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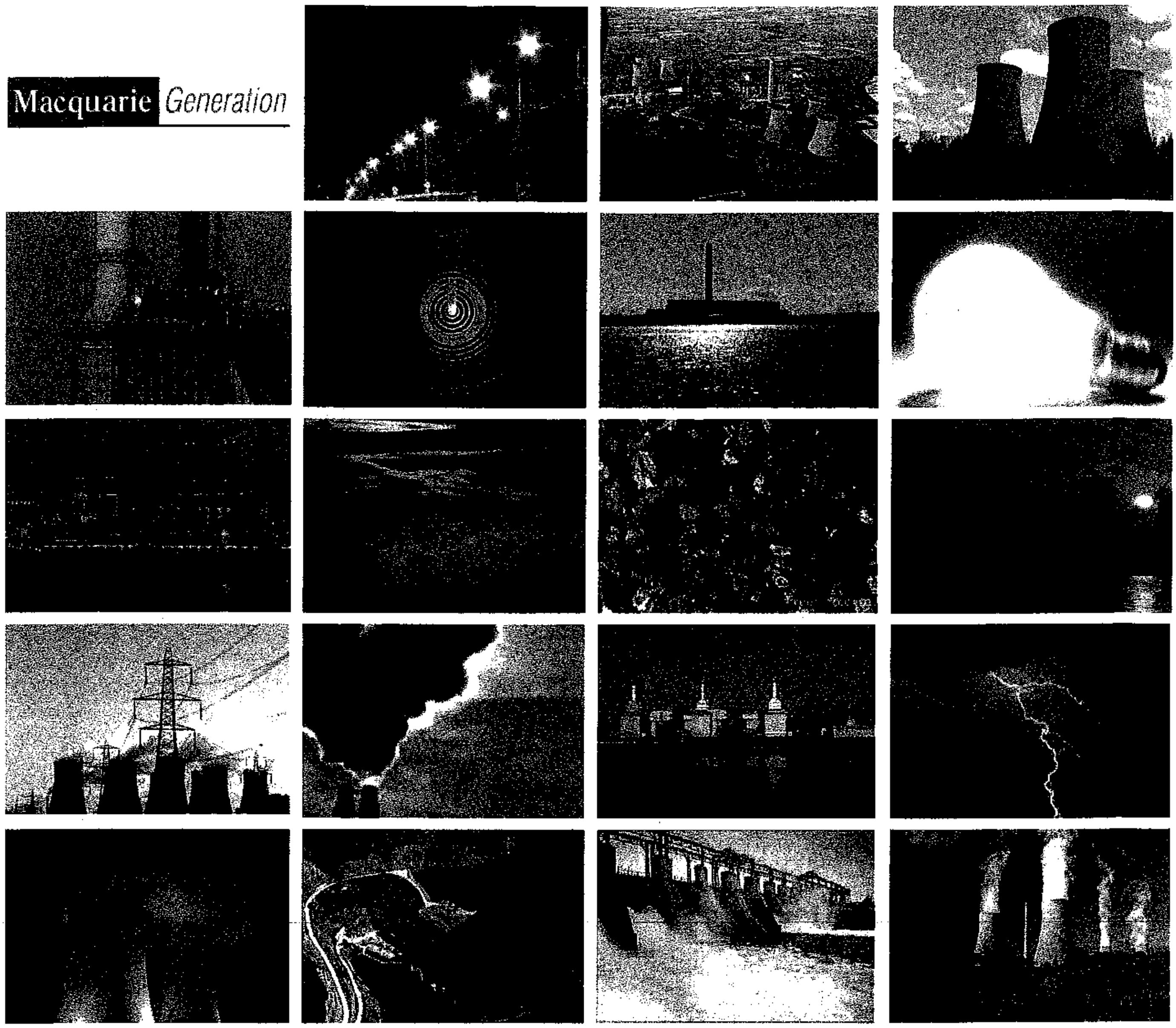
Liddell Power Station

Preliminary Environmental Site Assessment – Part 1

Environmental Resources Management

October 2013

Macquarie Generation



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Macquarie Generation – Project Symphony

Liddell Power Station

Preliminary Environmental Site Assessment

Ref: 0213879RP02_DRAFT Rev02

October 2013

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Liddell Power Station

Preliminary Environmental Site Assessment

Macquarie Generation - Project Symphony

October 2013

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Environmental Resources Management Australia Pty Ltd Quality System

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EXECUTIVE SUMMARY

ERM was engaged by Macquarie Generation to provide advice in relation to potential soil and groundwater contamination issues which may be relevant to the sale of certain electricity generation assets owned and operated by Macquarie Generation. The subject of this report is the Liddell Power Station.

The specific objectives for this stage of ERM's scope of works were to:

- *assess the nature and extent of potential soil and groundwater contamination issues which may be present at the site;*
- *develop a preliminary Conceptual Site Model; and*
- *develop a sampling plan and rationale for the future intrusive investigations required to establish a baseline of soil and groundwater conditions present at the site to support the potential sale of the site.*

ERM has undertaken this Preliminary Environmental Site Assessment (ESA) which includes background research from a variety of sources as well as management and staff interviews and site visits.

The Preliminary ESA identified a number of potential contamination sources, of which several were determined as Areas of Environmental Concern (AECs) as follows:

- *Hunter Valley Gas Turbines (diesel leaks);*
- *Bulk fuel storage and transfer (potential and historical leaks);*
- *Power Generating Units (potential and historical leaks);*
- *Transformer Road (numerous transformer units with oils);*
- *Ammonia Plant (potential and historical leaks);*
- *Oil and Grit Trap (accumulation of variety of contaminants from potential failure of system or leaks from holding tanks);*
- *Site Drainage Network (direct discharge to Lake Liddell and seepage to soil/groundwater through damaged pipework);*
- *Dangerous Goods, Flammable Liquids and Northern Stores Compounds No.1-No.3 (seepage to ground or discharge to drains);*
- *Asbestos (diffuse source due to large amount of asbestos material known to have been on site);*
- *Water Treatment/Demineralisation Plant (direct discharge to Lake Liddell via site drainage and seepage to soil/groundwater through damaged pipework);*

* *Landfills (composition of waste streams not entirely known, leachate generation may be occurring);*

* *TransGrid Switchyard (potential and historic leaks);*

* *Fill Material (site levelling and shoreline expansion using uncontrolled fill);*

* *Maintenance Workshop, Foam Generator and Unofficial Laydown Area (potential and historical leaks);*

* *Ash Placement (seepage to groundwater and surface water receptors);*

* *Current and Former Coal Storage Areas (runoff or seepage to groundwater and surface water receptors;*

* *Machinery Graveyard (potential and historic leaks);*

* *Water Intake and Pump Station (potential and historic leaks); and*

* *Former Construction Workshop and Storage Area (historic leaks).*

Based on the results of the Preliminary ESA undertaken by ERM and consideration of Government's intended approach to establishing a baseline of soil and groundwater contamination, a programme of intrusive (Stage 2) assessment of potential soil and groundwater contamination issues is provided.

The most appropriate sampling design is considered to be a judgemental (targeted) sampling of soil and groundwater at the established AECs for the site, which is also considered to provide suitable spatial coverage to act as a baseline assessment.

LIST OF ABBREVIATIONS

AHD	Australian Height Datum
ACM	Asbestos Containing Materials
AEC	Area of Environmental Concern
ANZECC	Australia and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AST	Above-ground Storage Tank
BTEX	Benzene, Toluene, Ethylbenzene and Xylenes
CEC	Cation Exchange Capacity
COPC	Contaminant of Potential Concern
DNAPL	Dense, Non-Aqueous Phase Liquid
DP	Deposited Plan
DQO	Data Quality Objective
EC	Electrical Conductivity
EDD	Environmental Due Diligence
EIL	Ecological Investigation Level
EIS	Environmental Impact Statement
EMS	Environmental Management System
EPA	Environment Protection Authority
EP&A	Environmental Protection and Assessment
EPL	Environment Protection Licence
ERM	Environmental Resources Management Australia
ESA	Environmental Site Assessment
ESL	Ecological Screening Level
HIL	Health Investigation Level

HSL	Health Screening Level
LDPE	Low-Density Polyethylene
LEP	Local Environmental Plan
LGA	Local Government Area
LNAPL	Light, Non-aqueous Phase Liquid
m bgl	metres below ground level
m btoc	metres below top of casing
MGA	Map Grid of Australia
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NSW	New South Wales
OEH	Office of Environment and Heritage
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane Sulfonate
PID	Photo-ionisation Detector
PRP	Pollution Reduction Plan
PSH	Phase Separated Hydrocarbon
QA/QC	Quality Assurance and Quality Control
RCU	Rail Coal Unloader
RO	Reverse Osmosis
RFP	Request for Proposal
RIVM	Netherlands National Institute of Public Health and the Environment
SAQP	Sampling, Analysis and Quality Plan

SOC	State-Owned Corporation
SOP	Standard Operating Procedure
SPR	Source-Pathway-Receptor
SVOC	Semi-Volatile Organic Compound
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TRH	Total Recoverable Hydrocarbons
UPSS	Underground Petroleum Storage System
UST	Underground Storage Tank
VEDD	Vendor Environmental Due Diligence
VOC	Volatile Organic Compound

1 INTRODUCTION

1.1 BACKGROUND

On 24 November 2011, the New South Wales (NSW) State Government (Government) announced that it would divest certain State-owned electricity generation assets.

In order to support the sale of certain electricity generation assets owned and operated by Macquarie Generation (a State Owned Corporation - SOC), ERM was engaged as the Site Contamination Environmental Adviser (the 'Adviser') to provide advice in relation to potential soil and groundwater contamination issues which may be relevant to the transaction. The subject of this report is Liddell Power Station (the 'Site').

1.2 OBJECTIVE

The specific objectives for ERM's scope of works were to:

- assess the nature and extent of potential soil and groundwater contamination issues which may be present at the Site and relevant receiving environments;
- identify what additional works may be required to establish a baseline of soil and groundwater conditions present at the Site to support the potential sale of the asset.

This Preliminary Environmental Site Assessment (ESA) comprises Stage 1 of the overall assessment, with Stage 2 comprising a detailed ESA in order to achieve the overall project objectives stated above.

1.3 SCOPE OF WORK

The scope of this Preliminary ESA was outlined in the ERM proposal dated 3 July 2013 and included the following key elements:

- development of a site history via interviews with employees and review of information such as:
    - relevant documents identified by employees;
    - the database managed by the NSW Office of Environment and Heritage for information on notices issued by the NSW EPA under the *Protection of the Environment Operations Act 1997* and the *Contaminated Land Management Act 1997*;

    - aerial photographs; and
    - civil engineering works records.
- review of existing soil and groundwater reports;
- desktop assessment of the environment in which the site is set such as drainage, geology, hydrogeology and soil conditions at the site and surrounding areas;
- inspection of the site;
- identification of actual and/or potential soil and groundwater Areas of Environmental Concern (AECs) in the context of a Conceptual Site Model (CSM) via:
    - identification of past and present potentially contaminating activities at, and adjacent to, the Sites;
    - identification of potentially impacted areas;
    - identification and assessment of the chemicals of potential concern (COPCs) that may have been associated with historical and current use of the site;
    - evaluation of the possible migration pathways of the COPCs; and
    - assessment of the sensitivity of surrounding areas and/or property.
- where Stage 2 intrusive investigations are necessary on each site and, more specifically:
    - where it may be necessary to undertake a preliminary sampling and analysis program at each site to assess the need for detailed investigation; and
    - a detailed scope-of-works for Stage 2 investigations at each site.

Spatially, the scope of ERM's assessment was limited to those areas shown within the site boundary presented in *Figure 1, Figure 2* and *Figure 3* of *Annex A.*

1.4 *MATERIAL THRESHOLD*

ERM adopts a technically rigorous approach to assessing potential risks and liabilities during Environmental Due Diligence (EDD), and typically focuses on what is *material* to the transaction. In this situation, a material threshold was applied to items contained within the EDD reports.

Based on ERM's experience of similar projects and discussions with the Client, ERM adopted a material threshold of $0.5M (+ GST if applicable) per contamination source.

In other words, in identifying contamination sources, ERM sought to define actual or potential sources where costs of remediation or management of the sources as required by regulators would exceed $0.5M (+ GST if applicable). Remediation or management includes additional assessment, environmental monitoring, management, containment or other remediation measures.

In addition, any issue that ERM considers could have the potential to lead to prosecution by the regulatory authorities that could lead to significant business disruption or reputational impact will be considered material.

1.5 *APPROACH AND METHODOLOGY*

ERM's approach to the assessment was to break the work down into individual tasks as follows.

1.5.1 *Project Initiation Meeting*

In order to ensure that ERM and Macquarie Generation were fully aligned in terms of the scope and anticipated deliverables, the key members of the ERM project team attended a project initiation meeting with Macquarie Generation and NSW Treasury at the Site.

1.5.2 *Review of Existing Data*

Relevant environmental information on the specific SOC asset was made available to ERM via an electronic dataroom.

In addition, ERM conducted background research using publicly available information on the Site. Background research included those items identified in *Section 3*, and *Annex D*. Following discussions with Macquarie Generation and given the timescale of this assessment, the large number of lots comprising the Site, the good level of information available on the history of the site available from both knowledgeable Macquarie Generation personnel and a review of historic aerial photography (refer to *Section 3.2*) a search of historic land titles and S. 149 certificates has not been undertaken.

