transmissivity.
F = View Factor

The calculation of the view factor (F) in **Formula B1.2** depends upon the shape of the flame and the location of the flame to the receiver. F is calculated using an integral over the surface of the flame, S. The formula can be shown as:

$$F = \int\int_S \frac{\cos\beta_1 \cos\beta_2}{\pi d^2}$$ ---------- (**B1.3**)

The above formula (B1.3) may be solved using the double integral or using a numerical integration method in spread sheet form. This is explained below.

A spreadsheet calculator (SSC)[1] has been developed to determine the radiation flux experienced at a "target" originating from a pool fire in a circular tank, bund or flammable liquid storage depot with fire walls. It is intended typically for fires of petroleum liquids though it can be used with any material so long as the "emissivity" of the flame is known. This is the heat flux at the surface of the flame and is given in kiloWatts per square metre (kW/m^2). The other parameters needed are: diameter of tank/bund, height of the tank/walls (if any), distance to target, height of flame, tilt of flame caused by wind. It is assumed that the tank/walls have some height although there is no reason not to use the calculator for pool fires at ground level by entering a zero height.

[1] The Spread Sheet Calculator was developed by Dr Wayne Davies of the Chemical Engineering Faculty, Sydney University and Mr. Steve Sylvester of AECOM.

The SSC is designed on the basis of finite elements. The fire is assumed to be in the shape of a cylinder of the same diameter as the tank at its roof. The height of the fire can be calculated using **Formula B1.1**. Once the flame height is known, the surface of the cylinder can be divided into many separate plane surfaces. To do this, a plan view of the tank/bund was drawn and the relevant distances and angles allocated. The plan view is for the target and the tank in the same horizontal plane.

The angle "theta" is varied from zero to 90 degrees in intervals of 2.5 degrees. Zero deg. represents the straight line joining the centre of the tank/bund to the target (x0, x1,x2) while 90 deg. is the point at the extreme left hand side of the tank/bund. In this way the fire surface is divided up into elements of the same angular displacement. Note the tangent to the circle in plan. This tangent lies at an angle, gamma, with the line joining the target to where the tangent touches the circle (x4). This angle varies from 90 deg at the closest distance between the tank /bund and the target (x0) and gets progressively smaller as theta increases. As theta increases, the line x4 subtends an angle phi with x0. By similar triangles we see that the angle gamma is equal to 90-theta-phi. This angle is important because the sine of the angle give us the proportion of the projected area of the plane. When gamma is 90 deg, sin(gamma) is 1.0, meaning that the projected area is 100% of the actual area.

Before the value of theta reaches 90 degrees the line x4 becomes tangential to the circle. The fire cannot be seen from the rear and negative values appear in the view factors to reflect this. The SSC filters out all negative contributions.

For the simple case, where the fire is of unit height, the view factor of an element is simply given by the expression:

VF = ∆A. sin(gamma)/(π. x4. x4) .... Eq 1

where ∆A is the area of an individual element at ground level.

Note the denominator (π. x4. x4) is a term that describes the inverse square law for radiation assumed to be distributed evenly over the surface of a sphere.

As we see the value of x4 increases as theta increase and the value of sin(gamma) decreases as theta increase. This means that the contribution of the radiation from the edge of the circular fire drops off quite suddenly compared to a view normal to the fire. Note that the SSC adds up the separate contributions of Eq 1 for values of theta between zero until x4 makes a tangent to the circle.

