Waste Management

9

9. Waste Management

This chapter of the Environmental Assessment provides the likely waste generation associated with the project. This will specifically look at the generation of obsolete equipment resulting from the upgrade of the turbines, boiler and auxiliary plant and the increases expected in the generation of fly ash and furnace ash.

9.1 Introduction

The Department of Environment and Climate Change's waste regulatory framework is administered under the principal legislation of the *POEO Act* and the *Waste Avoidance and Resource Recovery (WARR) Act 2001*. Achieving a reduction in waste generation, and turning waste into recoverable resources is a priority for NSW.

Changes to NSW waste legislation took affect in April 2008 following consultation with the waste industry and the broader community in 2007. The result of this consultation was a reduction in licensing categories for waste and a streamlined waste classification system (see Table 9.1).

Table 9.1 – Revised classifications for waste

Revised Classification	Old Classification
General solid waste (putrescible) (includes general household waste)	Solid waste
General solid waste (non-putrescible)	Solid waste Inert waste
Restricted solid waste	Industrial waste
Liquid waste	Group A (industrial liquids and sludges) Group B (grease trap and food waste) Group C (septic tank waste) Non-controlled aqueous liquid Hazardous liquid waste
(1) Hazardous waste (includes waste that meets the criteria for assessment as dangerous goods under the Australian Code for the Transport of Dangerous Goods by Road and Rail)[1]	Hazardous solid waste
Special waste (includes clinical and related waste, asbestos waste and waste tyres)	None existed

Source : DECCW website - http://www.environment.nsw.gov.au/waste/classification.htm

Note: (1) **Class 1**: Explosives, **Class 2**: Gases (compressed, liquefied or dissolved under pressure), **Class 8:** Corrosive substances, **Division 4.1**: Flammable solids (excluding garden waste, natural organic fibrous material and wood waste, and all physical forms of carbon such as activated carbon and graphite), **Division 4.2**: Substances liable to spontaneous combustion (excluding garden waste, natural organic fibrous material and wood waste, and all physical forms of carbon such as activated carbon and graphite), **Division 4.3:** Substances which in contact with water emit flammable gases, **Division 5.1**: Oxidising agents, **Division 5.2**: Organic peroxides, **Division 6.1:** Toxic substances

[1] From Australian Dangerous Goods Code and POEO Act (Part 3, clause 49)

The classifications are specified in the *POEO Act* (Schedule 1, Part 3) and by Department of Environment and Climate Change Guidelines[2]. Once a waste is properly classified, appropriate management options for it can be considered, as required under the *POEO Act* and the associated regulations.

The wastes likely to be generated as a result of the construction rehabilitation works will include general solid waste resulting from the removal of old and worn turbine and boiler parts.

The operation of the rehabilitated station will result in the same or similar waste streams to that of the currently operational station. There will be a likely increase in the production of furnace and fly ash. This is discussed separately in Section 9.4.

9.2 Regulations and Guidelines

9.2.1 Protection of the Environment Operations Act 1997

Environmental Protection Licenses are issued by the Department of Environment, Climate Change and Water to the owners of industrial premises under the *POEO Act*. The licence conditions relate to pollution prevention and monitoring, and cleaner production through recycling and reuse and the implementation of best practice.

Munmorah Power Station's EPL license provides list of possible wastes generated on the premises and what may be disposed of to the ash dam or within the ash dam catchment.

The wastes generated on site are also managed by Delta Electricity's waste management framework which addresses waste reduction, reuse and recycling.

9.2.2 Waste Reduction and Purchasing Policy

The NSW Government's Waste Reduction and Purchasing Policy (WRAPP) was announced by the Premier in September 1997. The policy requires all state government agencies and state owned corporations to develop and implement a WRAPP plan to reduce waste in four scheduled areas:

- paper products
- office equipment and components
- vegetation material
- construction and demolition material

It also requires that priority be given to buying materials with recycled content where they are cost and performance competitive. WRAPP plans provide information on strategies each agency will undertake to reduce waste and increase purchases of recycled content products and provide data on:

- total quantities of scheduled wastes being generated and recycled; and
- total quantities of materials being purchased which contain recycled content.

Delta Electricity fully complies with the NSW Government's WRAPP and aims to reduce landfill by about 10% each year in accordance with WRAPP (Delta Sustainability Report, 2008).

The WRAPP indicates that waste is sorted into general wastes (including putrescible wastes), recyclables, refuse oil, metals, timber, concrete and vegetation, with categories for recyclable waste being the same as that used by local Councils for residents (Connell Wagner, 2008). The most significant non-hazardous waste generated is ash (fly ash and furnace ash).

The policy requires agencies to report progress in implementing their WRAPP plans biennially to the Department of Environment and Conservation[3] and therefore monthly records are records are kept of:

- Rubbish to tip (tonnes)
- Recycled material (cubic metres)
- Scrap ferrous metal (tonnes)
- Waste oil (litres)
- 205 L drums
- Scrap ni-hard (tonnes)
- Paper
- Toner cartridges

[2] NOTE: The Department replaced the *Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-liquid Wastes* with a series of new Waste Classification Guidelines which are available from the Department website.

[3] Formerly the NSW Environment Protection Authority – http://www.wrapp.nsw.gov.au/whatis/aboutwrapp.shtml

9.3 Waste Generated During Construction

The proposed rehabilitation programme will not involve any significant changes to the current layout of the site. Therefore no major earthworks and demolition of existing plant will be required. The majority of the waste will be generated through the upgrade of some components and the replacement of other out moded boiler and turbine parts. The waste generated is likely to include:

- Condenser, furnace and turbine tubes
- Waterboxes, water coolers and strainers
- pipe work
- Outmoded pumps, motors and fans
- Heater baskets and seals
- Brush gear
- Hydrogen driers
- Seal oil systems
- Capacitors
- 110V and 50 Batteries
- Lamps, wiring

These wastes are all classified as General solid waste (non-putrescible) and would be form part of the normal register of waste generated during day to day maintenance operations and are managed in accordance with Delta Electricity's waste management framework.

There is also likely to be some liquid waste in the form of waste oil and waste water. These will also be managed in accordance with the waste management framework and within the current water management principles.

9.4 Waste Generated During Operation

9.4.1 Munmorah Power Station waste streams

The waste streams identified in Table 9.2 are generated during the normal day to day operation of Munmorah Power Station.

These streams, other than ash which is discussed in more detail in below, are not expected to change significantly as a result of the operation of the rehabilitated power station.