A site setting review was also undertaken to understand both the sensitivity of the surrounding area to environmental impact and the potential impact on the site resulting from neighbouring activities, past and present. Key areas addressed included site description and activities, site history, geology, hydrogeology and hydrology (refer to *Section 2*).

1.5.3 *Site Visits and Management Interviews*

ERM mobilised to site and completed site management interviews and a site visit to Liddell Power Station on 19 and 20 August 2013.

The assessment focussed on potentially material contamination issues that were considered likely to require further assessment relevant to Bidders and to identify where a baseline assessment may be required. Topics that were evaluated as non-material were not assessed in detail.

During the site visit, discussions and interviews were undertaken with the following staff:

- Environmental Manager - Mr. Howard Richards (environment team manager for both stations, based at Liddell Power Station);
- Environment Officer - Mr. Stephen Fell (environment specialist for Liddell Power Station, based at Liddell Power Station);
- Environment Officer - Ms. Kathryn Yates (environment specialist for Liddell Power Station, based at Liddell Power Station); and
- Site Engineer - Mr. John Bennetts (Liddell and Bayswater Power Stations).

1.5.4 *Preparation of Stage 1 ESA Reports*

The Stage 1 ESA Reports were prepared in general accordance with *Guidelines for Consultants Reporting on Contaminated Sites* (NSW OEH, 2011) on the basis of information collected during the previous tasks. In preparing these reports, (and in particular the proposed scope of work for Stage 2 assessments) ERM utilised a combination of experience gained in the planning and delivery of similar vendor due diligence projects for government, professional judgement of suitably qualified contaminated land professionals and reference to relevant guidelines made or approved under the *Contaminated Land Management Act 1997*, the National Environment Protection Council (NEPC) (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1), the* Australian and New Zealand Environment and Conservation Council (ANZECC) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* and guidelines and technical notes relating to the *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation* 2008 (made under the *Protection of the Environment Operations Act 1997*).

1.6 *REPORT STRUCTURE*

This report has been structured in order to align generally with the requirements for a Preliminary Environmental Site Assessment outlined with NSW EPA (2011) *Guidelines for consultants reporting on contaminated sites.* Where necessary, minor additions and modifications to the structure have been made to accommodate the fact that this assessment is being undertaken for a specific purpose (that being Vendor Environmental Due Diligence - VEDD).

2 SITE DESCRIPTION AND SURROUNDING ENVIRONMENT

Macquarie Generation owns and operates two large conventional coal-fired power stations in the Hunter Valley region of New South Wales. Liddell Power Station and Bayswater Power Station are located within three kilometres (km) of each other on either side of the New England Highway, approximately 25 km north-west of the township of Singleton and approximately 10 km to the south-east of the township of Muswellbrook. The two power stations share some infrastructure such as coal and water supply.

Liddell Power Station is located approximately one kilometre east of the New England Highway on the shore of Lake Liddell. A site location plan is provided as *Figure 1* of *Annex A*. The approximate coordinates of Liddell Power Station are 309693 m E and 6416597 m S. The Lot and Deposited Plan (DP) information relevant to the Site is outlined in *Annex C*. ERM notes that this information is considered to be preliminary at the time of preparation of this report as the Macquarie Generation ownership boundaries are in the process of being clarified.

Based on the possible separation of assets between Bayswater and Liddell Power Stations as set out in *Proposed Liddell & Bayswater B Subdivision* (Chelace GIS, 2013), the shared infrastructure has been allocated as follows:

- the land associated with the water transfer lines and coal transfer lines between the power stations have been separated by assessing the portions located within the boundaries of the respective sites as indicated on *Figure 3* of *Annex A;*
- Antiene Rail Coal Unloader (RCU) and Ravensworth RCU have been assessed as part of Bayswater Power Station; and
- Lake Liddell has been assessed as part of Bayswater Power Station.

2.1 SITE DESCRIPTION

2.1.1 *Overview*

Construction of Liddell Power Station commenced in the late 1960s. The power station was commissioned in 1971 with four generating units, each with nameplate rating of 500 MW. The power station was constructed as a base load facility, and for many years was the backbone of the NSW electricity system.

Liddell Power Station's proposed end of life is December 2022, however a Macquarie Generation engineering review concluded that an operational life to 2032 is feasible (*Liddell Asset Management Strategy*, 2010).

Photographs of the Site are presented in *Annex B*.

2.1.2 *Site Layout*

The facility is shown in the Site Layout Plan *Figure 2, Annex A*. The operational area of the Liddell Power Station is considered to incorporate the coal stockpiles and conveyors, electricity generation units (coal hoppers, bowl mills, feed systems, coal fired boilers, steam turbines, hydrogen cooled generators and transformers), air emission controls (fabric filters and chimney stack), bulk fuel storage and transfer infrastructure, cooling water processes (intakes, pre-treatment facilities, cooling towers and returns), wastewater holding ponds and treatment facilities, maintenance facilities and administration offices. Processes conducted within the main operational area are further detailed in *Section 4*.

The Site includes the following key features:

- Liddell Power Station's main power block including electricity generating units, auxiliary fuel storage, water treatment plant and associated infrastructure, workshops and stores;

- Lake Liddell, including cooling water intakes at the power station, the dam wall to the east (including a spillway and discharge point) and recreation areas to the north;

- Liddell Ash Dam, located approximately four kilometres (pipe run length) to the west across the New England Highway, and associated pipelines for ash slurry and return water;

- coal storage area and conveyors transporting from Antiene Rail Coal Unloader, Ravensworth Rail Coal Unloader, Bayswater Power Station and nearby mines;

- a 33 kV Switching Station to the immediate west of the main power block. This station switchyard (330 kV) is owned and operated by the transmission SOC TransGrid (assessment of conditions within the switchyard boundary is outside the scope of this report) ;

- Hunter Valley Gas Turbines (HVGT) approximately two kilometres south of the power station; and

- buffer lands surrounding the infrastructure described above.

In addition to Lake Liddell, water is supplied from off-site storage facilities detailed in *Section 4*. Review of environmental conditions at these off-site water storage facilities is outside the scope of this report.

2.2 *TOPOGRAPHY*

The Site lies within a broad river valley created by the Hunter River and its tributaries. Whilst the general slope in the area is towards the Hunter River in the south, the topography is characterized by undulating hills that leads to high variability in slope direction across the Site.

The operational area of the Liddell Power Station is identified to gently slope to the east. The main power block is cut into the slope of the hill, the section of which exposes natural bedrock (a conglomeratic sandstone). The 33 kV Switching Station at the higher end of the slope lies at an elevation of approximately 167 m above sea level. It drops down to the main power block at an elevation of approximately 145 m above sea level and reaches approximately 133 m above sea level at the edge of Lake Liddell. There is evidence to suggest the site level at the boundary with Lake Liddell has been raised over time through in-filling.

2.3 *GEOLOGY*

2.3.1 *Regional Geology*

The Site is located on the northern section of the Sydney Geological Basin and the 1:100 000 Hunter Coalfield geological map (Department of Mineral Resources 1993) indicates that the Bayswater Power Station is underlain by Permian age conglomerate, sandstone, siltstone and claystone of the marine derived Maitland Group. The 1:100 000 Hunter Coalfield geological map further indicates that Quaternary age alluvial sediments (consisting of silt, sand and gravel) are associated with the Bayswater Creek, Foy Creek and the Hunter River.

The Muswellbrook 1:25,000 Geological Sheet 9033-II-N (NSW Department of Mineral Resources) indicated the Liddell Power Station and the areas adjacent to Lake Liddell to the north to be underlain by Permian Age, Maitland Group, Mulbring siltstone consisting of dark-grey shale and siltstone.

The Jerry Plains Geological Series Sheet 9033-11-S (Edition 1) 1987 indicates the geology around the area adjacent to the south of Lake Liddell to consist of Permian Age, Singleton Super Group, Whittingham Coal Measures, Saltwater Creek formation comprising sandstone and siltstone with thin lenticular coaly bands and marine siltstone intercalated towards base.

2.3.2 *Local Geology*

Borelog data obtained from UPSS Groundwater Monitoring Well Reports (DLA Environmental, 2011) indicate the local geology beneath the area around the northern stack to consist of brown topsoil loam to up to 0.25 m, underlain by light brown gravelly sands up to 2.2 m, and then fractured rock: sandstone, limestone up to 4.2 m. Borehole ID L4 indicates fractured rock: sandstone limestone was encountered at 5.5 m

Soil data from the Atlas of Australian Soils 1:2,000,000 Map categorises soil in the area as 'sodosol' with the relevant Australian Soil Classification describing this as high sodium content, abrupt increase in clay content at depth, prone to crusting, dispersive; unstable soil structure prone to erosion; seasonally perched water tables.

2.4 *HYDROGEOLOGY*

2.4.1 *Regional Hydrogeology*

From a hydrogeology perspective, the sedimentary deposits can be categorised into the following units:

- low permeability conglomerate, sandstone, siltstone and mudstone that comprise the majority of the Permian sediments.
- low to moderately permeable coal seams, typically ranging in thickness from 2.5 m to 10 m, which are the prime water bearing strata within the Permian sequence.
- medium to highly permeable Quaternary alluvial sediments associated with the Bayswater Creek, Foy Creek and the Hunter River.
- regional groundwater flow is expected to be towards the Hunter River located to the south of the Site.

Due to the undulating nature of the topography, variation in localised groundwater flow directions are however probable with groundwater flow expecting to follow topography. Inferring localised groundwater flow from topography would suggest a groundwater flow component at the Liddell Power Station towards Lake Liddell.,.

2.4.2 *Local Hydrogeology*

Due to the undulating nature of the topography and the 'cut and fill' development of the operational area of the site, variation in localised groundwater flow directions are considered probable, however groundwater flow is expected to follow topography toward Lake Liddell. The limited nature of intrusive site investigations undertaken at the site does not allow local groundwater flow direction to be determined.

2.4.3 *Groundwater Use*

A search of publically listed boreholes on the New South Wales Government Natural Resource Atlas (NRA) NSW within a five kilometre radius identified eight groundwater bores. These bores are registered as monitoring, testing and industrial bores. According to the Development Application for the proposed Extension to Ash Dam (Coffey, 2011) the regional groundwater is considered to be of poor quality due to the relatively high salinity (3,500ug/L). Details of the bores are listed in *Table 2.1* (below).

Table 2.1 ***Registered Groundwater Bores in Proximity to the Site***

Bore ID	Distance from Site (km)	Direction from site	Water Bearing Zone (m bgl)	Use
GW201061	0.9*	South-east	12-15.1	Monitoring bore
GW047486	4.8	North-west	15-25	Industrial
-	-	-	28-40	-
-	-	-	43-70	-
-	-	-	75-92	-
GW080212	0.9*	East	-	Monitoring bore
GW024022	1.2	West	3	Industrial
GW200743	4	West	-	Test bore
GW200746	4	West	-	Test bore
GW201062	0.8	South	14.5-17.4	Monitoring bore
GW053862	4.5	West	15-17	Industrial
-	-	-	26-29	-
-	-	-	66-69	-
-	-	-	80-81	-
-	-	-	26-29	-
-	-	-	96-97	-

2.5 HYDROLOGY

The major hydrological feature in the Hunter Valley is the Hunter River, which passes through Muswellbrook, and is approximately 11 km to the south of the site.

In addition several local waterways pass through Macquarie Generation lands:

- Maidswater Creek and an un-named fourth order stream (formally a tributary of Saltwater Creek, and currently known as Wykes Gully for internal monitoring purposes) flow into the Antiene Arm of Lake Liddell. New England Highway, Main Northern Railway, Hebden Road and Antiene Rail Coal Unloader are within this catchment;
- Bayswater Creek and associated tributaries flow into Liddell Ash Dam then the western arm of Lake Liddell. Bayswater Creek then flows below Lake Liddell to the Hunter River in the south;
- unnamed Creek from Ash Dam Spillway (sometimes referred to as Skimmer Pond Creek);
- tributaries of Tinkers Creek below Freshwater Dam flow into Lake Liddell to the west of Liddell Power Station. Bayswater Power Station is sited within the catchment of Tinkers Creek;
- Chilcott Gully drains land to the north-east of Bayswater Power Station and flows into Lake Liddell in the south-west; and
- Pikes Creek drains the Pikes Gully (Bayswater) Ash Dam flowing to the north-east to Bayswater Creek, downstream of Lake Liddell.

2.5.1 *Lake Liddell*

Lake Liddell was constructed as water storage for the power stations and is located immediately adjacent to Liddell Power Station. The lake has a surface area of around 1100 hectares (ha), approximately 5 km by 5 km and is up to 32 m deep (Lake Liddell Hydrodynamic Modelling, Worley Parsons, March 2009).

The Lake supplies cooling water to Liddell Power Station and make-up water for the Bayswater Cooling Water Makeup Dam. It also accepts a range of treated discharges as discussed elsewhere in this report.

The Lake is constructed in a natural valley at the confluence of Bayswater, Tinkers and Maidswater Creeks (Macquarie Generation, undated). The lake is dammed on the eastern side and is equipped with a spillway leading to a large holding pond.