It is now necessary to do two things: (i) to regard the actual fire as occurring on top of a tank/bund and (ii) to calculate and sum all of the view factors over the surface of the fire from its base to its top. The overall height of the flame is divided into 10 equal segments. The same geometric technique is used. The value of x4 is used as the base of the triangle and the height of the flame plus the tank, as the height. The hypotenuse is the distance from target to the face of the flame (called X4'). The angle of elevation to the element of the fire (alpha) is the arctangent of the height over the ground distance. From the cos(alpha) we get the projected area for radiation. Thus there is a new combined distance and an overall equation becomes:

VF = ∆A. sin(gamma).cos(alpha)/(π. x4'. x4') .... Eq 2

The SSC now turns three dimensional. The vertical axis represents the variation in theta from 0 to 90 deg representing half a projected circle. The horizontal axis represents increasing values of flame height in increments of 10%. The average of the extremes is used. e.g. if the fire were 10 m high then the first point would be the average of 0 and 1 i.e. 0.5 m. The next point would be 1.5 m and so on.

Thus, the surface of the flame is divided into 360 equal area increments per half cylinder making 720 increments for the whole cylinder. Some of these go negative as described above and are not counted because they are not visible. Negative values are removed automatically.

The sum is taken of the View Factors in Eq.2. Actually the sum is taken without the ∆A term. This sum is then multiplied by ∆A which is constant. The value is then multiplied by 2 to give both sides of the cylinder. This is now the integral of the incremental view factors. It is dimensionless so when we multiply by the emissivity at the "face" of the flame, which occurs at the same diameter as the tank/bund, we get the radiation flux at the target.

The following data was input to the spread sheet calculator:

- Pool diameter – 3.9m
- Flame height – 9.2m
- Transmissivity – 0.835
- SEP – 95.1 kW/m^2 (Ref.7, pg16/206)
- Angle of flame tilt – 15^o

The results of the analysis, using the SSC, indicated that the distance to a heat radiation of 4.7kW/m^2 was 14.2m from the fire.

B1.2 Mix Truck Fires

The ANFO mix is made up of about 94% ammonium nitrate and 6% diesel. The mix truck mainly carries Ammonium Nitrate with a relatively small diesel tank of about 500 litres.

An incident involving a collision between a mix truck and another vehicle may lead to diesel fuel tank damage, leak and spill of fuel on the ground around the vehicle. This incident would result in a pool of fuel oil under the vehicle and, if ignited, a pool fire would result. In a collision incident, resulting in truck rollover and tank damage, the impact would be relatively severe causing tank contents to release quickly. The resultant pool would spread over the ground to a depth of 5mm (Ref.8).

Pool Diameter

Based on a pool depth of 5mm (Ref.8) and a volume of 500 litres, the pool diameter would be 11.3m. It is noted that for diesel fires, the fuel spreads to a depth of 5mm. The burndown rate for diesel is 5mm/min (Ref.6). Hence, this fuel source in this incident would be exhausted within 1 minute, however, other combustibles on the vehicle (e.g. tyres, paint, cabin upholstery, etc.) would continue to burn, but with much less intensity.

Flame Height

From formula B1.1, $L = 42 \times 11.3 (0.0667/(1.2(9.81\times 11.36)^{0.5}))^{0.61} = 19.4$m

Heat Radiation Distance to 4.7kW/m^2

Using the SSC with the following data:

- Pool diameter – 11.3m
- Flame height – 19.7m (using **Formula B1.1**)
- Transmissivity – 0.8
- SEP – 51 kW/m^2 (Ref.7, pg16/206)
- Angle of flame tilt – 15^o

The results of the analysis, using the SSC, indicated that the distance to a heat radiation of 4.7kW/m^2 was 24.4m from the fire.

B1.3 Diesel Storage Fire

Diesel storage will be in three horizontal tanks, each of 110,000 litre capacity. One tank will be used for the fuelling of trucks and the other tank for loading mix trucks for the manufacture of ANFO. The tanks will be located in a common bunded area.
5
Dimensions of diesel storage tanks and bunded area are:

- Diesel tank dimensions – 3.5m diameter x 11m long;

- Diesel tanks bund – 22m long x 18m wide x 0.5m high

Using the same methodology for heat radiation calculations as presented in Figure B1.1, the following data is developed:

Equivalent bund diameter:

Area of bund = 22 x 18 = 396m^2

Area of equivalent circle – 396 = $\pi/4 \times (D^2)$

D = $(396 \times 4 / \pi)^{0.5}$ = 22.5m

Flame height

From formula B1.1, L = $42 \times 22.5 (0.0667/(1.2(9.81 \times 22.5)^{0.5}))^{0.61}$ = 31.26m

Heat Radiation Distance to 4.7kW/m^2

Using the SSC with the following data:

- Pool diameter – 22.5m
- Flame height – 31.26m (using **Formula B1.1**)
- Transmissivity – 0.783
- SEP – 28 kW/m^2 (Ref.7, pg16/206)
- Angle of flame tilt – 15^o

The results of the analysis, using the SSC, indicated that the distance to a heat radiation of 4.7kW/m^2 was 31.1m from the fire.

B1.4 Lube Oil Storage Fire

Lube oil will be stored in a bunded area within the pit top services compound. The bund will be in the order of 8mx5m.

Using the same methodology for heat radiation calculations as presented in Figure B1.1, the following data is developed:

Equivalent bund diameter:

Area of bund = 8 x 5 = 40m^2

Area of equivalent circle – 40 = $\pi/4 \times (D^2)$

D = $(40 \times 4 / \pi)^{0.5}$ = 7.1m

Flame height

From formula B1.1, $L = 42 \times 7.1 (0.0667/(1.2(9.81 \times 7.1)^{0.5}))^{0.61} = 14.02m$

Heat Radiation Distance to 4.7kW/m^2

Using the SSC with the following data:

- Pool diameter – 7.1m
- Flame height – 14.02m (using **Formula B1.1**)
- Transmissivity – 0.783
- SEP – 71.2 kW/m^2 (Ref.7, pg16/206)
- Angle of flame tilt – 15^o

The results of the analysis, using the SSC, indicated that the distance to a heat radiation of 4.7kW/m^2 was 19.9m from the fire.

B1.5 Earthmoving Equipment Refuelling Fire

Earthmoving equipment will be refuelled from a tanker vehicle that will circulate around the mine and fuel vehicles as required. In the event of an incident where a fuel hose breaks or an operator drops a hose whilst fuelling, there is a potential for a spill around the localised area of the failed or dropped hose. The operator or equipment driver would then respond and shut down the fuel transfer. Assuming, conservatively, this takes around 15 seconds with a flow rate of around 300L/min. the total spill would be around 75 Litres. Based on a spread to a depth of 10mm (conservative value for uncovered ground, Ref.8), the pool area would be:

Area = 0.075/0.01 = 0.75m^2
Diameter of pool = 0.98m

Using the same methodology for heat radiation calculations as presented in Figure B1.1, the following data is developed:

Flame height

From formula B1.1, $L = 42 \times 0.98 (0.0667/(1.2(9.81 \times 0.98)^{0.5}))^{0.61} = 3.54m$

Heat Radiation Distance to 4.7kW/m^2

Using the SSC with the following data:

- Pool diameter – 0.98m
- Flame height – 3.54m (using **Formula B1.1**)
- Transmissivity – 0.89
- SEP – 126.7 kW/m^2 (Ref.7, pg16/206)
- Angle of flame tilt – 15^o

The results of the analysis, using the SSC, indicated that the distance to a heat radiation of 4.7kW/m^2 was 4.8m from the fire.

B2. EXPLOSION OVERPRESSURE ANALYSIS

B2.1 Background

Detonators, primer and charge cords are not classified as high explosives (i.e. TNT or RDX). Detonators contain a small quantity of highly sensitive material (e.g. lead azide) that is readily initiated by electric current or impact pressure. This material is surrounded by a primer, (e.g. gun powder) which burns or decomposes rapidly when ignited. Primers burn rapidly releasing large volumes of hot expanding gases from a relatively small quantity of material.