Table 9.2 – General waste streams generated Munmorah Power Station

Waste Stream	Description	Arrangement	Volume Recycled \ Reused
General waste	Household waste that contains putrescible organics	Municipal Services	
Ash	Fly ash Bottom ash Cenospheres	Vales Point ash dam – Blue Circle Ash (combined figure for Delta CC ash production) Munmorah ash dam – Blue Circle Ash – Note that no ash is reclaimed from Munmorah ash dam. Blue Circle Ash only reclaim at Vales Point ash dam. Morgan Ash take flyash direct from fabric filter hopper outlets at Vales Point. Vales Point ash dam – Blue Circle Ash	17% - 30% 1% (Cenospheres)
Mixed recyclables	Paper, cardboard boxes and cartons, Glass, PET plastic containers (not plastic bags), Aluminium and steel cans	Municipal Services	60 to 80%
Metals	Mixed ferrous Other non-ferrous metals	Specialist waste contractors	40 to 80%
Electrical	Scrap electrical cables, components, sundry items	Specialist waste contractors	40 to 60%
Drums / containers	205L Metal drums 20L & 25L plastic drums 200L Hydrazine containers	Specialist waste contractors Specialist waste contractors Specialist waste contractors	70% 40 to 80% 40 to 80%
Oils / Grease	Lubricating and sump Oil Turbine oil Transformer oil Grease	Specialist waste contractors Specialist waste contractors Specialist waste contractors Specialist waste contractors	40 to 80% 40 to 80% 40 to 80% 10 to 40%
Solvents / paints	Parts cleaning solvent Other solvents and paints	Specialist waste contractors	60 to 90%
Batteries	Vehicle batteries Rechargeable (Ni-Cd) batteries	Specialist waste contractors	60 to 80% Not recycled
Tyres	Tyres (car and coal vehicles)	Specialist waste contractors	60 to 80%
Other	Toner cartridges Styrofoam Salvage items Sewage effluent Conveyor belts	Specialist waste contractors Specialist waste contractors Specialist waste contractors San Remo sewage treatment plant Specialist waste contractors	60 to 80% 60 to 80% >80% n/a 60 to 80%

NOTE: Estimates are low (10 to 40%), moderate (40-60%), High (60-80%), Very High (>80%)

9.5 Ash Generation and Storage

The combustion of coal produces around 25% ash of which about 10% is furnace ash and 90% is fly ash. While beneficial use of the ash product is preferred and promoted, the majority of ash produced by power stations is currently stored in ash dams.

Munmorah Ash Dam is located on the southern side of the Pacific Highway, approximately 1 km north of Munmorah Power Station, immediately west of Lake Munmorah. The Munmorah Ash Dam was originally designed to store both furnace ash and fly ash from Munmorah Power Station, but since the early 1970's, fly ash from Munmorah Power Station has been deposited in the Vales Point Ash Dam. The fly ash from Munmorah power station is collected in the fabric filters and is transported via two fly ash pipelines to the disposal point at Vales Point Ash Dam.

Vales Point Ash Dam is located on the western side of the Pacific Highway, approximately 1 to 2 km southwest of Vales Point Power Station, at the southern end of Lake Macquarie. It was originally designed to store fly ash and furnace ash produced by Vales Point Power Station and commenced operating in 1962. (Aurecon, May 2009)

9.5.1 Current estimated storage capacity and dam volumes

A capacity survey of the Vales Point and Munmorah ash dams was undertaken in 2008 (Connell Wagner, 2008). Projections of ash production were based on historical levels of coal usage, ash generation and ash sales. These were used to predict possible ash scenarios and hence the expected storage life of the facilities (Table 9.3).

Table 9.3 – Estimated ash dam capacity (Aurecon, May 2009)

Ash dam	Area (ha)	Estimated Capacity (m^3)	Estimated Life
Vales Point	450	17.5 million	2032 (~23 years), if annual average ash sales were 20%
Munmorah	105	2.8 million	Not calculated – assumed sufficient

9.5.2 Storage capacity based on increased power generation

Based on the results of the ash dam surveys undertaken by Connell Wagner in 2008, a further investigation was carried out to establish future ash storage requirements following the progressive commissioning of the rehabilitated plant around 2014 to 2015. This information is based on the assumption that Munmorah will operate at 700MW at 80% capacity factor and based on current planned operations for both Vales Point and Munmorah Power Stations.

Ash production volumes are dependant annual power production requirements for the power station, power plant design and performance, coal properties (particularly % ash content) and ash sales. Based on these requirements a number of scenarios were identified as being indicative of future coal characteristic and of future planned ash sales. The scenarios are as follows:

- range of coal with varying ash content ie 22% and 24% based on historical data.
- Ash sales from Vales Point Power Station – 20% (it is currently estimated that approximately 17% of ash from Vales Point ash dam is sold)
- Ash sales from Munmorah Power Station – 20% No ash is currently sold at Munmorah Power Station

Table 9.4 provides a summary of various scenarios based on 100% coal firing and based on the worse case scenario. This table indicates when ash storage at Vales Point ash dam will be exhausted, based on current wet transport and placement methods.

Table 9.4 indicates that the rehabilitation of Munmorah Power Station will shorten the expected life of the ash dams by anything between two and eight years depending on the ash content of the coal. The impact of ash sales to industry for beneficial use is significant.

As part of the technical investigations carried out by Aurecon, the PROATES model was also used to calculate the ash disposal requirements for the various gas / coal scenarios. Table 9.5 summarises these results. All cases assume the 24% ash 'rehabilitation' design coal.

Table 9.4 – Predicated life for Vales Point ash dam (100% coal firing)

	BASE CASE	CASE 1	CASE 2
Scenario / ash content of coal	**Munmorah not Rehabilitated**	**Munmorah Rehabilitated**	**20% Fly Ash Sales from Munmorah**
20% Fly Ash Sales from Vales Point PS			
22%	**2033/2034**	2025/2026 (-8)	2026/2027 (-7)
24%	**2031/2032**	2023/2024 (-8)	2024/2025 (-7)

NOTE: Numbers in parenthesis (-8) indicate the reduction in predicted life time in years from the base case (Munmorah not rehabilitated and closing in 2012)

Table 9.5 – Calculated ash production rates taken from PROATES (Aurecon, 2009)

	Original Perf (1969) 2 X 350MW 100% Load	Recent Perf. (2006) 2 X 290MW 100% Load	Predicted Performance 2 X 350MW 100% Load				Approx 80% Load
Gas input energy	**0.0%**	**0.0%**	**0%**	**25%**	**50%**	**75%**	**0.0%**
Total ash (kg/s)	10	9	10	7	5	3	8
Total ash (kt/yr/Unit)	324	298	306	233	157	79	259
Total ash (kt/yr/Station)	647	595	613	465	315	159	517
Fly ash (kt/yr/Station)	550	506	521	396	267	135	440
Bottom ash (kt/yr/Station)	97	89	92	70	47	24	78

Table 9.6 – Predicted life for Vales Point ash dam based on PROATES calculated ash production rates (24% ash)

	BASE CASE	CASE 1	CASE 2
Gas input energy	**Munmorah not Rehabilitated**	**No fly ash sales**	**20% ash sales**
0%	2031/2032	2021/22 (-10)	2024/2025 (-7)
25%		2022/23 (-9)	2025/2026 (-6)
50%		2023/24 (-8)	2028/2029 (-3)
75%		2025/26 (-6)	**2032/2033 (+1)**

Figures in bold indicate an extension of life over the current expected 2031/32

Table 9.6 indicates the estimated time when ash storage at Vales Point ash dam will be exhausted, based on current wet transport and placement methods and using the values provided in Table 9.5

The Munmorah Ash Dam has an estimated storage capacity of 2.8 million m^3. If it is assumed both furnace ash and fly ash are stored in Munmorah ash dam, with no ash sales it is estimated that for assumed ash content between 22% and 24% Munmorah Ash dam is capable of storing the total ash production for seven to eight years, using the existing wet disposal slurry system.