Water is periodically discharged from Lake Liddell to manage salinity and level. The discharge point is at the dam wall, and discharges flow via Bayswater Creek to the Hunter River, 12.8 km downstream.

Discharges are under the Hunter River Salinity Trading Scheme (regulated under Bayswater's Environment Protection Licence (EPL) 779) and are made at times of high river flows and low background salinity levels.

Lake Liddell is also used by the public for recreation. The Lake Liddell Recreation Area is situated on a northern reach of the lake off Hebden Road. It caters for day visitors and campers, and the area is used for water-skiing, sailing, swimming and fishing (NSW Government Visit NSW website 21 June 2013). The area is managed by the Lake Liddell Recreation Area Reserve Trust appointed by the NSW Government to manage Crown Land (NSW Government LPMA website 21 June 2013).

Lake Liddell is surrounded by buffer land to the north. The eastern side is bordered by an open cut coal mine. The west and south are occupied by Liddell Power Station and Bayswater Power Station, respectively.

2.6 *SURROUNDING ENVIRONMENT*

The Site is surrounded by areas used mainly for mining purposes with some grazing, bushland, viticulture and thoroughbred horse stud farms in the region. An aerial image of the surrounding land-use is provided in *Figure 3, Annex A.*

Key industrial uses in the area include:

- Macquarie Generation's Bayswater Power Station located approximately 4 km to the south west of the site; and
- existing and former coal mines.

The closest residential areas to the Site include:

- rural residencies that do not form part of residential centres;
- Jerrys Plains Village, located approximately 11 km to the south of the Bayswater Power Station;
- Singleton is approximately 25 km to the south-east (population 16 135 according to 2011 Census QuickStats); and
- Muswellbrook is approximately 10 km to the north-west (population 11 042 according to 2011 Census QuickStats).

2.7 *SENSITIVE RECEPTORS*

A summary of sensitive receptors identified as relevant to the Site include:

- indoor and outdoor human health receptors in the form of industrial on-site and off-site users;
- intrusive maintenance workers both on and off-site;
- residential receptors and potential groundwater users in the vicinity of the site;
- recreational users of Lake Liddell;
- ecological receptors, including freshwater ecological receptors in the local creeks and Lake Liddell.

3 SITE HISTORY AND REGULATORY SETTING

3.1 SUMMARY OF SITE HISTORY

Construction of the Site started in the 1960s and was commissioned in 1971. The first generator was completed in 1971, two more were completed in 1972 and the fourth generator completed in 1973. The Macquarie Generation website (http://www.macgen.com.au/Generation-Portfolio/) states, "Liddell Power Station was the first major power station to be located inland away from abundant salt water supplies traditionally used for cooling purposes. As a result Lake Liddell was constructed for cooling and water storage." The site was originally fitted with the electrostatic precipitators for dust collection, with more efficient fabric filters being retrofitted in the early 1990s to reduce particle emissions.

3.2 SUMMARY OF HISTORICAL AERIAL PHOTOGRAPHS

A review of historical aerial photographs obtained from the NSW Government Land and Property Information service is summarised below. The photos reviewed are supplied within *Annex D*. Key issues are incorporated throughout this report. Aerial photographs prior to construction of the Liddell Power Station were not available for review.

Table 3.1 Summary of Historical Aerial Photographs

Year	Site	Surrounding Area
1974	The Liddell Power station appears to be well established on the western foreshore of Lake Liddell. Features within the Power Station appear consistent with the current infrastructure. Well established roadways connect the Power station with the New England Highway and the Liddell Ash Dam and Ash Skimmer Dam. Ash slurry appears to fill the mouth of the dam only. The Antiene Rail Coal unloader passes immediately north of Lake Liddell towards the Ravensworth township. A coal conveyor runs south of Lake Liddell, between the Liddell Power Station and Ravensworth Coal Unloader facility. Remaining buffer lands are sparsely vegetated.	The Freshwater Dam is situated south of the Liddell Ash Dam. Open cut coal mines including the Howick Mine, Ravensworth Mine, Swamp Pit Mine, and Liddell Coal Mine have commenced operations in the area. Several apparent dams occupy an area along the south-eastern foreshore of Lake Liddell, and immediately north of Macquarie Generation owned land.
1982	The Liddell Power Station remains unchanged. The Liddell Ash Dam has expanded towards the south-east by approximately 30%.	Construction has commenced at the Bayswater Power station, south of the Liddell Ash Dam. Where apparent dams were previously identified south-east of Lake Liddell, several of these dams appear to have been backfilled, with only the footprint now evident. A major coal stockpile is noted, and a rectangular clearing (inferred to be

Year	Site	Surrounding Area
		the Hunter Valley Load Point) has been established. Surrounding coal mines expand operations, and dams - likely associated with the Hunter Valley Load Point, and Liddell coal mining operations have been built within this area, east of Lake Liddell.
1993	The layout of the power station and extent of the Ash Dam remains unchanged. Ash slurry comprises approximately half of the Ash Dam. Several large roadways have been built within area, including a roadway through the western portion of the Liddell Ash Dam.	Several large coal stockpiles, buildings, and other infrastructure are located where the apparent dams were present south-east of Lake Liddell. The dams appear to have been backfilled and re-vegetated. A small open cut mine has been established within this area, north of the Howick mine. A significant open-cut mine - Liddell Mine in in operation north of the area, immediately east of Lake Liddell. The Drayton Mine appears well established, immediately north and west of the Liddell Ash Dam.
2003	The layout of the power station remains unchanged. Liddell Ash Dam has significantly changed shape. A north-west dam wall has been constructed on the western portion of the Ash Dam where the roadway was identified in the 1993 aerial photography. The Ash Dam has extended in a south-westerly direction, and the central portions of the dam have now been segmented into lagoon like configurations. A portion within the centre of the Dam appears to be revegetated.	The Drayton Mine appears to have significantly expanded operations immediately west of the Ash Dam. An open cut mine identified in the 1993 aerial immediately north of the Ash Dam has been back-filled and revegetated. Several large coal stockpiles, buildings, and other infrastructure are located where the apparent dams were present south-east of Lake Liddell. The dams appear to have been backfilled and re-vegetated. A small open cut mine has been established within this area, north of the Howick mine. A significant open-cut mine - Liddell Mine in in operation north of the area, immediately east of Lake Liddell. Howick Mine remains in operation, and the Hunter Valley Coal Preparation Plant has been established between Howick and Ravensworth mines.
2009 (reviewed via Google Earth)	The layout of the power station remains unchanged, with the exception of the installation of a series of solar panels to the south of the electricity generating units. Liddell Ash Dam continues to change shape, expanding to the extent of the roadway built west of the Dam. Portions of the Dam apparently filled with ash and backfilled have been revegetated.	Mining remains active in the surrounding area; significant operations are evident immediately west of the Site and appear to utilise the Ash Dam facility. Liddell Mine also remains a large operation immediately east of Lake Liddell.

3.3 *ZONING & LANDUSE*

Macquarie Generation landholdings cover approximately 10 074 ha, encompassing Liddell and Bayswater Power Stations, ash dams and ancillary operations. Macquarie Generation's land falls within both the Muswellbrook Shire and Singleton Local Government Areas (LGA); however Liddell Power Station is located entirely within the the Muswellbrook Shire Council's LGA.

A large portion of the Liddell Power Station landholding is zoned *SP2 Infrastructure Zone* under the Muswellbrook Local Environmental Plan (LEP) 2009 with smaller parcels of land in the north (near Antiene) and west (to the south of Bayswater Conveyor) zoned *RU1 Rural 1 Primary Production*.

3.4 *ENVIRONMENTAL APPROVALS, LICENSES AND MANAGEMENT*

Macquarie Generation operates under a range of State and Commonwealth Government environmental legislation. It is noted that whilst a comprehensive review of planning approvals and general environmental management was beyond ERM's scope of work for this assessment, in some instances these approvals and management system provide context for potential contamination sources (eg ash disposal) and hence a summary of salient points in relation to these issues has been set out in this report.

3.4.1 *Planning Approvals*

Most development at the site pre-dates current planning requirements enforced through the *Environment Planning and Assessment Act 1979.*

The relevant planning instruments at the time of and throughout construction were the local Council's Interim Development Orders (IDO) No 1 and 2 developed under the under *Local Government Act 1919* (Clayton Utz, 2013).

Review of the IDOs and related information suggests that at the time of construction and commissioning the Liddell Power Station development was permissible and Council was unable to restrict or prohibit development of the Liddell Power Station (within the boundaries of the 'site') including maintenance repair and extension.

The commencement of the *Environment Planning and Assessment Act 1979* gave the operation of the Liddell Power Station, as it existed at the time, continuing use rights through Section 109, which states:

> *"Nothing in an environmental planning instrument operates so as to require consent to be obtained under this Act for the continuance of a use of a building, work or land for a lawful purpose for which it was being used immediately before the coming into force of the instrument or so as to prevent the continuance of that use except with consent under this Act being obtained".*

Alterations and additions post 1 September 1980 were subject to the provisions of the *Environment Planning and Assessment Act 1979.*

Key planning approvals and consents known to ERM are summarised in *Table 3.2.*

Table 3.2 *Key Planning Approvals for Liddell Power Station*

Development	Description	Approval Authority and Number	Date
Hunter Valley Gas Turbines	Installation of two 25 MW gas turbine generating units for black start up, including two 2 ML distillate oil tanks, access roads and vehicle turning area	Muswellbrook Shire Council *DA54/B6*	19/6/1986
Sewage Effluent Reuse Project	Two hectare woodlot and a sewage effluent irrigation system adjacent to Liddell power station.	Muswellbrook Shire Council *DA 98/1995*	25/7/1995
Sewage Effluent Reuse Amendment	Location of irrigation system to be moved from woodlot to the ash dam. Total area to be irrigated of approx. 30 ha with approx. 2 ha irrigated at any one time.	Muswellbrook Shire Council *DA 98/1995 s96 Modification*	15/12/2005
East-West Gas Pipeline	Approx. 25 km gas supply pipeline to allow gas from Hunter Valley coal mines to be used as a supplementary fuel in Liddell power station.	Department of Planning *MP07_0028 Project Approval*	20/7/2009
North-South Gas Pipeline	Approx. 51 km gas supply pipeline to allow gas from Hunter Valley coal mines to be used as a supplementary fuel in Liddell power station.	Department of Planning *MP08_0061 Project Approval*	24/7/2009
Extension of Liddell Ash Dam	Elevation of ash dam wall to allow additional ash slurry disposal as per SoEE.	Muswellbrook Shire Council *DA1/2011*	31/10/2011

3.4.2 *Environmental Protection Licences*

Macquarie Generation holds Environmental Protection Licence EPL No. 2122 (issued under Section 55 of the *Protection of the Environment Operations Act 1997)* for the premises described as Liddell Power Station, New England Highway Liddell NSW 2333.

The EPL authorises the following scheduled activities:

- generation of electrical power from coal (> 4000 GWh generated); and
- coal works (> 5 000 000 tonnes handled).

The EPL applies to all activities conducted at the Site including the listed ancillary activities:

- chemical storage;
- helicopter-related activities (the plant has a landing area for helicopters);
- operation of emergency 1.5 MW diesel generator;
- operation of gas turbine;
- sewage treatment; and
- waste storage.

The EPL has recently been reviewed and amended through discussion between the EPA and Macquarie Generation. The latest variation to the EPL is dated 20 September 2013 and is next due for review in July 2018.

The EPL includes load-based licensing provisions, monitoring requirements and/or setting of concentration limits for emissions of pollutants discharged to air, water and land (for various locations), although dominantly relates to emissions to air. The EPL includes a range of conditions from the general requirement to operate in a "proper and efficient" manner to specific conditions such as methods for monitoring and analysis.

The EPL includes Pollution Reduction Programs (PRPs) relating to the following issues:

- management of backwash from the Water Softening Plant (that is, the clarifier and demineralisation plant at Liddell Power Station), which is currently discharged to Lake Liddell;
- management of water in relation to the ash dam; and
- upgrades to the Liddell Ash Line Settling Pond in relation to water and ash management.

ERM notes that these PRP requirements are considered to be an operational issue and are thus outside the scope of this investigation.

Non-compliances reported under EPL 2122 as identified in the 2013 Environmental Compliance Audit (ERM, 2013) and considered to represent potential contamination of soil and groundwater are outlined in *Table 3.3* (below).

Table 3.3 Summary of Environmental Non-Compliances which are Relevant to Potential Contamination Issues

Report Reference	Requirement	Comment	Contamination Significance
L1.1	Except as may be expressly provided in any other condition of this licence, the licensee must comply with section 120 of the *Protection of the Environment Operations Act 1997.*	Liddell Power Station has a number of discharge points to Lake Liddell (and tributaries such as that have potential to contain pollution). Discharges to Lake Liddell include: treated stormwater discharging from the main oil/grit interceptor; cooling water discharging from the main canal; Liddell Ash Dam discharges (dam wall seepage, overflow from ash line dam, water used in process), coal stockpile and coal conveyor sediment trap supernatant. The site inspection suggested that a number of the discharge points are not well controlled due to challenges in maintenance of the treatment facilities. A PRP has been included in the newly amended EPL to assess the management options for discharges from the demin backwash water into Lake Liddell with report due to EPA 30 August 2013. A further PRP is under development for the Tinkers Creek Settling Ponds. All discharges from Liddell are being assessed in liaison with the EPA with management options being considered.	Contaminants may be exiting the site from discharge points into Lake Liddell and other surrounding waterways.
		Four groundwater monitoring wells installed at the Underground Storage Tanks in August 2011 (three down hydraulic gradient, one up gradient). Concentrations of TPH compounds above the Site Acceptance Criteria were detected within three monitoring wells (two down hydraulic gradient, one up gradient).	Previous groundwater results indicate the presence of groundwater contamination
O1.1	Licensed activities must be carried out in a competent manner. This includes: (a) the processing, handling, movement and storage of materials and substances used to carry out the activity; and	Numerous outstanding actions from previous dangerous good storage audits. Observations during site inspection include: - anecdotally chemical deliveries are unsupervised; - staining and corrosion from chemical deliveries noted	Potential for migration of asbestos in shallow soils from the asbestos landfill. Potential contamination of soil and groundwater due to chemical/waste spills/leaks.