ANFO is a low explosive and, when ignited, also decomposes rapidly producing large quantities of hot nitrogen gas and water vapour. In low explosives there is a fine line between rapid decomposition and detonation, hence in the mining environment, the explosive power of ANFO is produced by its confinement in a stemmed hole.

TNT (trinitrotoluene) is a high explosive and is manufactured to contain three nitro groups bonded around a single methylbenzene ring. Initiation of TNT results in detonation, releasing large quantities of explosive power. Invariably, detonators and primers are used to initiate TNT.

Based on the above details, TNT produces larger blast power than detonators or ANFO. In this study, TNT has been used as the basis for the blast impact calculations and, hence, the blast analysis provides a conservative screening tool for the study.

B2.2 Shotfirers Vehicle Explosion

Shotfirers will typically carry a 25kg of explosives (detonators, primer and blast cord, etc.) from the magazine to the blast pad. An explosion involving this material may project an overpressure wave offsite. The maximum permissible offsite overpressure impact from an explosion is 7kPa (Ref.3). Assuming conservatively that detonators/primer/blast cords have an equal explosive power to that of TNT (see Section B2.1), the distance from an explosion involving 25kg of TNT to an overpressure of 7kPa is calculated using Equation 5.1.

Scaled distance (λ) = $R/(M_{TNT})^{0.333}$ -----------(B2.1)

Where: λ = scaled distance read from the graph of Incident Overpressure for Surface Bursts (**Figure B1.2**, Ref. 6)

R= Distance from the centre of the explosion (m)

M_{TNT} = Mass of TNT (kg)

For an overpressure of 7kPa the scaled distance is 15 (from **Figure B1.2**)

Hence,

$15 = R/(25)^{0.333}$

$R = 15 \times (25)^{0.333}$

R = 44m

B2.3 Mix Truck Explosion

In the mix truck the only explosive mixture is the ANFO in the mix pump and pipework leading to the bore hole. An estimate of the quantity of ANFO in the pump and pipework has been made based on the pump and pipework volume and the density of Ammonium Nitrate, noting that ANFO is made up of 94% Ammonium Nitrate.

Pump volume (based on MONO pump) is 50mm diam x 300mm long

Volume = $\pi/4(0.05)^2 x0.3 = 6x10^{-4} m^3$

Pipework (50mm) from the mix pump to the bore hole is about 3m.

Volume = $\pi/4(0.05)^2 x3 = 0.006m^3$

Total volume of Ammonium Nitrate = $0.0066m^3$

Ammonium Nitrate has a density of $1730kg/m^3$ (Ref.9). Mass of Ammonium Nitrate in the pump and pipework is:

Mass = $0.0066m^3$ x $1730\ kg/m^3$

Mass = 11.41kg

Assuming conservatively that ANFO has the equivalent explosive power of TNT, and using **Formula 2.1**, the blast distance to an overpressure of 7kPa from an explosion involving 11.41kg of ANFO is estimated as follows:

For an overpressure of 7kPa the scaled distance is 15 (from **Figure B1.3**)

Hence,

$15 = R/(11.41)^{0.333}$

$R = 15 \times (11.41)^{0.333}$

R = 34m

B2.4 Magazine Explosion

The magazine on site will store about 500kg of explosives (detonators, primer and cords). Assuming conservatively that ANFO has the equivalent explosive power of TNT, and using **Formula 2.1**, the blast distance to an overpressure of 7kPa from an explosion involving 500kg of explosives is estimated as follows:

For an overpressure of 7kPa the scaled distance is 15 (from **Figure B1.2**)