As the currently operating units at Vales Point Power Station are expected to continue operating until 2029, a further estimate of available ash storage has been undertaken based on, the storage available in Munmorah ash dam and the surplus storage available in Vales Point Ash Dam. This scenario considers the possible separation of the Vales Point and Munmorah assets, in a way that does not impact Vales Point operations.

Taking the storage capacity scenarios of both ash dams in to account, with the proviso that ash storage for Vales Point Power Station is able to store its projected ash production, it is predicted that, in the absence of significant increases in the demand for ash products, flyash could continue to be stored in Vales Point Ash Dam until around 2019/20. Beyond that, alternative ash storage strategies for about 6 Mt of Munmorah fly ash, probably within the boundaries of the existing Central Coast Ash Dams would need to be investigated.

Several options for flyash disposal technologies have been identified and considered feasible at a conceptual level, but there would need to be further detailed feasibility studies to confirm their viability. The options are considered in the following section.

9.6 Future ash disposal options for Munmorah

At Delta Electricity's request, Aurecon has undertaken a preliminary investigation of viable options for the disposal of flyash from Munmorah Power Station, beyond the current projected life of the Vales Point ash dam.

9.6.1 Assumption used

A number of assumptions have been used to assess future ash storage options. The worse case scenario assumed is 26% ash content and current estimated ash sales of 17%.

It has also been assumed that Munmorah will be re-furbished in the period 2012/13 and that Vales Point cease operation in 2029 and Munmorah will cease operation in 2034.

9.6.2 Ash disposal options considered

The following options have been identified Table 9.6 provides an overview of the feasibility and environmental considerations for each of the options.

- **Options 1a and 1b**: Retain the current lean slurry disposal systems at Vales Point (1a) and Munmorah (1b) with additional ash terracing to increase storage capacity. This technique of ash storage is a proven storage method for a range of industrial by-products.
- **Options 2a and 2b**: Install a dry ash collection system with pneumatic conveyer to transport flyash to Vales Point Ash Dam (2a) and to Munmorah Ash Dam (2b)
- **Options 3a and 3b**: Install a dry ash collection system and use trucks to transport flyash to Vales Point Ash Dam (3a) and Munmorah Ash Dam (3b)
- **Options 4a and 4b:** Install a dry ash collection system with enclosed conveyer to transport flyash to Vales Point Ash Dam (4a) and Munmorah Ash Dam (4b)
- **Options 5a and 5b:** Installation of dry ash collection system with dense slurry mixing and pumping system to Vales Point Ash Dam (5a) and Munmorah Ash Dam (5b).
- **Option 6:** It may also be possible to pump flyash to a nearby disused mine site for back-filling. This would be done by dense slurry pumping.
- **Option 7:** For all the above options, additional ash terracing, ash fencing and/ or turkeys-nest emplacements could be installed on top of the existing ash placements, to enable the stacking of flyash to a higher level.

Raising the level of the ash dam may also be an option once the dam is filled, with the ash dam wall extensions being constructed of flyash, and terraced back in from the existing ash dam walls.

Table 9.7 – Summary of flyash disposal options for Munmorah and Vales Point

Option Number	description	Comment	Environmental Considerations
1a	retain lean slurry disposal system to Vales Point ash dam with additional ash terracing to increase storage capacity	This is a low cost option using current system. Adding a series of ash fences will enable ash terracing and/or turkey-nesting and the stacking of flyash to a higher level. This technique of ash storage is a proven storage method for a range of industrial by-products.	• Lake Water usage – High water usage and associated ash water management requirements. Possible impacts on groundwater and discharge to local catchment • Dust – some dust emissions from ash dam surface if allowed to dry out • Visual – additional visual impact may result as the height of the dam is increased
1b	retain lean slurry disposal system with new pipelines to Munmorah ash dam with additional ash terracing to increase storage capacity	Low cost option with established access. Includes new flyash conveying pipeline is laid in the existing bottom ash conveying pipeline corridor to the Munmorah ash dam. A return water system will need to be provided to recover the water from the lean slurry for re-use.	• Lake Water usage – High water usage and associated ash water management requirements. Possible impacts on groundwater and discharge to local catchment. Water return system would ensure re-use of water and place less dependence on domestic water supply. • Dust – some dust emissions from ash dam surface if allowed to dry out • Visual – additional visual impact may result as the height of the dam is increased • Other – the use of existing pipeline corridors will minimise additional impacts during construction ie vegetation clearing, heritage
2a	Install dry ash collection system with pneumatic conveying to Vales Point ash dam	High capital and operating costs for compressor plant. This option is not practical and has **not been considered further**, due to the distance involved (approximately 3.5 to 4 km)	Not considered further
2b	install dry ash collection system with pneumatic conveying – Munmorah ash dam	Conveying system requires very large, dedicated compressed air plant to shift the flyash. High capital and operating costs associated with compressor plant.	• Lake Water usage – significantly reduced surplus water required and therefore reduced associated management issues ie possible groundwater impacts and discharges to local catchment are reduced • Dust - areas of exposed uncapped ash are reduced but an ongoing dust suppression system including need for water truck or sprinkler system will be required for the conveyor system • Noise – noise impacts will likely result due to the compressor operation but noise impacts considered less than option 3a and 3b and can be managed. • Other – the use of existing pipeline corridors will minimise additional impacts during construction ie vegetation clearing, heritage