Report Reference	Requirement	Comment	Contamination Significance
	(b) the treatment, storage, processing, reprocessing, transport and disposal of waste generated by the activity.	around unloading facilities; - corrosion of cement to soil observed in pits handling acid water overflows; and - carrier pipeline for ammonia to Demin plant exposed - potential damage by vehicle collision including mower. Asbestos waste wrapped in plastic and placed inside sheds prior to a campaign of disposal on site. Some wrapped plastic pieces of asbestos noted on the surface of the landfill and not covered. Asbestos Management Plan (AMP) outlines disposal methodology which includes storage of waste bags inside a waste drum, bin or skip until disposal to landfill.	
O2.1	All plant and equipment installed at the premises or used in connection with the licensed activity: (a) must be maintained in a proper and efficient condition; and (b) must be operated in a proper and efficient manner.	Challenges in maintenance of several key environmental controls were noted during the site visit: - Belts on the oil/grit interceptor were not in service. The interceptor was not working effectively and an oil sheen was noted in the treated effluent and at the discharge point at Lake Liddell; - Approximately one third of the aerators on the sewage treatment plant were not in service; - Significant corrosion of concrete flooring was noted in the dangerous goods compound used primarily to house demineralisation chemicals; - Several bunds around bulk storage tanks were observed to be heavily stained on the external walls, suggesting that seal is not provided/maintained and bunds do not provide appropriate containment; and - Coal stockpile sediment traps contained a large volume of sediment and did not appear to have been maintained at the time of the audit (in order to allow the traps to function effectively).	Potential contamination of soil, groundwater and surface water due to waste spills/leaks/releases.

3.4.3 *Environmental Management*

Macquarie Generation maintains an ISO14001 certified Environmental Management System (EMS) for Liddell Power Station which is audited annually. The audit focuses on compliance with the aspects of ISO14001 and does not assess the implementation or effectiveness of the system.

A number of environmental plans for Liddell Power Station have been developed under the EMS and/or in response to regulatory requirements, however the assessment of the implementation of these has not been completed as part of this assessment.

Environment specialists form a joint team that covers both the Liddell and Bayswater Power Stations, although some staff are specifically responsible for a site and are based at that location:

- Environmental Manager – Mr. Howard Richards (environment team manager for both stations, based at Liddell Power Station);
- Environment Officer - Mr. Stephen Fell (environment specialist for Liddell Power Station, based at Liddell Power Station);
- Environment Officer – Ms. Kathryn Yates (environment specialist for Liddell Power Station, based at Liddell Power Station);
- Environment Officer – Ms. Elle Hutchinson (environment specialist for Bayswater Power Station, based at Bayswater Power Station); and
- Environment Officer – Mr. Matthew Parkinson (environment specialist for Bayswater Power Station, based at Bayswater Power Station).

A recent Environmental Compliance Audit undertaken by ERM in July 2013 (ERM, 2013) found that Macquarie Generation has generally achieved a high level of compliance with the conditions of the EPL. Not all data or documents were available for review to assess compliance with the approval conditions. Primarily the main issues revolve around the storage of dangerous goods potentially resulting in releases, and also discharge to waters, which may result in soil and/or groundwater contamination.

The audit found several non-compliances with the relevant approvals and licence that apply to the site which had potential to be associated with soil and/or groundwater contamination. These include:

- current discharges to Lake Liddell that potentially contain pollution (potential non-compliance with Section 120 of the POEO Act, 1997) ;
- numerous actions are outstanding from previous Dangerous Goods audits with the site inspections confirming challenges in this area; and

- the site inspections noted maintenance of environmental controls is not always completed in a timely manner.

ERM understands that Macquarie Generation are aware of the relevant issues in the July 2013 audit which relate to exceedences of the EPL performance criteria, and that these issues are being addressed in consultation with the EPA.

4 OPERATIONS

4.1 INTRODUCTION

This chapter provides an overview of site operations in order to provide context to subsequent assessment of potential for contamination. A brief description of key activities is provided including, in particular, chemical and waste storage. Key operational areas are presented in the Site Layout Plan provided as *Figure 2, Annex A.*

4.2 WATER SUPPLY

Macquarie Generation has prepared a Water Management Licence Site Management Plan (undated) and the information on water storages is sourced from this plan and the Macquarie Generation website. Further details on water management at Liddell Power Station are presented in *Section 4.13.*

Water for the Liddell and Bayswater Power Stations is sourced primarily from the Hunter River. This can be supplemented by the Barnard River Scheme which takes water from the upper reaches of the Manning River and pumps it to the upper reaches of the Hunter River.

Half of Macquarie Generation's water supply is held in Glenbawn Dam under a Major Utility Allocation Licence. The other half of the water supply is intended to be pumped periodically during high flow events in the Hunter River, which occur downstream of Glenbawn Dam (Macquarie Generation website 21 June 2013).

Water is dammed at the following locations:

- Glenbawn Dam (Hunter River) (72-76ML);
- Barnard Weir (Barnard River) (62ML);
- Orham Creek Dam (Barnard River); and
- Oakey Regulating Dam (Barnard River tributary).

Macquarie Generation holds various conditional water licences that permit the taking of water from various sources.

Water from these sources is pumped to various constructed dams near the Power Stations:

- Lake Liddell, adjacent to Liddell Power Station;

- Plashett Dam (also known as Plashett Reservoir), eight kilometres south-west of Liddell Power Station;

- Freshwater Dam (also known as the Bayswater Domestic Water Dam or Bayswater Reservoir), adjacent to Bayswater Power Station and used for process and domestic water supply for both sites; and

- Bayswater Cooling Water Makeup Dam.

Water pumped from the Hunter River either pumps directly to the Bayswater Cooling Water Makeup Dam or passes through a Lime Softening Plant to remove hardness. The Softening Plant and associated Sludge Lagoons are located between Plashett Dam and the Bayswater Power Station. This treated water is then transferred to either Lake Liddell or the Freshwater Dam.

4.3 *COAL FUEL SUPPLY AND STORAGE*

4.3.1 *Sources and Receival*

Liddell Power Station receives black coal from local coal mines via overland conveyor, and from regional coal mines via rail. Rail receival facilities are located at Ravensworth and Antiene as detailed below. Facilities are available to receive coal by road, however station staff advised that this is not a significant transport mode at present.

Liddell and Bayswater Power Stations operate an integrated system of coal procurement and receival. While stockpiles are located at each plant, coal can be conveyed between the power stations and Bayswater holds the bulk of the coal stockpile.

Major sources of coal include Wilpinjong mine (Peabody, Ulan), Mount Arthur (BHP, Hunter Valley), Ravensworth (Xstrata, Hunter Valley) and Mangoola (Xstrata, Hunter Valley). Coal is generally unwashed.

The potential for the operation of both Ravensworth and Antiene Rail Coal Unloaders (RCUs) to have resulted in contamination of soil and/or groundwater is assessed as part of Bayswater Power Station.

4.3.2 *Antiene Rail Coal Unloader*

Antiene RCU is the main delivery point for coal for Liddell Power Station. Antiene RCU is located approximately 2.5 km to the north of Liddell Power Station, adjacent to a northern branch of Lake Liddell and two creeks that feed into it (Maidswater Creek and an unnamed creek).

Antiene RCU was constructed in 2006 and consists of:

- a rail spur off the Main Northern Line and balloon loop for turning;
- a coal receival area including access roads, an in-ground coal hopper, conveyor systems and a control house;
- above ground fuel and oil storage; and
- conveyors leading to the Power Stations.

The facility is operated by Pacific National under an Operational Environmental Management Plan.

4.3.3 *Ravensworth Rail Coal Unloader*

Ravensworth Rail Coal Unloader is operated on a quarterly basis for the purposes of operator training and to ensure it remains serviceable. The facility can only accommodate small train shipments and is limited to a two wagon unloading capacity.

4.3.4 *Liddell Coal Stockpiling and Delivery*

Liddell's coal stockpiles are located on the south-western side of the power block. Coal is delivered by conveyor to the main receiving bin and is discharged to the main stockpile that holds approximately one million tonnes (Mt) of coal. Liddell is equipped with a roofed area within the stockpile for dry storage of some of the stockpile.

Liddell is also equipped with coal stockpile bays serviced by stacker reclaimers on rails. A small control building is located adjacent to the bays. Some of these bays (stockpile area, stackers, reclaimers and conveyors) are not currently in service. The bulk of the coal is therefore stored in the main stockpile.

The coal bays drain to a concrete pipe that diverts water to two locations with a pit. The pit is intended to drop out coal particles. The pits discharge to the cooling water outlet channel. The pipeline also discharges direct to the cooling water outlet channel once the pits are full of sediment.

The main stockpile drains to an open stormwater channel that rings the area. The channel discharges at the end of the cooling water outlet channel before discharge to Lake Liddell.

A secondary long-term coal stockpile is located to the south of the main stockpile. This area drains through swales to Lake Liddell.

The coal towers along the conveyor line are also equipped with sedimentation ponds that discharge to Lake Liddell along existing drainage lines. Further details on the construction of these sedimentation ponds (i.e. lined vs. unlined) was unavailable at the time of assessment.

4.3.5 *Mobile Plant Maintenance and Refuelling*

A maintenance and refuelling area for mobile plant associated with coal stockpiling is located adjacent (west) to the main stockpile.

The area is equipped with an enclosed shed and a maintenance bay covered with an awning. A dish drain surrounds the bay and discharges to the main stockpile open water channel.

A bunded waste oil tank (approx. 2000 L) is located outside the maintenance shed.

A 70 000L self-contained diesel above ground storage tank is provided for refuelling. A former 115 000 L diesel underground storage tank (UST) was replaced in 2012 with the clearance certificate pending at the time of this audit. Four groundwater monitoring wells were installed at the location of the former 115 000 L UST in August 2011 (three down hydraulic gradient, one up gradient). Concentrations of TPH or BTEX compounds above the Site Acceptance Criteria were not detected (DLA Environmental, 2011).

A small administration/control building is located on the northern side of the mobile plant area. As this building is not connected to sewer, it is equipped with a septic system. The size of the septic system is unknown. Effluent is understood to be irrigated to a grassed area nearby. This septic system is registered with Muswellbrook Shire Council. Further details on construction of the septic system (ie date, capacity, etc) were not available at the time of assessment.

4.4 *AUXILIARY FUEL STORAGE*

Liddell Power Station uses diesel as fuel for boiler ignition. The Fuel Installation is located on the south-east corner of the power block and consists of a number of large above ground diesel storage tanks and associated transfer systems:

- three 363 kL (325 kL working capacity) tanks in a bunded area (Tanks A, B, C); and
- one 1000 kL tank in a bunded area (Tank D).

Two additional tanks are present in this area but are no longer used (Tank E and F - capacities 1000 kL each) - but contain residual sludge (see *Section 4.5*). These tanks were used to store auxiliary fuel associated with the alternative programme described below.

4.5 *ALTERNATIVE FUEL*

Liddell Power Station was previously licenced to use a range of alternative fuels in the boilers. Alternative fuels included waste oil, oyster poles and Liquid Alternative Fuel sourced from the Sydney Olympic site.

Fuels were delivered to the boilers by a range of mechanisms and some systems are still in place, although the alternative fuel programme has been disbanded:

large bunded tanks for Liquid Alternative Fuel (LAF) (formerly auxiliary fuel stores). There are two tanks each with a capacity of 1 ML (labelled E and F - the same tanks referred to in *Section 4.4*). Site staff advised that these contain residual LAF and sludge that is intended for off-site disposal; and

- bunded tanks for waste oil and the associated covered delivery area and transfer lines. The area is located on the south-east of the power block and there are three above ground steel tanks each with a capacity of 55 000L. Site staff advised that these contain residual waste oil that is intended for off-site disposal.

4.6 *ELECTRICITY GENERATION UNITS*

4.6.1 *Main Power Generating Plant Area (Power Block)*

The main generating plant area houses four units and associated infrastructure:

- coal hoppers, bowl mills and pulverised fuel feed systems;
- four coal-fired boilers;
- turbine house incorporating four steam turbines driving four hydrogen cooled generators;
- a centralised control room;
- generator transformers (four plus spare) and electrical connection to the adjacent TransGrid 330 kiloVolt (kV) switchyard via overhead connectors;
- station service and auxiliary transformers;

- DC systems and associated internal battery banks;
- uninterrupted Power Supply; and
- pulsed bag filter houses and two chimney stacks (each serving two boilers).