Hence,

$15 = R/(500)^{0.333}$

$R = 15 \times (500)^{0.333}$

R = 119m

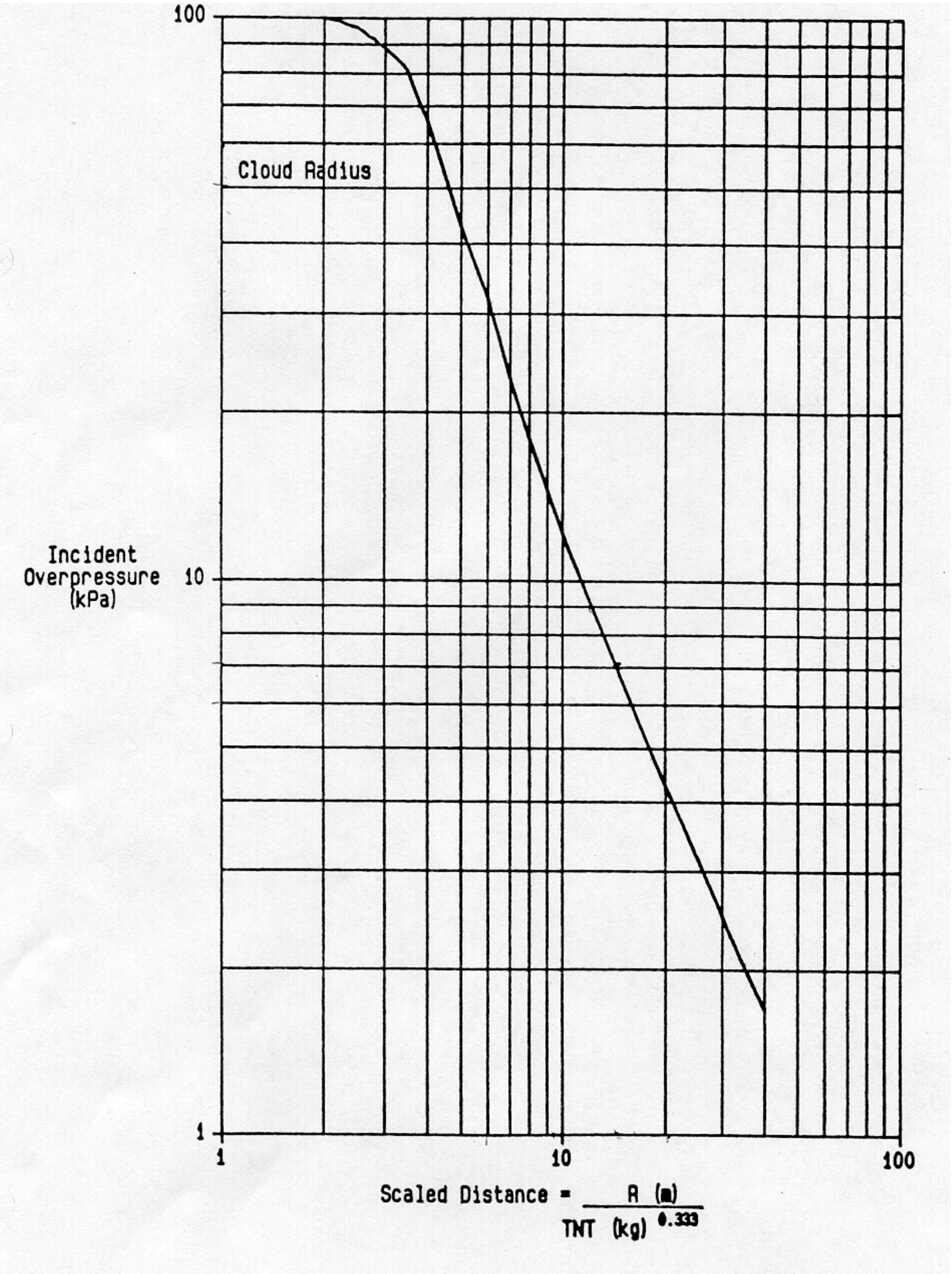


FIGURE B1.2
INCIDENT OVERPRESSURE FOR SURFACE BURST
(Source: Ref.6)

AECOM

Worldwide Locations

Australia	+61-2-8484-8999
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