Option Number	description	Comment	Environmental Considerations
3a	install dry ash collection system at Munmorah with fly ash being trucked to Vales Point ash dam	This option was **not considered further,** as it would involve regular and frequent truck movements on public roads between Munmorah and the Vales Point ash dam.	The potential for ash spillage and/ or airborne dust during transport and the hazard created by the significant truck movements on public roads are likely to be unacceptable.
3b	install dry ash collection system with fly ash being trucked to Munmorah ash dam	The suitability and/or need to upgrade the access road would need to be assessed. This method of ash placement is currently successfully used at various locations, including Delta Electricity's Mount Piper Power station near Lithgow.	• Lake Water usage – low water usage and therefore significantly reduced surplus water and associated management issues. • Dust - Reduced areas of exposed uncapped ash however ongoing dust suppression will be required until exposed areas are capped ie additional water trucks or sprinkler system. • Transport – increased number of trucks required to travel between the power station and ash dam with possible dust and noise issues to be managed. • Noise – noise of compressors, conveyors at ash dam etc will be managed through the noise management plan. Levelling and compacting of the conditioned fly ash within the storage area would be achieved using a front-end loader or bulldozer • Other – if access road require upgrade, possible impacts associated with vegetation clearing would need to be assessed. If managed correctly this can be achieved with minimal impact.
4a	install dry ash collection system with enclosed conveyor taking flyash to Vales Point ash dam	Ash conveyor would probably follow existing ash or coal conveyor corridor. Required to travel a long distance and would need to cross the Pacific Highway possibly requiring a dedicated conveyor bridge. Ongoing maintenance of ash conveyor will be required and can be difficult.	• Lake Water usage – low water usage and therefore significantly reduced surplus water and associated management issues. • Dust - Reduced areas of exposed uncapped ash however ongoing dust suppression will be required until exposed areas are capped ie additional water trucks or sprinkler system. Although an enclosed system there may be potential for dust escaping along the conveyor route which would be managed. • Noise – increased noise over conveyor route. Noise at ash dam would need to managed as levelling and compacting of the conditioned fly ash would be achieved using a front-end loader or bulldozer • Transport – Avoids the use of trucks on roads • Other – the use of existing pipeline corridors will minimise additional impacts during construction ie vegetation clearing, heritage. However if a dedicated conveyor bridge is required an more detailed assessment will be required at the time of construction

Option Number	description	Comment	Environmental Considerations
4b	install dry ash collection system with enclosed conveying to Munmorah ash dam	The conveyor to Munmorah ash dam would need to follow the existing bottom ash slurry disposal pipeline corridor, or the pipeline access road. Apart from the potential for localised impacts, this option would be expected to be practicable and achievable.	• Lake Water usage – low water usage and therefore significantly reduced surplus water and associated management issues. • Dust - Reduced areas of exposed uncapped ash however ongoing dust suppression will be required until exposed areas are capped ie water trucks or sprinkler system. Although an enclosed system, potential for dust escaping along the conveyor route would require management. • Noise – increased noise over conveyor route although less likely impact the local residents compared to option 4a. Noise at ash dam would need to managed as levelling and compacting of the conditioned fly ash would be achieved using a front-end loader or bulldozer • Transport – Avoids the use of trucks on roads • Other – the use of existing pipeline corridors will minimise additional impacts ie vegetation clearing, heritage
5a	install dry ash collection system with dense slurry mixing and pumping system – Vales Point ash dam	A new dense phase fly ash pipeline would be required but would follow existing pipeline corridor. System is used at other mines in NSW.	• Lake Water usage – lower water usage than the lean phase slurry and therefore reduced surplus water and associated management issues. • Dust - Reduced areas of exposed uncapped ash however ongoing dust suppression will be required until exposed areas are capped ie water trucks or sprinkler system. • Noise – some noise suppression may be required at Munmorah for the pumps but likely to be managed within the noise management plan. • Other – the use of existing pipeline corridors will minimise additional impacts ie vegetation clearing, heritage
5b	install dry ash collection system with dense slurry mixing and pumping system – Munmorah ash dam	A new dense phase fly ash pipeline would be required but would follow existing pipeline corridor. A return water system would need to be provided to recover the water from the slurry for re-use.	• Lake Water usage – lower water usage than the lean phase slurry and therefore reduced surplus water and associated management issues. Water return system will also ensure re-use of water and place less dependence on domestic water supply • Dust - Reduced areas of exposed uncapped ash however ongoing dust suppression will be required until exposed areas are capped ie water trucks or sprinkler system. • Noise – some noise suppression may be required at Munmorah for the pumps but likely to be managed within the noise management plan. • Other – the use of existing pipeline corridors will minimise additional impacts ie vegetation clearing, heritage

Option Number	description	Comment	Environmental Considerations
6	install dry ash collection system with dense slurry mixing and pumping system – backfill disused mine	Potential to sterilise access to coal resources.	Environmental issues will vary depending on site selected and would require detailed evaluation of any proposed site. • Lake Water usage – potential groundwater contamination, although less water is used in the dense slurry than is used in a lean slurry. • Visual – visual impacts are reduced substantially with the underground storage of fly ash
7	ash terracing, ash fencing and/ or turkey-nesting	Can be applied to most of the above options and is relatively inexpensive to do. Large gains in available storage volume can be achieved.	• Visual – additional visual impact may result as the height of the dam is increased • Dust – ongoing dust suppression will be required until exposed areas are capped ie water trucks or sprinkler system. • Other – Erosion controls and management required

9.6.3 Discussion

It is estimated that until Munmorah is decommissioned (in 2034) up to 8.77 million m^3 flyash will require disposal. Of this only 840,000 m^3 can be disposed of using current methods in the Vales Point ash dam (assuming 26% ash content of coal, current 17% ash sales at Vales Point, no raising of ash dam walls or ash terracing and Vales Point being decommissioned in 2029). Projections based on a combination of worst case scenarios suggest that alternatives for Munmorah flyash disposal could be required as early as 2011.

However, given that Munmorah Ash Dam has a 2.8 million m^3 capacity, both flyash and furnace ash could be directed to the Munmorah Ash Dam for an intermediate period of time (up to at least 2019 depending on ash sales). This would require the establishment of a return water management system for the effective management of surplus water.

A preliminary investigation has shown that alternative technologies for the storage of the worst case surplus ash are viable at a conceptual level, but will need to be considered in more detail, to confirm their viability and a preferred option.

9.7 Beneficial uses for fly ash

Furnace ash and fly ash can be used for a number of building and landscaping products. The quality of ash by products is dependent on the quality of the coal, the efficiency of the furnace, the method of ash collection, crushing, transport, where the product is collected and any further treatment undertaken.

9.7.1 Furnace ash uses

- To provide a lightweight aggregate in concrete. Lightweight concrete is mainly used to create lightweight masonry products.
- Furnace ash can be used as a sand replacement for road base, building foundations, pipe bedding and other construction uses where sand is used.
- Due to its particle size and grading furnace ash can be used where free draining or filtering material is needed.
- Furnace ash has successfully been used in blends with organic material to produce potting mixes and topdressing.

9.7.2 Fly ash uses

- Dry fly ash can be used as a partial replacement for cement in concrete. The addition of fly ash produces a more durable concrete.
- Fly ash stabilised with cement can be used for road construction as a road base.
- Fly ash can be used for structural purposes such as retaining walls, embankments and landfill.
- Fly ash is being used as landfill to rehabilitate open cut coal mines.
- Trials in Western Australia have proved the viability of fly ash when used to amend topsoils, for use in non-edible agriculture such as turf farms and subsequent uses in park lands and golf courses.

9.7.3 Cenospheres

Many plastics, composites and paints use fillers during their manufacturing processes. Cenospheres can be used as a filler for various applications. These include:

- pattern making
- mould making and casting
- foam-filled sandwich glass fibre panels
- fire-resistant boarding
- urethane systems
- PVC frames
- putty
- paint and varnish
- radio and infra-red stealth.