At the time of site inspection, Generating Unit 4 was out of service due to a plant failure.

4.6.2 *Hydrogen Supply*

Hydrogen for generator cooling is supplied via cylinders stored near the demineralisation plant. Cylinders are housed in a fixed roofed store (approximately sixteen 72 L cylinders on pallets connected to supply lines), or on pallets while awaiting use. Cylinders are refilled by road tanker from a separate location.

The former hydrogen manufacturing plant (located in the same area) is not in service.

4.6.3 *Carbon Dioxide Supply*

Carbon dioxide is used for generator purging and fire systems.

Two 7 000 L steel ASTs containing carbon dioxide are located on the northern side of the power block, and are equipped with evaporators and supply lines.

Carbon dioxide for the fire suppression system at the HVGT is supplied via approximately twenty 45 kilogram (kg) cylinders. The fire suppression system has been recently approved for upgrade.

4.6.4 *Ammonia Supply*

Anhydrous ammonia is stored in bullets to the south-west of the power block. Ammonia is mixed into solution in a small tank adjacent to the facility. As the reaction is exothermic the tank is cooled with water sprays. Pipelines then carry the aqueous ammonia to the demineralisation plant.

4.7 *TRANSMISSION*

The Liddell 330 kV switchyard is located on the western side of the power block and is operated by TransGrid. It is understood that land occupied by the switchyard is also owned by TransGrid.

4.8 EMERGENCY GENERATOR

An emergency diesel generator is located on the southern side of the power block area. The generator is not currently in service. Diesel is supplied from the Fuel Oil Installation and is held in a bunded steel 5 000 L AST at the generator.

4.9 BLACK START CAPABILITY (HVGT)

The HVGT power station provides black start capability to the power station, and is therefore only used in response to major blackouts. The HVGT is started every two to three months to confirm it remains operational and prevent the motors seizing from lack of use. The HVGT is located approximately four kilometres south-east of the power block, near the 33 kV switchyard.

HVGT comprises two 25 MW diesel-fuelled gas turbine plant equipped with compressors for incoming air, turbines, exhausts, transformers, diesel stores and fire-water supply. A small administration building is located near the plant. As this is not connected to sewer it is equipped with a septic system which is not currently registered with MSC.

Diesel stores consist of two bunded steel 250 ML ASTs that are refilled by road tanker.

4.10 33KV SWITCHYARD

A 33 kV switchyard is located on the northern side of the Hunter Valley Gas Turbines. The switchyard is gravelled and surrounded by a dish drain (which is in poor condition).

4.11 SOLAR STEAM PLANT

The solar steam plant was installed as a pilot in 2004 and was subsequently expanded in 2008. The facility is located on the southern side of the power block.

The solar steam plant is designed to heat auxiliary steam by reflecting the rays of the sun onto steam tubes using a large array of engineered mirrors (compact linear Fresnel reflectors).

The plant is equipped with water circulation systems, a steam drum and mirror cleaning systems. A control room is located on the northern side of the array.

4.12 *Ash Placement*

4.12.1 *Liddell Ash Dam*

Liddell Power Station's ash emplacement area is located four kilometres to the west of the main plant, to the west of the New England Highway. The western boundary adjoins the Drayton Coal Mine.

The ash emplacement area is in the upper catchment of Bayswater Creek and was constructed by damming a natural valley. The ash dam has been in use since Liddell Power Station commenced operation and remains in operation. Over the life of the power station, the ash dam has been progressively developed under various planning instruments resulting in a surface area of approximately 2.7 km^2 (Coffey 2012). In 2012, the ash dam was nearing its approved capacity and development consent was therefore obtained from Muswellbrook Council to increase the height of the ash dam walls, with these works underway during the site inspection.

Liddell Power Station uses approximately 5.5 Mt of coal per year, which results in the production of approximately 1.6 Mt ash per year based on 28% ash content of coal (Coffey 2012).

Liddell fly ash and bottom ash is pumped as a slurry to the southern side of the Ash Dam where the ash settles out and the decant water returns to Liddell via the Return Water Line to be reused for the slurry. The Power Station is in the process of converting to a dry collection system for bottom ash, however ERM understands that following collection, the bottom ash will continue to be slurried for transport to the ash dam. Macquarie Generation personnel also indicated that fabric filter bags and bonded asbestos cement pipe sections have also been disposed in the Ash Dam previously.

Excess water (from high rainfall events) overflows to the Ash Skimmer Dam and then to Lake Liddell.

There are several potential water discharge points from the Ash Dam area. These are the Ash Skimmer Dam, seepage through the Ash Dam wall itself, seepage through the base to groundwater and Tinkers Creek. Tinkers Creek is situated downstream from the ash dam area and is a potential receptor, however it also acts as a pathway as it flows into Lake Liddell. A settling pond is located between the dam and Tinkers Creek to provide some control on the particulate discharge to the creek.

4.12.2 *Drayton Colliery Void*

An open cut coal mine void formed by Drayton Colliery is located on Macquarie Generation land. This void was proposed as a potential ash emplacement area but was not accessible within the required timeframe. This void could potentially be used for additional ash emplacement if required in the future, subject to approvals.

4.13 *WATER MANAGEMENT SYSTEMS*

4.13.1 *Cooling Water*

Cooling water for Liddell Power Station is sourced from Lake Liddell. The intake and pump station is located on Lake Liddell on the northern side of the power block.

Cooling water is passed through trash racks and rotating screens and gathers in a forebay before passing through four large pumps (plus one standby) that carry the water to the units.

Cooling water is dosed with scale and erosion inhibitor which is stored in IBCs around the pump station. There are approximately 30 IBCs stored on the tarmac/concrete in this area. The IBCs are not in a bunded area.

A disused chlorination plant is located adjacent to the pumping station. There is no current chemical storage associated with this area. Concrete plinths which may have been associated with former bulk storage tanks and disused above ground pipework and pumps are situated to the immediate west of the former chlorination plant building.

After passing through the plant condensers and other cooling systems, cooling water is discharged via a large open channel to the south of the power block. This channel discharges to Lake Liddell. The channel is equipped with a weir to assist with slowing down flow, and an oil detection unit located upstream of the weir. Two oil booms are located downstream of the weir.

4.13.2 *Process Water*

Process water is sourced from either the Bayswater Demin treated water or the Freshwater Dam. Water from the Freshwater Dam is pre-treated in a sand filter, clarifier and demineralisation plant located on the south-west corner of the power block.

Sand filter backwash is disposed to the Ash Dam.

The clarifier includes:

- a delivery bay for flocculant (hydrated ferric chloride);
- two large ASTs (holding ferric chloride) housed inside a plant room; and
- a large clarifier equipped with clarified water intake trays discharging to the demineralisation plant.

The demineralisation plant includes:

- mixed (cation and anion resin) bed vessels;
- storage tanks for acid regeneration (sulphuric acid, four tanks of 49.8 kL);
- storage tanks for caustic regeneration (sodium hydroxide, four tanks of 71.8 kL);
- two freshwater storage tanks located above the plant;
- two demineralised water storage tanks located above the plant.

Spent resin and regeneration wastewater is disposed to Lake Liddell.

4.13.3 *Domestic Supply and Firewater*

Water for domestic use is treated and chlorinated prior to use. The chlorination plant is located adjacent to the demineralisation plant. The chlorination plant (also referred to the as 'chlorine room') contains an external locked gated compound containing chlorine gas cylinders. At the time of the visit there was 280 kg of gas stored in the cylinders. Chlorine is transferred via above ground pipework into the chlorination plant.

A firewater reservoir tank (1.1 ML) is located on the northern side of the power block near the cooling tower intake plant (north of the plant access road). The fire fighting water is derived from process water.

4.13.4 *Sewage Treatment*

The sewage treatment plant (STP) is located to the east of the power block adjacent to Lake Liddell. The STP accepts domestic wastewaters only and ERM understands that no off-site sources of domestic waste are accepted.

The STP is an aerated digester. Sludge is disposed to the small retention ponds adjacent to the STP on a campaign basis. Treated water passes through three settling ponds before being pumped to the ash dam.

4.13.5 *Stormwater*

Stormwater from the power block area and surrounds is assumed to be potentially contaminated with oil, ash or coal. Stormwater is directed to a large oil-grit trap adjacent to the STP.

The oil grit trap consists of four bays designed to allow settling of sediments, followed by a belt oil skimmer. Captured oil is stored in a pit which is periodically emptied by a sucker truck (Transpacific). Treated stormwater is discharged to Lake Liddell through a wide diameter pipe located immediately to the south of the oil grit trap. The discharge point is equipped with an oil boom.

4.14 *IN-SITU WASTE DISPOSAL*

A number of landfilling locations were identified by site staff during the visit as set out below. These involve emplacement of waste material for disposal purposes and also the use of material to expand the shoreline. There were no detailed records available for review in regards to the exact size, design (eg use of liners and leachate control), types of material emplaced and periods of operation for all of the locations identified. A 2013 document prepared by John Bennett of Macquarie Generation entitled 'Liddell Power Station, Review of Waste Material Locations' and drawing LD 571685 of the Asbestos Dump layout were the principal data sources and are summarised in the following sections.

4.14.1 *Landfilling: Southern Area*

Borrow Pit

Located on the eastern side of the outfall canal, this contains bottom ash, soil and construction materials (eg steel, concrete and cables). Site staff indicated no putrescible matter is emplaced in this area. This area is still in use, spoil and concrete was observed on the tip face during the site visits.

Filled Gully

Located on the eastern side of the Solar Plant. Infilled gully which contained similar material to the Borrow Pit.

Clover Leaf Ponds

On the eastern side of the southern waste disposal area. Contains material dredged from the station oil water separator from 1976-2000. Listed as ash, dust, grit and coal fines.

Asbestos Landfill

At southern end of this area is the Asbestos Landfill. The access road to the asbestos landfill is gated. The asbestos landfill is within the boundary of the wider station and is therefore protected by the extensive security fencing around the land borders. A plan provided by site staff indicates this has been in operation since 1978. The area is still used, as asbestos containing materials are regularly discovered during maintenance operations. An open pit to the immediate west is used as the active asbestos landfill area. Material is double bagged, housed in a small storage shed until the excavator is available, and is then placed into the pit and covered.

Nine locations on the landfill plan are also marked as Slurry Pits. No further information was available as to the nature of the slurry.

On the northern side of the asbestos landfill is an area which was overlaid by 'station rubbish' in approximately 1990-2000. This has since been capped and closed.

Further north of the overlapping asbestos and station rubbish area is a third area which is known as the Liddell Rubbish Dump. This was in operation from approximately 1970-2000. It contained mixed rubbish and has been capped.

4.14.2 *Landfilling Eastern Area*

This area is located to the east of the Main Power Block.

Boomerang Pond Area

An area of coal fines and grit is present at the shoreline which was sourced from the Boomerang Pond. An area of clean fill was also emplaced between the Boomerang Pond and the lake.

Former Gully

A former gully was infilled with clean earth and was adapted as an oil skimmer pond in approximately 1990.

4.14.3 *Shoreline Expansion*

The shoreline has been extended along the southern and eastern edges of the site. The area between the Sewage Treatment Plant and the Cooling Water Intake has been extended with fill comprising coal fines and ash in approximately 1970-1980.

Site staff indicated that the southern shoreline of the Coal Handling Plant is also believed to have been extended, possibly by the overspill of coal fines. The shoreline east of the M1 Conveyor is believed to have similarly expanded.

In 2000 an area of the foreshore to the east of the solar array was repaired and realigned. Clean earth and rock fill was used.

4.15 *Ex-situ Waste Disposal*

The following waste streams are removed from site and managed by waste contractors:

- waste oil - Transpacific;
- domestic and office waste – Remondis.

4.16 *Workshop and Stores and Compounds*

There are several workshops located through the Power Station including:

- the main workshop and apprentices workshop on the western side of the power block;
- contractor workshop located on the south-east corner of the main operational area;
- workshops for ash plant and another workshop near the transformers.

An open-air store for redundant or mothballed equipment known as the 'graveyard' is located to the north of the coal yard.

The Main Store is located to the north of the administration building. The Vehicle Refuelling Depot is located adjacent to the Main Store and consists of two Underground Storage Tanks (USTs) which are used to store unleaded petrol and diesel. The USTs are both steel and comprise a 26 400 L capacity unleaded petrol tank and a 21 000 L capacity diesel tank. The age of the USTs is unknown. There are four monitoring wells in the vicinity of the USTs. These are discussed further in the Previous Environmental Investigations (refer to *Section 5.5*)

4.17 *Inventory of Chemicals and Wastes*

An inventory of significant storage facilities is provided in *Annex E*, based on the site's Dangerous Goods Notification. Minor stores are also kept in the maintenance workshop and other operational areas.

The site had a variety of bulk (>1000 L) chemical storage:

- petrol;
- diesel;
- waste oil;
- sodium hydroxide;
- liquid recycled fuel;
- anhydrous ammonia;
- transformer oils;
- hydrogen peroxide;
- corrosion inhibitors; and
- coagulants (e.g. Ferric chloride).

The storage and contamination potential of these chemicals is discussed in detail in *Section 6.*

A number of large transformers contain significant quantities of insulating oil. Due to the age of the facility, polychlorinated biphenyl (PCB) additives would have historically been extensively used in insulating oils in transformers, capacitors and light fittings. Site staff confirmed that four transformers have either currently or historically used PCBs, with a further twelve considered highly probable.