(UK DTI, 2002)

9.7.4 Improving ash quality

Ash quality is of importance if the product is to be used in particular industries, this is specially so for the construction industry. At present the ash that is sold is extracted from the ash steams at locations that maximise its value for certain uses.

Carbon in ash has the greatest impact on the quality of ash, but fineness of flyash and colour (whiteness) of cenospheres can reduce the value of the product.

Numerous technologies can be considered for improving the quality of the flyash (ie beneficiation); however the adoption of these technologies depends

on current markets and economics. While not a significant issue at present, the beneficiation of fly ash may become increasingly important should Delta Electricity be required to increase the amount of fly ash utilised in the future (UK DTI, 2002).

9.8 Mitigation Measures

Delta fully complies with the NSW Government's WRAPP and aims to reduce landfill by about 10% each year in accordance with WRAPP (Delta Sustainability Report, 2008).

Solid waste is segregated into recyclable and non-recyclable waste products where possible and disposed off-site by licensed waste contractors. All waste is classified and disposed of in accordance with the *Waste Classification Guidelines*[4] produced by the Department of Environment, Climate Change and Water.

The Munmorah ash dam is managed through the Central Coast Ash Dam Management plan, which is revised on a five yearly basis. This includes the ongoing monitoring of discharges from the ash dam (Chapter 8) and ongoing monitoring of dust emissions (Chapter 7).

In the absence of new markets, sales of Delta Electricity Central Coast flyash, furnace ash and cenospheres is expected to continue at around current rates. While Delta Electricity aims to increase these sales in the future and continues to encourage development of new markets for these products in creases in the volume of ash sales are not certain. It is noted that current ash sales reflect the state of the market for the beneficial use of ash products at present and significant increases may be unlikely without market and regulatory changes.

In order to secure the projected ash disposal requirements for Vales Point Power Station, the rehabilitated Munmorah Power Station will need to develop new ash storage arrangements.

A preliminary investigation has identified that viable options for the disposal of flyash from Munmorah Power Station can be developed. Several options for flyash storage technologies have been identified and considered feasible at a conceptual level. Some of these options, subject to further detailed investigation, appear to be capable of being incorporated within existing disturbed areas of one or both power station sites.

Further detailed feasibility studies are required to confirm a preferred option. While the development of a new ash storage system may require a separate Environmental Approval, potential Environmental concerns have been screened in this EA.

A decision to proceed to seek approval to develop a new storage would be based on commercial arrangements and actual ash production rates and storage requirements in the next few years.

9.9 Conclusions

As the rehabilitation works will occur within the existing plant layout of the power station, the management of solid and liquid waste will be managed in accordance with existing waste management plans. Delta Electricity are required to record and report the quantities of wastes generated on an annual basis.

In the absence of new markets, sales of Delta Electricity Central Coast flyash, furnace ash and cenospheres is expected to continue at around current rates.

Based on projections of the life of the Vales Point Ash Dam, and in consideration of current ash sales, fly ash from Munmorah can be stored within this facility for around 6 – 7 years without jeopardising the storage requirements for Vales Point. .

In the event that options for the co-firing with gas become commercially attractive, lower coal usage would result and therefore less ash would be produced and the period that ash storage is available would be extended.

Currently fly ash is disposed of at Vales Point ash dam and furnace ash from Munmorah Power Station is disposed of in the Munmorah ash dam. Munmorah ash dam has a capacity of 2.8 million m^3 which is expected to be more than sufficient to store furnace ash for the proposed 20 year life extension of the power station.

Fly ash from Munmorah Power Station will continue to be disposed of at Vales Point ash dam while surplus storage beyond the projected life of Vales Point Power Station is available. Beyond this (estimated 6-7 years), fly ash disposal from Munmorah will require the development of new ash storage options. The necessary planning approvals for additional storage of Munmorah fly ash will be sought as required.

[4] Waste Classification Guidelines replaced the *Environmental Guidelines: Assessment, Classification & Management of Liquid & Non-Liquid Wastes (1999)*

Hazard and Risk

10

10. Hazards and Risks

This chapter of the Environmental Assessment examines the hazards and risks associated with the 'potentially hazardous' aspects of the Proposal.

10.1 Introduction

The NSW Department of Planning (DOP) has requested that a Preliminary Hazard Analysis (PHA) and risk assessment (RA) be conducted for the proposed Munmorah Power Station rehabilitation. The Director- General's requirements stipulate that a screening of potential hazards on site and determination of the potential for offsite impacts and any requirements for a PHA be completed before approval. The PHA should identify potential off site impacts and must be prepared in accordance with the Department's relevant documentation and guidelines.

Preliminary risk screening of the proposed development is required under NSW *State Environmental Planning Policy No 33* (SEPP 33). SEPP 33 requires the proponents of potentially hazardous and/or offensive developments to undertake a PHA to determine the level of risk to people, property and the environment at the proposed location and in the presence of controls.

Should the risk level exceed the criteria of acceptability or if the controls are assessed as inadequate to prevent offensive impacts on the surrounding land users, the development is classified as a 'hazardous industry' or 'offensive industry' respectively and may not be permissible within most industrial zones in NSW.

A development may also be considered potentially hazardous with respect to the transport of dangerous goods. A proposed development may be potentially hazardous if the number of generated traffic movements (for significant quantities of hazardous materials entering or leaving the site) is above the cumulative annual or peak weekly vehicle movements. Table 2 in the document *Applying SEPP 33* (DUAP, 1994) outlines the screening thresholds for transportation. If the development's transportation of dangerous goods exceeds the thresholds a route evaluation study should be completed in accordance with the route selection guidelines prepared by the Department of Planning.

10.1.1 Dangerous goods storage and handling at Munmorah

Delta Electricity currently holds a manifest of quantities for Dangerous Goods associated with Munmorah Power Station. The full list is included as Appendix G and includes:

- flammable gases
- non-flammable gases
- flammable liquids
- corrosive substances
- combustible liquids.

Dangerous Goods stored on-site would remain unchanged from current operations except for any increases that would occur if CO_2 and solvent storage facilities are developed at the site. In addition, a 300 mm pipeline approximately 500 m in length would transport natural gas at 1000 kPa from the boundary to burners operating in the boilers. It is assumed that the pipeline would flow continuously and would not be classified as a storage facility.

10.2 Methodology

The PHA is provided in full in Appendix G, and aims to provide sufficient information and an assessment of risks to demonstrate that that Proposal satisfies current risk management requirements. The primary role of the PHA is to demonstrate that residual risk levels, having considered risks and proposed mitigation measures and safeguards, are acceptable in relation to the surrounding land use and that the risks would be appropriately managed.

The PHA included the following steps:

- identifying hazards and abnormal process conditions that could lead to hazards
- identifying inherent and existing safeguards
- assessing the risks by determining the probability (likelihood) and consequence (severity) of hazardous events for people and the surrounding land uses and environment
- identifying opportunities to reduce the risks by elimination, minimisation and/or incorporation of additional protective measures.

A preliminary risk screening of the proposed development, as required under SEPP 33, was undertaken to determine the need for a PHA. The preliminary screening assesses the storage of specific dangerous goods classes that have the potential for significant off-site effects. The results of the preliminary screening are discussed in Section 10.5.1.

The DOP's document *Multi-Level Risk Assessment* (1997) suggests the use of preliminary analysis of the risks related to a proposed development to enable the selection of the most appropriate level of risk

assessment in the PHA. This preliminary analysis includes risk classification and prioritisation based on a risk assessment undertaken during review of the design for the proposed installation.

There are three levels of risk assessment in the Multi-Level Risk Assessment. A level one assessment is essentially qualitative identifying all possible risk scenarios and their relevant consequences and likelihoods. An evaluation of the risks should be completed in conjunction with the qualitative criteria in the Hazardous Industry Planning Advisory Paper No. 4 (HIPAP No. 4). It should demonstrate that adequate safeguards are in place to ensure the ongoing safety of a proposal. A level two assessment is semi-quantitative and should include sufficient quantification of any significant off-site consequences to determine that the relevant risk criteria would be met. A level three assessment is a full quantification of the relevant risk scenarios and should be conducted in accordance with the Hazardous Industry Planning Advisory Paper No. 6 (HIPAP No. 6).

In order to identify the potential hazards involved for the Proposal, facilitated risk assessments were conducted at the Munmorah Power Station site on 18 August 2009 and by phone conference on 20 August 2009. The assessment included reviewing the layout, function, operation and maintenance of the proposed natural gas burner pipe work and system, the new coal conveyor system and the proposed carbon capture and storage plant and identifying means (hazards and scenarios) by which Delta Electricity employees, contractors, visitors and neighbours may be injured by the proposed changes. The risk assessment excluded occupational risks and detailed design issues.

The agreed scope and boundaries of the risk assessment were:

- risks arising from storage and handling of dangerous goods; and
- process emissions to air/water/land.

Packaged systems (natural gas burners, burner valve trains and burner management systems) were assumed to be supplied fit for purpose and have not been included in this assessment. Work related to coal fired rehabilitation was included in this assessment only where it could have potential off-site impacts. Existing infrastructure for Colongra was considered as an affected neighbour.

The risk assessment was conducted in the form of a structured workshop, facilitated by Advitech and attended by Delta Electricity and Aurecon personnel involved in the facility's design, development and operation. A systematic approach was used to identify risk scenarios and minimise the possibility of missing important information consistent with the requirements of *AS/NZS4360 Risk Management* (2004).

10.3 Risk Criteria

10.3.1 Risk classification and prioritisation

The risk assessment used guide words and descriptive scales to determine the probability of each identified hazard and its consequences. This provided an estimate of the likely rate of occurrence of hazardous events and their severity, from which a measure of the risk was obtained through application of a risk matrix.

The risk associated with a proposed development is determined by combining the likelihood of the potentially hazardous events and their consequences/severity. The process of combining consequences and likelihoods gives appropriate weight to the range between small consequence events (which are relatively frequent) and events of major consequence (which are very infrequent).

Advitech's Risk Classification System was used for this risk assessment. Consequence was scored by assigning a value between 1 and 5 (1 was least consequence, 5 was greatest consequence), and then likelihood was given a ranking between A-E (A was more likely, E was less likely). The resulting risk score was determined according to the matrix provided in Table 10.1 below where risk = consequence x likelihood. (Refer Section 6.8 of Appendix G for more detail).

Table 10.1 – Risk assessment

Consequence	Likelihood					
		A	B	C	D	E
	1	25	24	22	19	15
	2	23	21	18	14	10
	3	20	17	13	9	6
	4	16	12	8	5	3
	5	11	7	4	2	1

Ranking	Range	Priority
Extreme	20-25	Requires urgent and immediate attention, senior management response needed.
High	12-19	Requires proactive management, senior management attention needed.
Moderate	6-11	Requires active monitoring, management responsibility must be assigned.
Low	1-5	Dos not require active management, manage with routine procedures.

10.3.2 Level of risk assessment

Multi-Level Risk Assessment (DOP, 1997) provides guidance on choosing the level of assessment required based on dangerous goods classes. For Australian Dangerous Goods (ADG) classes 1 to 3, four conditions need to be satisfied for a purely qualitative assessment to be acceptable:

1. *All points on the indicative societal risk curve produced from the risk classification and prioritisation should be below the negligible line.*
2. *There should be no events with consequences extending significantly beyond the site boundary at a frequency of greater than 1 x10^{-7}.*
3. *The process and operation should be well understood and covered by established and recognised standards and codes of practice.*
4. *If there are any off-site consequences these will not impact on any sensitive adjoining land use. For Class 8 dangerous goods a qualitative analysis, which includes a demonstration of compliance with all relevant standards and codes and the published NSW risk criteria (HIPAP No. 4) should normally suffice. In particular, adequate measures to protect the biophysical environment should be clearly demonstrated. If the qualitative analysis cannot demonstrate there will be no significant risk (ie that risk criteria would be satisfied), a higher level of analysis will be required.*

Qualitative risk assessment

A qualitative assessment of the risks imposed by a development is required in accordance with the DOP's HIPAP No. 4. There are four criteria that a potentially hazardous development is assessed against. The criteria are:

1. *All 'avoidable' risks should be avoided to ensure that risks are not introduced in an area where feasible alternatives are possible and justified.*
2. *Where the consequences of a hazardous incident are significant to people and the environment, then all feasible measures should be adopted so that the likelihood of such an incident occurring is very low.*
3. *The consequences of the more likely hazardous events should be contained within the boundaries of the installation.*
4. *Where there is an existing high risk from a neighbouring hazardous installation, additional hazardous developments should not be allowed if they add significantly to that existing risk.*

10.4 Surrounding Land Uses

It was necessary to take into account surrounding land uses and their proximity to the Proposal site during the risk assessment. Surrounding land uses were classified in accordance with land use categories as defined in HIPAP No. 4.

Table 10.2 shows the distance from the power station to each of the neighbouring land users.

Table 10.2 – Surrounding land users

Land User	Distance (km)	Direction	Land Use Category
Lake Munmorah residents	3.0	NE	Residential
San Remo residents	1.3	W	Residential
Doyalson residents	1.6	NW	Residential
Halekulani residents	1.2	SE	Residential
Colongra Gas Turbine	0.15	E	Industrial
Lake Budgewoi	2.0	SW	Active open space
Lake Munmorah	1.6	E	Active open space

10.5 Hazard Identification

10.5.1 Preliminary risk screening

The majority of Dangerous Goods on-site are already stored and appropriately managed. Additional dangerous goods stored on-site in relation to the proposed rehabilitation would be liquid CO_2 and amine/ammonia solution, in the event that a Carbon Capture Plant is installed in the future. The natural gas entering the site in pipeline is not classified as a storage depot. The existing dangerous goods have been included in the SEPP33 screening due to the natural gas pipeline running through the power station site.