The Environmental Management and Control Manual (April 2010) states, "All PCB compounds are considered to have been removed from site. Some transformers with replacement PCB free oil have a blue label stating that they may contain PCB's but at a level lower than the detectable limit. These are considered PCB free."

A letter was also sent to the Department of Environment and Climate Change NSW in October 2008 (ENV.04.01.007) stating that there were no PCB wastes stored at the site and that all power and voltage transformers were refurbished or replaced between 1985 and 1996. The transformers were drained and filled with new transformer oil certified to be PCB free. The letter indicated that transformers were systematically tested and typically indicated concentrations of PCBs of less than 1 ppm. All other known sources such as ballast capacitors and invertor power supplies were also removed and were replaced with PCB free components during the 1985-1996 period. The remaining quantity of waste PCB material was removed in accordance with EPA requirements in 1997.

5 *SITE CONTAMINATION HISTORY*

5.1 *OVERVIEW*

The site has been in industrial use since the early 1970s. Potential and identified areas of contamination can be subdivided into the following categories:

- historical mining and landfilling activities;
- historical power station operations;
- current power station operations;
- chemical storage and waste inventory; and
- a review of the limited soil and groundwater investigations completed to date.

Potential and identified areas of concern in terms of soil and groundwater contamination are presented in *Section 6.*

5.2 *NSW EPA CONTAMINATED SITE RECORDS*

The NSW EPA Contaminated Lands Register lists facilities that are known to be contaminated and are regulated by the NSW EPA under the *Contaminated Land Management Act 1997*. At the time of this assessment (August 2013) the Site was not listed on the register. A registered sites search for the Muswellbrook and Singleton local government areas did not identify any relevant facilities.

NSW landowners and occupiers who believe that their sites may be contaminated above certain levels specified in the *Contaminated Land Management Act 1997* must notify the NSW EPA of the suspected contamination. The contamination may or may not be significant enough to warrant regulation by the EPA. Following notification, the EPA conducts an assessment process to determine whether regulation is required. The *NSW EPA List of Contaminated Lands Notified to the EPA* describes these sites. At the time of this assessment Liddell Power Station has been notified to the EPA as potentially contaminated. The EPA initial assessment is listed as 'in progress' with the contamination of this Site being assessed by the EPA. Sites which have yet to be determined as significant enough to warrant regulation may result in no further regulation under the *Contaminated Land Management Act 1997*.

5.3 *PRODUCT SPILL AND LOSS HISTORY & OTHER DISCHARGES*

Due to the long history of the site, a comprehensive listing of spills and inadvertent discharges is not available. However, from a review of available documents and interviews with site staff, the following basic summary of known incidents is supplied (note that the majority of these were obtained from the Incident and Communication Complaint Register, this was discontinued in 2006 - a note in the dataroom (LI.ENV.02.06) indicated that "All environmental complaints transferred to EMS database (ISOsoft) after 9 June 2006. There have been no complaints since this date and therefore no entries in the database. "). The following information is not intended to be a comprehensive assessment of the spill and loss history of the site (which was not possible on the basis of information available, often including the precise location of release), but an indication of the types of loss of containment the site has encountered:

- HVGT diesel leaks – two spills of diesel were listed as part of a BP Asset Management check in 2010. One is from 1990 where diesel leaked into bunds, estimated that in excess of 30 000L overtopped and found its way to Lake Liddell (refer to *Section 6.2.1*). Details of the second incident are unknown.

- Ammonia leak – from ammonia plant, exact volume and date unknown. Information provided verbally by Macquarie Generation personnel during ERM's site visit.

- Waste Oil leak – overfill of tank and bund overflow of tank in Transformer Road in 2012. Oil reached drains and flowed to oil and grit trap. A contractor pumped out the waste oil. Information provided verbally by Macquarie Generation personnel during ERM's site visit.

- Diesel leak at Mobile Plant Refuelling Area in 2013, approximately 1000 L leaked to ground. Information provided verbally by Macquarie Generation personnel during ERM's site visit

The following incidents are taken from the Incident and Communication Complaint Register. No further details on these incidents was available at the time of assessment:

- Oil spill – tanker overturned on approach road to site in May 2003. Oil was contained and EPA notified.

- Fuel oil spill – underground transfer line between fuel oil tanks leaked in June 2003. Pipework repaired and contaminated soil removed.

- Diesel leak – 700L lost from locomotive at Ravensworth Rail Unloading Facility in June 2003. Contaminated ballast removed.

- Fuel oil spill - failure of redundant underground pipe in July 2004, caused seepage to soil. Surface oil drained to oil and grit trap. Pipe was removed and blanked. Contaminated soil was removed.

- Oil leak - at stormwater outlet in February 2005. Booms installed. No further information given.

- Biodiesel spill - at the LAF unloading area in May 2005. Spill confined to road bund. Build-up of gelled glycerol based material had accumulated in vicinity of drain outlets.

- Oil spill at #4 SAH - in May 2005, spill contained. No further information given.

- Oil spill at #4 Turbine - in June 2005, oil contained. No further information given.

- Oil spill at #4 Defoam tank - in June 2005. Valve repaired and area cleaned/contained.

- LAF leak – to boiler basement in June 2005. No further information given.

- Ignition oil leak – old drain line had not been blanked off. 300 L of ignition oil leaked into basement area in June 2005

- Fuel oil leak - pipework leak in December 2005 allowed fuel spray into basement area. Area contained and cleaned.

- Turbine oil leak - bund found to be full of oil in January 2006. 2500 L had accumulated. Bund emptied and repaired.

- Oil leak - reported as 'large oil leak' beneath #4 due to hydraulic line fracture in April 2006. Area contained and cleaned.

- Purifier leak - 5000 L lost due to failure of purifier in April 2006. Recurrence in May 2006 resulted in loss of estimated further 7000 L to turbine drains.

- Oil leak - at pyrites cubicle, hydraulic line fracture in May 2006. Area contained and cleaned.

- Fuel oil spill - in basement of #4 due to failure of oil gun resulted in overboarding of catch tank in June 2006.

5.4 *PREVIOUS ENVIRONMENTAL INVESTIGATIONS*

There have been few intrusive soil and groundwater assessments completed at the site to date. As summarised below, these have been targeted to specific identified issues rather than presenting a comprehensive assessment of site conditions.

DLA Environmental (2011), UPSS Groundwater Well Monitoring Report, Liddell Power Station

Two areas of the site contain underground petroleum storage systems (UPSS). These are at the Mobile Plant Refuelling Area to the south west of the Coal Reclaimer Bays and the Light Vehicle Refuelling Area to the Main Store. DLA was commissioned to install four wells at each site, with three down hydraulic gradient wells and one up gradient well at each site.

Bore logs indicated that the Light Vehicle Refuelling area was underlain by gravelly sands to a depth of 2.5 m in wells L1-L3, but with a greater thickness of 5.2 m in well L4. Underlying the gravelly sands was sandstone bedrock proven to a depth of 7.5 m in well L4. No data on groundwater levels was provided.

Borelogs from the Mobile Plant Refuelling Area indicated orange and grey clays proven to a depth of 10 m. The soil profile was indicated as wet beyond a depth of 8 m. No soil samples were collected and submitted for chemical analysis.

Sampling of the groundwater was undertaken using low flow sampling techniques in August 2011. Samples from the Light Vehicle Refuelling Area wells were reported to contain detectable hydrocarbons, but did not exceed the Site Acceptance Criteria (SAC) - in this case - ANZECC 95th percentile criteria. Samples from the Mobile Plant Refuelling Area wells did not contain concentrations above the laboratory limit of detection.

Coffey Environments (2011), Proposed Extension to Ash Dam Liddell Power Station, June 2011.

Groundwater data was collected from five wells in the vicinity of the existing ash dam as part of the proposed dam extension application. The spread of wells were considered to be representative of groundwater conditions beneath the site and also those down hydraulic gradient of the ash dam. The water samples were analysed for heavy metals, polycyclic aromatic hydrocarbons (PAH), cations/anions, total organic carbon and nutrients. The analytical results were then compared to the ANZECC (2000) guidelines.

The results indicated slightly elevated copper results (2ug/L vs. criteria of 1.4ug/L) and calcium (no criteria) in the down gradient wells. Selenium had been previously noted as a contaminant of concern, however this was not present above the laboratory limit of detection in the samples analysed. Coffey stated that when compared to the up-gradient well, it appeared that the ash dam had no significant impact on regional groundwater quality.

5.5 *OTHER ENVIRONMENTAL DATA*

A number of water and sediment samples have been collected at the site between August 2012 and January 2013. Information on the exact locations of the sampling points, the identity of the samplers and the purpose of the sampling is unknown. These are collated in a series of spreadsheets for both Bayswater and Liddell which were present in the dataroom (Reference ENV 04.03.15 to ENV 04.03.20 inclusive). For Liddell there are samples from four sediments sites in the lake, the dam wall, sewage ponds, potable water, the cooling water inlet and outlet, oil and grit trap, ash dam and Tinkers Creek. Samples are analysed for a variety of inorganic and organic determinants.

6 PRELIMINARY CONCEPTUAL SITE MODEL

6.1 INTRODUCTION

A conceptual site model (CSM) is a representation of the sources of contamination, potential receptors and pathways which the receptors may be exposed to the contaminants. The development of a CSM is an iterative process, staring with a preliminary CSM based on a review of background data for the site and any available data from previous intrusive investigations. The CSM is refined by identifying data gaps and undertaking additional investigation to address these gaps, often in a staged approach. Typically the CSM is based on a 'lines-of evidence' approach where multiple data sources are used in the assessment of actual and potential risks to human health and the environment.

The preliminary CSM for Liddell Power Station is derived from an assessment of the information reviewed to date and presented in the preceding sections of this report. The sources, pathways and receptors will be specifically addressed in the following sections and a graphical representation of the preliminary CSM is presented in *Annex G*.

In order to generate what the SPR linkages are, the first step is to identify the Areas of Environmental Concern (AECs) which may give rise to potential contamination issues. Following our review of site data and site visits we have identified a number of AECs that limit our ability to assess risk (environmental, financial or regulatory) and require further investigation. The following section describes AECs that are considered to represent data gaps in the CSM that warrant further assessment. The location of the AECs are shown *Figure 3, Annex A*.

6.2 AREAS OF ENVIRONMENTAL CONCERN

6.2.1 *Hunter Valley Gas Turbines (HVGT)*

The HVGT power station provides black start capability to the power station, with potential contamination sources of primary concern including bulk fuel (diesel) storage and fuels and oils associated with turbine and transformer activity. Numerous hydrocarbon releases have been documented in the past, including a 30 000L release in 1990 which resulted in migration of contaminants to a nearby tributary of Lake Liddell. It is understood some remedial works were completed around the time of the incident but no information was available for review. Significant surface staining was observed around the turbines and fuel storage area, including upon areas of open ground or concrete of poor integrity. It was also observed that the drainage network and bund arrangement within the facility is poorly maintained with potential for direct release to underlying soil.

It is understood that the HVGT drainage system has previously been through a cleaning, inspection and upgrade process. Interceptors installed at the down gradient boundary of the facility also showed evidence of leakages indicating interceptors maybe overtopping, with a review of operational integrity currently being undertaken.

Given the limited availability (anecdotal) of previous environmental characterisation or remediation works, the historical use of the facility including the storage of fuels and hydrocarbons, the known release events and visual inspections of staining and concrete/bund integrity, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.2.2 *Bulk Fuel Storage and Transfer*

Numerous bulk fuel storage areas representing potential sources of contamination are located throughout the operational area of the site. Each of these are presented below, with bulk fuel storage considered as a one AEC for the purpose of this report. Tanks and lines are integrity tested on a routine basis.

Fuel Oil Installation ASTs

The Fuel Oil Installation stores large quantities of fuel (primarily diesel) for boiler ignition and is located on the south-east corner of the power block. The tanks in this area contain four active tanks (A-D) and two disused tanks (E-F) with the latter likely to contain residual sludge. Documents reviewed and interviews with site personnel indicate there have been historical underground and above ground pipework leakages. Spills in the bunded sections of this area or at the refuelling points or vehicle wash down bays are routed to a blind sump which is pumped out regularly. Integrity testing of the tanks and wet stock reconciliation information is understood to be undertaken but was not available for review.

Given the absence of previous environmental characterisation work, and based on the history of fuel storage and likelihood of release, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

Waste Oil ASTs – Liquid Alternative Fuels

Three 55 000 L tanks containing waste oil are located on the south-east of the power block. While appearing in visually good condition, several in-bund sumps were observed to contain oil providing evidence of release from the primary storage units.

Given the absence of previous environmental characterisation work, and based on the history of fuel/oil storage and likelihood of release, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

Waste Oil AST - Transformer Road

The waste oil AST is understood to be fed by a drainage system that collects waste oil for the turbine units. From interviews with site personnel it is understood the tank and associated bund was overfilled in 2012 with oil lost to ground surface, reaching the drainage network and flowed to oil and grit trap. It is likely that some of the released oil reached ground beneath the area. It is unclear if other release events have occurred from this potential contamination source historically.