Table 2 of the PHA (Appendix G) summarises the proposed and current inventory of Dangerous Goods in accordance with the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (ADG Code) and compares the total storage quantity against the storage screening thresholds.

Storage quantity screening

The quantity of ADG class 2.1 stored on the power station site, at the closest distance of 80 m from the site boundary, is below the threshold quantity for that distance. Similarly for ADG class 2.3, the quantity stored on site is below the threshold quantity. The 299 m^3 total storage of ADG class 8 is above the threshold of 25 m^3 for packaging group II.

Class 1 (C1) and Class 2 (C2) dangerous goods are not included in SEPP33 screening unless they are stored in the same location as ADG class 3. As both C1 and C2 are stored on the power station site the combined storage volumes for ADG class 3, C1 and C2 have been applied to the threshold values. The above ground and below ground storages were separated as per the procedure in *Applying SEPP33*. The total above ground storage of ADG classes 3, C1 and C2 is 39 m^3 which is above the screening threshold of 19 m^3 at 80 m from the site boundary. The total below ground storage of ADG classes 3, C1 and C2 is 973 m^3 which is also above the screening threshold of 19 m^3 at 80 m from the site boundary.

Based on current technologies, the proposed carbon capture plant will store either 150 m^3 of amine solution classified as ADG class 2.1 or 15 m^3 of ammonia solution classified as ADG class 8. The amine solution storage would exceed the screening threshold of 20 m^3 at a distance of 10 m from the boundary. The ammonia solution on the other hand would not exceed the screening threshold of 25 m^3 for packaging group II. As the SEPP 33 screening threshold are exceeded for ADG classes 8 and 3 substances on the power station site and ADG class 2.1 on the carbon capture site the development is classified as a potentially hazardous industry.

Transport screening

Applying SEPP33 states that proposed developments may also be deemed potentially hazardous if the numbers of generated traffic movements, for significant quantities of dangerous goods entering and leaving the site guideline levels. The volumes and transport frequency of dangerous goods associated

with the carbon capture plant are presented in Table 3 of the Preliminary Hazards Report (Appendix G). The development would not modify the transport of the existing dangerous goods to and from the power station site and therefore has not been included in the transport screening. The CO_2 generated from the carbon capture plant would most likely be piped offsite due to the large volume.

The volume of ADG classes 2.1 and 8 substances exceed the quantity per load threshold and therefore are classified as a significant quantity per delivery. The total number of deliveries for each substance, of 90 and 30 per annum respectively, is below the screening threshold of 500. The development is therefore deemed not potentially hazardous with respect to transport.

10.6 Risk Assessment Results

Results of the risk assessment were recorded during the workshop directly into a spreadsheet template provided by Advitech. The risk assessment spreadsheet is contained in an Appendix of the full report (included as Appendix G). All high risk scenarios identified during the risk assessment (ie with a risk score of 12 or higher) are detailed in Table 9 of Appendix G. High consequence risk scenarios (ie with a consequence score of 2 or higher) are detailed in Table 10 of Appendix G. There were no high likelihood risk scenarios (ie with a likelihood score of B or higher) identified in the risk assessment.

There were six high cumulative risk scenarios identified during the risk assessment. The first four involved a possible fire from the natural gas pipeline due to construction, operation or maintenance activities. The other two scenarios involved a possible CO_2 leak from a storage tank rupture and a possible ammonia leak from a truck accident entering a site during delivery.

There were three high consequence risk scenarios identified during the risk assessment. The first two involved a possible CO_2 leak from rupture of a storage tank or equipment corrosion. The third scenario involved a possible ammonia leak from a truck accident entering the site during delivery.

10.6.1 Multi level risk assessment discussion

1. *All points on the indicative societal risk curve produced from the risk classification and prioritisation should be below the negligible line.*

   Societal risk is expressed in the form of an F-N curve (where F is the frequency of the event offering, and N is the number of people affected). The *Multi Level Risk Assessment* (1997) includes a curve which outlines the storage volumes for certain dangerous goods.

   Of relevance to this assessment is Liquefied Petroleum Gas (LPG) and compressed hydrogen. For LPG to be considered a societal risk based on the F-N curve, the storage quantity needs to be above 1 tonne. The storage quantity for this power station is 0.4 m^3 (equivalent mass 200 kg). For compressed hydrogen the storage quantity needs to be above 5 tonnes, however the storage for this power station is 0.15 m^3 (equivalent mass of 10.6 kg). Given the small storage volumes, this risk condition is satisfied.

2. *There should be no events with consequences extending significantly beyond the site boundary at a frequency of greater than 1 x10^{-7}.*

   The risk of a natural gas leak and subsequent fire was identified in the risk assessment as a possible scenario. The extent of possible impacts from a fire cannot be determined by a purely qualitative method and therefore quantification of this risk scenario is required. The same can be said for a possible CO_2 or ammonia emission also identified in the risk assessment. Therefore condition 2 cannot be satisfied with purely qualitative measures (see Section 10.6.2 for more detail).

3. *The process and operation should be well understood and covered by established and recognised standards and codes of practice.*

   The natural gas firing system proposed for the Munmorah Power Station site is similar to other gas fired power stations in operation. The carbon capture technology proposed is also in operation at various locations The site would be constructed and operated according to all the relevant standards and codes of practice as such Condition 3, will be satisfied.

4. *If there are any off-site consequences these will not impact on any sensitive adjoining land use.*

   The risk of a natural gas leak and subsequent fire was identified in the risk assessment as a possible scenario. Similarly to condition 2 the extent of possible impacts from a fire can not be determined by a purely qualitative method

and therefore quantification of this risk scenario is required. The same can be said for a possible CO_2 or ammonia emission also identified in the risk assessment with possible off-site impacts. Therefore condition 4 cannot be satisfied with purely qualitative measures (see Section 10.6.2 for more detail).

10.6.2 Qualitative risk analysis

1. *All 'avoidable' risks should be avoided to ensure that risks are not introduced in an area where feasible alternatives are possible and justified.*

   All storage and processes at the facility would be designed as inherently safe to avoid unnecessary risk scenarios. Delta Electricity would have procedures in place, eg emergency plan, safety training, etc. to ensure all risks are at an acceptable level.

2. *Where the consequences of a hazardous incident are significant to people and the environment, then all feasible measures should be adopted so that the likelihood of such an incident occurring is very low.*

   There were three risk scenarios identified as having significant consequences, ie a CO_2 or ammonia emission. The likelihood of a CO_2 emission was rated as rare and the likelihood of an ammonia emission was rated as unlikely.

3. *The consequences of the more likely hazardous events should be contained within the boundaries of the installation.*

   There were no hazard scenarios identified with a high likelihood of occurrence.

4. *Where there is an existing high risk from a neighbouring hazardous installation, additional hazardous developments should not be allowed if they add significantly to that existing risk.* With the exception of the Colongra Gas Turbine, the neighbouring facilities include bushland areas and residential areas. These would not be classified as hazardous installations. The Colongra Gas Turbine has been the subject of the PHA which revealed acceptable risk levels.

10.6.3 Quantitative risk analysis

Three risk scenarios were identified as requiring further quantitative analysis following the qualitative risk assessment. They included:

- natural gas release from pipeline and subsequent fire
- CO_2 release from the storage tank and possible asphyxiation
- a delivery truck accident at the entrance to the site and subsequent ammonia cloud release.

Natural gas release

Table 11 of Appendix G provides a comparison of the distance to the relevant risk criteria calculated in a previous study for gas supply to the adjoining Colongra Gas Turbine Power Station with the actual distance from the proposed pipeline to the closest land user for each category. The Proposal would see a reduction in the pipeline pressure for the Munmorah Power Station gas supply.

Carbon dioxide release

A quantitative assessment of the likely release rate of CO_2 has been conducted and found to be 36 kg/s, based on an open/ruptured 100 mm pipe. The main concern with releasing this amount of CO_2 is that of possible asphyxiation of workers at the neighbouring Colongra Gas Turbine Facility. According to *AS1894 The Storage and Handling of Non-flammable Cryogenic and Refrigerated Liquids* (1997) the first stage of asphyxiation occurs when the oxygen content of the atmosphere drops below 14%. The relevant CO_2 concentration at this point would be 33.3%.

Distance calculations were then conducted to determine the extent a high pressure CO_2 jet would reach before the concentration of CO_2 would drop below 33.3%. The distance was found to be 5.4 m from the emission source, which is within the site boundary and so the risk is considered to be acceptable.

Ammonia release

The scenario of an accident at the entrance to the site involving a delivery truck transporting ammonia was identified as a risk scenario with potential off-site impacts. To quantitatively assess this, a worst case scenario for nearest land users was assumed and modelled with AUSPLUME version 6.0 software whereby:

- ammonia solution is transported to site in intermediate bulk containers (IBC) on the back of a truck
- the entire solution is spilt forming a 100 m^2 pool and vapour cloud.

The maximum concentration of the vapour cloud calculated in the AUSPLUME model for a worse case scenario was 118.6 mg/m^3 which is well below the fatality concentration (5,000 ppm, equivalent to 3,680 mg/m^3). The distance calculated for the concentration of the vapour cloud to be below the 15 minute short term exposure level was 45 m and therefore does not encroach on any surrounding land users, as the nearest land user is 550 m away.

10.6.4 Aviation safety

The rehabilitation would not involve any alteration to the existing chimney at Munmorah Power Station. Emissions from Units 3 and 4 discharge through the eastern most of the two 155 m tall chimneys at the site. The characteristics of the flow at the stack exit are described in Chapter 4, based on modelling of changes resulting from the rehabilitation works (Aurecon, 2009). The emissions are around half the combined emissions from four unit station. Emissions from units 1 &2 occurred through the adjoining second stack.

Airports in vicinity of Munmorah Power Station (approximate distance to nearest km)

- Warnervale 10 km
- Belmont 18 km (not confirmed whether in operation)
- Cessnock 50 km
- Newcastle/Williamtown 53 km
- Maitland 56 km

The air space above the existing power station is not subject to any exclusion zone or danger areas, as classified by CASA.

Air Services Australia (inquiry reference number 223763) has advised that:

- Low level aircraft will be flying random flights over the vicinity of Munmorah Power Station depending on where they want to go. The area is outside controlled air space and is the jurisdiction of the controllers.
- Random flights may travel over that area at an altitude of 8500 feet and the departure paths of jets and propeller aircraft would be at 9000 feet or above. This would be the case for flights between Sydney and West Maitland and Sydney and Williamtown.
- Additionally, hospital helicopters travelling to Gosford hospital may also travel in the air space in the vicinity of the power station. WestPac have confirmed that the current operating protocols for the rescue helicopters is adequate and the Proposal would not have any additional impacts to the helicopter service, as helicopters would

The modelling outcomes demonstrate a small increase in the final stack exit velocity which equates to an approximate 6% increase in the volumetric flow rate. It is predicted that this would have a negligible effect on plume rise from the one chimney servicing units 3 and 4 and this would be significantly less than the plume rise that occurred for the four unit station. This being the case the rehabilitation would not alter the effect of the existing emissions on aviation safety, which are currently acceptable to CASA.

CASA also advised that the location of the stack is in their records. The stack is illuminated from below at night.

A comparison of the historical and flow rates following rehabilitation is provided in Table 10.3.

Table 10.3 – Comparison of stack exit conditions in the historical case and the predicted conditions for the rehabilitated plant

Munmorah stack exit conditions	Volumetric flow (m^3/s)	Exit velocity (m/s)	Stack exit temperature (K)
Historical plant (4 unit station duplicated these emissions from the second chimney)	892	18.2	403
Rehabilitated plant (2009 PROATE Modelling)	948	19.4	426
Percentage change	+6.3%	+6.6%	+5.7%

10.7 Mitigation Measures

Appropriate safeguards should be incorporated into the design and operation of the Proposal as prevention or protection measures for higher-level risks. These measures may include plant design features, organisational safety controls, and emergency and counter disaster procedures. Options should be evaluated on the basis of the extent of risk reduction and the extent of benefits or opportunities they create. In general, the cost of managing risks should be commensurate with the benefits obtained.

In general, each identified risk scenario had actions assigned by the workshop team, to treat the risk. In some cases, the workshop team deemed current barriers to be adequate to address the risk, and no further action was required. Risk treatment actions recorded in the workshop aimed to reduce the identified risk to 'As Low As Reasonably Practicable' (ALARP).

Most identified risks cannot be eliminated, but can be mitigated or reduced in some way. The preferred method of risk treatment uses engineered (physical) barriers to prevent the risk occurring, otherwise procedural controls may be proposed to prevent the risk, or respond appropriately if the risk scenario does occur. The proposed measures were listed in the risk assessment matrix which is included as an Appendix in the full working paper (Appendix G).

10.8 Conclusions

All risks associated with the rehabilitation identified during the risk assessment with high cumulative, consequence and likelihood scores have been qualitatively assessed and have demonstrated effective technical and management controls to ensure the ongoing safety of the Proposal. None of the other hazard scenarios identified were considered to have the potential of presenting an unacceptable risk to surrounding land users.

Quantitative calculations of a possible natural gas leak scenario and subsequent fire, CO_2 release and ammonia release scenarios demonstrated that such scenarios would not impact on neighbouring land users. The risk assessment has demonstrated that the Proposal can operate with an acceptable risk level provided that the documented procedures and controls are applied.