Given the absence of previous environmental characterisation work, and based on the history of oil storage and the known release event, further investigation would be required to provide a baseline for this area and to assess potential material issues including migration of the contaminants via the site drainage network to the oil and grit trap.

Light Vehicle Refuelling Area - Main Store

This area contains an unleaded and diesel UST with a shed containing two fuel dispensers. There are also associated underground fuel lines, plus fill points and vents. Site staff indicated that both systems were integrity tested and found that the lines associated with the diesel tank failed, and the unleaded petrol tank itself failed, although documentation was not available for verification.

The area has been investigated as per the requirements of the *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008* (the 'UPSS Regulation'), with four monitoring wells installed. Sampling of these wells indicated detectable concentrations of COPCs. Interviews with site personnel also revealed two USTs have previously been removed from this area, with each reported by management to be observed in poor condition, including suspected holes within associated fuel lines during removal. No tank removal/destruction certificates were available for review.

While previous environmental characterisation work has been undertaken to investigate this potential source, based on the results obtained and complications relating to the assessment of groundwater flow direction and recharge rates, further investigation in the form of resampling of these wells and additional investigation locations in the broader area are considered warranted to assess potential material environmental issues associated with soil and groundwater conditions (particularly migration pathways such as service lines within the area).

Mobile Refuelling and Maintenance Plant

Located immediately west of the coal storage facility, the mobile refuelling facility has a number of current and historic potential contamination sources, including:

- Former 100 000L UST, now removed, and associated fuel lines, remote fill point and oil water separator that remain in-situ. The tank was reported by management to be observed to be in poor condition upon removal however the tank removal/destruction certificate was not available for review.
- Existing Self-Contained Diesel AST which recently reported a spill issue during refuelling. Visually impacted soil is believed to have been removed however no investigation of groundwater impact has been undertaken. It was also observed during the site inspection that the pipework connecting the tank to the refuelling bay (routed around the external walls of the workshop building) has a number of the elbow joints which signs of staining indicated leaks have occurred;
- Existing waste oil UST located on the eastern side of the maintenance workshop with evidence of staining within the bund. Also observed was a bund overflow valve which discharges to ground outside the bund; and
- Lubricant Bay and Maintenance Workshop with observations of heavy staining within the drainage system suggesting historic leakage in this area.

While previous environmental characterisation work has been undertaken to remove the UST and achieve compliance with NSW UPSS Regulations, based on the aggregation of potential sources in this location, further investigation in the form of resampling of these wells and additional intrusive investigation works within the AEC are considered warranted to assess potential material environmental issues associated with soil and groundwater conditions.

Former Transformer Oil ASTs

Two 68 000L ASTs historically used for transformed oil storage are located to the west of the transformer area. The tanks appear in visually good condition and are currently understood to contain residual waste oil. Soil and groundwater in this area has not previously been investigated.

Emergency Generator AST.

This 5000L diesel AST in the southern area of the Power Block is raised several meters above ground level. It is located inside a brick bund. The fuel is supplied to it from the main Fuel Oil Installation area via underground lines. Soil and groundwater in this area has not previously been investigated.

Turbine Oil AST

Situated north of the Main Power Block within a concrete block bund. Pipework inside the bund beneath the fill point showed staining suggesting periodic leaks have occur. Drains are located immediately outside the bund. Soil and groundwater in this area has not previously been investigated.

6.2.3 *Power Generating Units*

The main building of the power station contains the four power generating units (described in *Section 4.6*), consisting of the turbine house and auxiliary bay, boiler house and fabric filters. The primary source of potential contamination results from the vibration of the turbines within these units which results in a continual loss of oil. This was visually observed during the site inspection. Most of this is captured in internal drains and transferred to either the Waste Oil AST – Transformer Road, or the oil and grit trap, however there are some spills which collected on the ground surface below the units and have the potential to directly impact underlying soil and groundwater by migration through cracks in concrete or via broken drains.

No investigation has previously been completed within the immediate area of the power generating units due to access and safety limitations. Targeted investigation of these units is not considered possible due to the operational nature of the facility. To address this AEC, it is considered data collected from around the perimeter of the Power Generating Units, collected during the targeted investigation of separate individual AEC and supplemented by additional locations as necessary, will be sufficient in terms of spatial coverage and analytical suite to assess the potential for migration of COPCs from the location of the Power Generating Units.

6.2.4 *Transformer Road*

Transformer Road, located immediately west of the Power Generating Units or 'Power Block' contains two Station Transformers and four Power Unit Transformers. The potential contamination source exists in the significant volumes (68 000 L) of transformer oil contained within each, with several of the bunds observed to be stained and in poor condition.

Given the absence of previous environmental characterisation work, and based on the history of oil storage and evidence of historical release, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.2.5 *Ammonia Plant*

The ammonia plant currently has a mixing tank which is externally water cooled. Any discharge from the ammonia plant discharges directly to drains which flow into the Outfall Canal. Site personnel indicated that there was anecdotal evidence of a historical leak of an aqueous solution to ground in this area, however they were unaware of the date of the incident or the volumes involved. It was also identified during the site inspection that a building believed to contain asbestos in this area was exhibiting signs of building material deterioration, which may result in shallow soil impacts from asbestos fibres.

Given the absence of previous environmental characterisation work, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.2.6 *Oil and Grit Trap*

The Oil and Grit Trap, located adjacent to the shore Lake Liddell, receives the majority of drainage for the site, which collects potentially contaminated waters from across the operational area of the site, including the Power Generating Units. Numerous historical spills have been reported to have direct impacts to the Oil and Grit Trap including the transport and collection of significant amounts of fuels and oils, ash and coal (as described in *Section 4.13.5*). The associated oil water separator and sump may also have experienced over-topping during its operations. Information on the construction design was not reviewed as part of this assessment, but it is understood from verbal information supplied by Macquarie Generation personnel during ERM's site visit that the intention of the system was to act as a sedimentation pond, not a contaminated water treatment system.

Given the absence of previous environmental characterisation work, and the uncertainty associated with the volume for potential contaminants received during its operation and the potential for seepage from the system, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.2.7 *Site Drainage Network*

The network of drains which runs beneath the site represents an AEC as the majority of the lines are underground, are greater than 40 years old, have transported various COPCs (including corrosive chemicals) either by design or as a result of spills, and there is visible evidence of compromised integrity to suspect direct discharge to surrounding soil and groundwater.

Targeted investigation of the drainage network is not considered possible due to the diffuse nature of the system, access beneath the main power block and potential contamination. To address this AEC, it is considered data collected from around the perimeter of the Power Generating Units and throughout the operational area of the Power Station, collected during the targeted investigation of separate individual AEC, will be sufficient in terms of spatial coverage and analytical suite to assess the potential for migration of COPCs (of a material nature) that may have migrated from the drainage network.

6.2.8 Dangerous Goods, Flammable Liquids and Northern Stores Compounds No.1-No.3

These areas have been treated as a single aggregated source area based upon an understood commonality of location and type of potential contamination sources, on the northern boundary of the Main Power Block area.

The eastern end of this AEC contains the Flammable Liquids store. This contains small quantities of ethanol, acetone, ethyl methyl ketone, xylenes and petrol in a locked storage shed. It is unclear what has historically been stored in this area, including upon the open ground that surrounds the store.

The western end of this area of potential concern contains Stores Compounds No.1-No.3 which were observed to be concrete sealed. Stores Compound No.1 and No.2 contain little by way of COPCs, being mostly parts storage areas. Store Compound No.3 however contains drum storage and disused transformers (which may contain oils). Observed chemical storage includes (with typical volumes).

- hypochlorite solution: 2000 L
- hydrazine hydrate: 4000 L
- acrylic acid: 1500 L
- ammonia solution: 4000 L
- tetrachloroethylene: 2000 L
- chlorophenols: 800 L
- potassium bromate: 125 L

Given the absence of previous environmental characterisation work, and the current and historic storage a variety of COPCs, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.2.9 *Asbestos*

There is a long history of asbestos use and disposal on the site. Use of asbestos on the site is considered common with operations that commenced prior to the 1980's and include its use in pipework cement (including the pipework connecting the Power Block to the Ash Dam), heat, fire, and acid resistant gaskets, pipe insulation, ceiling insulation, and general building materials. The sites asbestos register is supplied as *Annex F*.

The plans of the asbestos landfill (which is understood to be licensed and surveyed) indicate emplacement has been occurring since at least 1978. Asbestos is continuing to be discovered in the plant areas, removed as required and emplaced within the current licenced landfill area. In addition, the tennis courts have been found to contain asbestos in the playing surface.

Targeted investigation of potential asbestos impacts to soil will be directed by observed site conditions (such as deterioration of building materials at the ammonia plant, or the identification of asbestos in the surface material of the tennis court), but given the potential diffuse nature of impacts, it is considered the most appropriate approach to address this AEC is to utilise the spatial coverage achieved during the targeted investigation of separate individual AEC to assess the potential presence and risk associated with asbestos within soil.

6.2.10 *Water Treatment/Demineralisation Plant Area*

This AEC comprises two adjacent areas which are at separate elevations. The demineralisation plan is sited within the south western corner of the Main Power Block, which is cut into the bedrock. The Water Treatment Plant is located on the original ground surface level above the cutting and is approximately 8 -10 m higher.

Potential contamination sources include the two bulk ferric chloride ASTs which are located inside a Plant Room, (although they sit within a bund at the same level as the Demineralisation Plant), the fill point is on the road at the Water Treatment Plant Elevation. This fill point shows signs of spillage and there is staining evident down slope to the south along the road which leads towards the Outfall Canal.

The Demineralisation Plant contains a number of bulk chemical ASTs. These are bunded however external pipework and drains run through the area. A number of the drains which carry process water show signs of extensive corrosion due to the nature of the acids and alkalis they transport. There is potential for leakages to have occurred along these lines before their ultimate discharge point known as the 'water treatment plant discharge' which is direct to Lake Liddell.

Given the absence of previous environmental characterisation work, and based on the history of chemical storage and likelihood of release, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.2.11 *Landfills*

Landfill areas were presented in *Section 4* and indicated areas of station rubbish and asbestos landfilling to the south of the Main Power Block. Only limited information with respect to survey plans and content were available for review.

Given the absence of previous environmental characterisation work, and the absence of specific information on landfill content and scale, further investigation would be required to provide a baseline for this area and to assess potential material issues, in particular any leachate that may be present from previously constructed cells.

6.2.12 *TransGrid Switchyard*

The TransGrid Switchyard, although not owned by Macquarie Generation, is a potential AEC due to the storage/use of transformer oil which may have historically may have contained PCBs. Given the slope of the site there is potential for leaks from the Switchyard to migrate toward the Main Power Block area on to the site as an offsite source.

Given the absence of previous environmental characterisation work, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination surrounding the switchyard (investigation is not proposed within TransGrid owned land due to access and safety issues).

6.2.13 *Fill Material – Site Levelling / Shoreline Expansion*

Interviews with site personnel revealed that the shoreline to the east of the Power Station has been extended over time through the placement of fill material. It is understood that the fill materials used as part of this process include the material 'cut' during development of the Power Plant itself, other virgin excavated material from across the site, waste stream materials such as coal fines, ash and material dredged from the oil and grit trap, and other station rubbish material. Anecdotal evidence exists with respect to possible placement locations, but no formal records were found to have been kept.

Given the absence of previous environmental characterisation work, limited records or tracking of waste disposal practices associated with the shoreline expansion, and the uncertainty associated with the content of the fill material used, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination and to assist with the identification and delineation of areas of infilling.

6.2.14 *Maintenance Workshops, Foam Generator and Unofficial Laydown Area*

There are various workshops around the site as identified in *Section 4*. During the site inspection, these workshops were found to contain small scale chemical storage, with generally good housekeeping practices in place, and were not considered to pose a significant risk soil and groundwater contamination. The External Plant Workshop located to the south of the Power Block was found to contain comparatively larger scale storage (approximately twenty 205 L drums of oil) and had a vehicle wash down bay and oil/water interceptor.

In addition to the maintenance areas, a foam generator used for fire suppression purposes (no information was available on whether fire training may have historically been undertaken on the site) and an unofficial (and unsealed) laydown area adjacent to northern stack have been identified as potential AECs for the site, and based on their proximity to the Main and Apprentice Workshops have been grouped together for assessment purposes.

Given the absence of previous environmental characterisation work, and the uncertainty around previous practices and potential storage of solvents (including chlorinated solvents), the workshops, foam generator and laydown area have been aggregated into an AEC for investigation to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.2.15 *Ash Placement*

The placement of waste ash is fundamental to the ongoing operation of the facility and is described in detail in *Section 4*. The Ash Dam Extension consent granted in 2011 states that a Water Management Plan is to be prepared. This has been drafted by Coffey Environmental and a final version is awaited. In terms of relevance to soil and groundwater contamination, the Water Management Plan is required to contain a surface water monitoring plan, a groundwater monitoring plan and a surface and groundwater response plan. The consent does not stipulate specific areas to be monitored or COPCs to be analysed. A draft of the specific surface water and groundwater monitoring plans has not been available for review.

The Ash Dam is considered and AEC based on the potential inputs to, and migration from the dam, including specific contaminants such as metals and petroleum hydrocarbons, as well as the saline nature of the water that may potentially seep or discharge from the dam to receiving environments (primarily Lake Liddell and associated tributaries).

Given the limited availability of previous environmental characterisation works and sampling infrastructure, the potential COPCs identified, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.2.16 *Current and Former Coal Storage Areas*

This area is defined as the current Coal Stockpile and former Coal Stockpile which extended further south along the shores of Lake Liddell. The primary concern in the current Coal Stockpile is via the transport of coal fines via surface water run-off into drainage channels and ultimately into Lake Liddell.

It is recognised that the coal conveyor system and associated sediment ponds may represent an AEC (related to mechanical operations (oils) and coal fines that may migration to Lake Liddell), however these have not been considered to warrant targeted environmental investigation. It is considered unlikely that coal conveyors would represent a significant contamination issue in the context of the site-wide assessment; however, based on the lack of investigation data for this AEC, further investigation is considered to be required to provide a baseline and to assess potential material environmental issues associated with soil and groundwater conditions.

6.2.17 *Machinery Graveyard*

To the south of the exit road to the gatehouse (and north of the Coal Reclaimer Bays) is an area used for the storage of redundant machinery and scrap. The area is unpaved and due to the potential for disused machinery to contain residual oils or chemicals which have the potential to seep/leak to ground or asbestos, it has been considered and AEC.

Given the absence of previous environmental characterisation work at this location, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.2.18 *Water Intake and Pump Station (Disused Chlorination Plant)*

This AEC, located immediately adjacent to Lake Liddell, contains two transformers (A and B) which show some evidence of surface staining from oil discharge/release. The area also contains a disused chlorination plant formerly used to add chlorine to the cooling water to prevent fouling.

Given the absence of previous environmental characterisation work, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination, particularly given its proximity to Lake Liddell.

6.2.19 *Former Construction Workshop and Storage Area*

Based on interviews with site personnel, during construction of the Liddell Power Station, a workshop area, storage yard, vehicle parking and administration offices were established to the north west of the Power Block area, immediately west of the Water Intake and Pump Station. Limited details are available on the exact nature of operations or materials stored here, thought the temporary storage for potentially contaminating materials cannot be discounted.

Given the absence of previous environmental characterisation work at this location, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.3 EXPOSURE PATHWAYS

There are several potential exposure pathways in which contaminants may impact sensitive receptors:

- transport via the site drainage system into surface waters;
- leakage from the site drainage system into groundwater;
- seepages of spilt chemicals/fuels direct to ground;
- leaching of metals from soil into groundwater;
- dermal contact with contaminated soils;
- ingestion of contaminated soils/sediments;
- inhalation of vapours related to impacted soils/groundwater (e.g. in presence of LNAPL);

- seepage from Ash Dam and overflow/skimmer ponds into local streams;
- inhalation of asbestos fibres; and
- groundwater flow into surface water (e.g. Lake Liddell).

6.4 *SENSITIVE RECEPTORS*

The sensitive receptors identified are as follows:

- indoor and outdoor human health receptors in the form of industrial on-site and off-site users;
- intrusive maintenance workers both on and off-site;
- residential receptors and potential groundwater users in the vicinity of the site;
- recreational users of Lake Liddell;
- aquifers beneath the site and nearby potable wells; and
- ecological receptors, including freshwater ecological receptors in the local creeks and Lake Liddell.

7 RECOMMENDATIONS FOR STAGE 2 ASSESSMENT

Based on the results of the Preliminary ESA undertaken by ERM and consideration of Macquarie Generation's intended approach to the assignment of liability relating to soil and groundwater contamination issues, a programme of intrusive (Stage 2) assessment of potential soil and groundwater contamination issues is proposed to assess current conditions at the site and relevant off-site receiving environments.

The following sections set out the proposed scope for the Stage 2 works in general accordance with the requirements set out in NSW EPA (2011).

It is noted that the Stage 2 ESA scope of work presented herein is preliminary, and the final agreed scope of works for the Stage 2 ESA will be detailed in a separate Sampling Analysis and Quality Control Plan (SAQP) which should be viewed in conjunction with this report.

The primary objective for the Stage 2 ESA is to gather data from applicable environmental media in order to develop a baseline assessment of environmental conditions at the site and immediate surrounding receiving environments at the time of the transaction. Data obtained during completion of the Stage 2 ESA will also be used to assess whether there are contamination issues present which will exceed the material threshold and may also be used to inform future management of contamination issues both at the Site and in relation to the relevant receiving environments.

7.1 DATA QUALITY OBJECTIVES

Prior to commencement of the Stage 1 works, Data Quality Objectives (DQOs) were established for the project in line with the requirements and process outlined in NSW DEC (2006) *Guidelines for the NSW Site Auditor Scheme (2nd edition).*

These DQOs were developed to define the type and quality of data required from the site assessment program to achieve the project objectives outlined in *Section 1*. The DQOs were selected with reference to relevant guidelines published by the NSW Environmental Protection Authority (EPA), ANZECC and the NEPC, which define minimum data requirements and quality control procedures. The application of the seven-step DQO approach identified in NSW DEC (2006) is presented in full in *Annex H*.

7.2 *SAMPLING RATIONALE*

Based on a review of the available data, and the establishment of potential Areas of Environmental Concern, the most appropriate sampling design to achieve the stated project objectives is considered to be primarily based on a judgemental (targeted) sampling program, which in itself provides good coverage of operational areas or areas, and minimal additional sampling undertaken to provide spatial coverage for low risk areas of the site (eg buffer lands) or to fill material data gaps within the CSM. It is noted that intrusive investigations may be limited to areas where access and site activities enable investigations to occur without unacceptable health and safety risks to personnel and / or unacceptable disruption to site operations. The sampling plan will be discussed with site management prior to the commencement of works to assess this risk. As such, the sampling design currently proposed is considered indicative, and subject to minor alteration.

Given the scale of the site, different sampling densities to be adopted relative to the contamination risk and logistical constraints in different areas of the site. The sampling approach is generally in accordance with the NSW EPA (1995) *Sampling Design Guidelines*. The NSW EPA (1995) guidelines do not recommend a minimum number of sampling points for sites larger than 5.0 ha. The Site has been divided into smaller areas of concern based on a review of historical activities and identified potentially contaminating activities as recommended in the NSW EPA (1995) guidelines.

The proposed sampling locations are provided in *Figures 4a* to *4g* of *Annex A*, with information on rationale, COPCs and number of investigation locations provided in *Table 7.1* (over).

Table 7.1 ***Proposed Sampling Approach***

Area of Environmental Concern	AEC ID	Issue	Analytes	Proposed Boreholes & Monitoring Wells
Ammonia Plant	LA	Contamination of shallow soils for deterioration of asbestos building materials and potentially aqueous ammonia solution.	Standard Suite* plus pH and major cations / anions	• 3 monitoring wells • 2 soil bores
Ash Placement (Ash Dam)	LB	Contamination of soil, groundwater and sediment from seepage/leachate or overflow as Ash Dam content.	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium pH, major cations/anions,	• 15 monitoring wells • 42 surface soil samples for asbestos only (beneath ACM pipeline)
Bulk Fuel Storage and Transfer	LC to LH	Contamination of soil and groundwater from loss of fuel.	Standard Suite*	• 19 monitoring wells • 17 soil bores • Sampling existing wells of suitable condition around UPSS
Current and former coal storage area	LI	Contamination of soil, groundwater and sediment from seepage/leachate or surface water runoff of contaminants from stockpiled coal.	Standard Suite*	• 9 monitoring wells • 5 soil bores
Dangerous Goods, Flammable Liquids and Stores	LJ	Contamination of soil and groundwater from releases from current and historic dangerous goods storage.	Standard Suite* plus VOCs (chlorinated hydrocarbons (TCE etc.)), PCBs	• 4 monitoring wells • 12 soil bores
Former Construction Workshop and Storage	LK	Contamination of soil and groundwater from spillage of fuels, oils and lubricants	Standard Suite*	• 3 monitoring wells • 2 soil bores
Hunter Valley Gas Turbine	LL	Contamination of soil and groundwater from current and historical activities, including known and suspected releases of fuels and oils.	Standard Suite* plus PCBs	• 9 monitoring wells • 19 soil bores
Machinery Graveyard	LM	Contamination of soil and groundwater from historic dumping of material or releases from decommissioned equipment.	Standard Suite*	• 3 monitoring wells • 1 soil bore
Oil and Grit Trap	LN	Contamination of soil and groundwater from seepage or overflow of contaminants delivered by the site drainage network	Standard Suite* plus VOCs and PCBs	• 7 monitoring wells
Former and current maintenance stores, workshops, foam generator and unofficial lay-down areas	LO	Contamination of soil and groundwater from spillage of fuels and oils, lubricants and parts washing solvents, fire fighting foams.	Standard Suite* plus VOCs (chlorinated hydrocarbons (TCE etc.)), PCBs, PFOS/PFOA.	• 17 monitoring wells • 9 soil bores

Area of Environmental Concern	AEC ID	Issue	Analytes	Proposed Boreholes & Monitoring Wells
Fill Material (Site Levelling and Shoreline Expansion)	LP	Identification of content and delineation of fill materials.	Standard Suite*	• 6 monitoring wells • 14 soil bores
Transformer operations / Transformer Road	LQ	Contamination of soil and groundwater from transformer oil.	Standard Suite* plus PCBs	• 7 monitoring wells • 12 soil bores
TransGrid Switchyard	LR	Contamination of soil and groundwater from releases from current and historic operations.	Standard Suite* plus VOCs and PCBs	• 4 monitoring wells
Landfills (Waste Disposal and Borrow Pit)	LS	Identification of content and delineation of fill materials.	Standard Suite*	• 2 monitoring wells • 4 soil bores
Water Intake and Pump Station	LT	Contamination of soil and groundwater from water treatment activity and transformer storage and operation.	Standard Suite*	• 4 monitoring wells
Water Treatment Plant	LU	Contamination of soil and groundwater from releases from current and historic operations.	Standard Suite*	• 3 monitoring wells • 5 soil bores
Buffer Land	LV	Contamination of soil and groundwater from historical activities or use of impacted fill material. Assessing migration of potential contamination across the Site boundaries where there are no investigations locations as part of other AECs	Standard Suite*	• 13 monitoring wells • Visual inspection • Supplemented with additional investigation locations from other surrounding AECs
Power Generating Units (boilers / turbines)	-	Contamination of soil, groundwater and drainage network from loss of fuels and oils from boiler and turbine operation.	Standard Suite* plus PCBs	• Coverage of perimeter achieved through investigation of other AECs.
Site Drainage Network	-	Contamination of soil and groundwater from releases from poorly maintained drainage network.	Standard Suite* plus PCBs	• Coverage achieved through investigation of other AECs.
Asbestos	-	Contamination of shallow soils from deterioration of building materials, surface coverings (tennis courts), pipework and insulation etc.	Asbestos	• Coverage achieved through investigation of other AECs and asbestos sampling in 50% of soils samples.

Notes:

* - Standard Suite includes TRH (C_6 – C_{40}), BTEX, suite of 8 metals, PAHs, phenols. 50% of samples will be analysed for asbestos/VOCs/SVOCs/OCPs/OPPs

One soil sample from each AEC will be analysed for cation exchange capacity and pH for use in determining the appropriate ecological screening levels to apply.

Selected soil samples will be analysed for particle size distribution and total organic carbon to allow for adoption of appropriate health screening levels for vapour inhalation risk.

7.2.1 *Waterways*

Sediment sampling is not proposed as part of the Stage 2 investigation at Liddell Power Station as Lake Liddell and associated waterways do not form part of the proposed Liddell Power Station transaction.

7.2.2 *Existing Groundwater Wells*

It is proposed that existing groundwater monitoring wells will be sampled during Stage 2 soil and groundwater investigation works. Sampling will only occur where the groundwater monitoring well are deemed to be suitable. The suitability of the existing groundwater monitoring wells will be assessed based on the following steps:

- ground truthing of the groundwater monitoring wells;
- bore logs will be reviewed to confirm that the wells were appropriately constructed and screened within the groundwater bearing strata; and
- the groundwater monitoring wells will be gauged to confirm the total depth of the well against the bore logs and the depth of groundwater.

The sampling process and analytical suite for existing wells deemed suitable will be in accordance with that adopted for newly installed wells.

7.3 *PROPOSED SAMPLING METHODOLOGIES*

The soil and groundwater investigation works will generally involve the following key steps:

- underground service location and mark-out (this main influence currently proposed investigation design);
- proposed borehole location mark-out;
- coring of hard standing surfaces;
- drilling and soil sampling of subsurface material using push tube and / or auger drilling;
- installation of 50 mm diameter groundwater monitoring wells in selected boreholes screened appropriately to intersect the aquifer of interest and facilitate measurement of NAPL (if present);
- backfilling of boreholes;

- reinstatement of hardstanding surfaces;
- surveying the location of boreholes and monitoring wells; and
- development, measurement of water levels and sampling of the groundwater monitoring wells.

7.3.1 *Proposed Field Screening Protocols*

The following field screening protocols are proposed for the Stage 2 works:

Soil

Soils will be logged by an appropriately trained and experienced scientist/engineer to record the following information: soil/ type, colour, grain size, sorting, angularity, inclusions, moisture condition, structure, visual signs of contamination (including staining and fragments of fibrous cement sheeting or similar) and odour in general accordance with AS 1726-1993;

A duplicate of each soil sample will be collected for field screening and will be placed in a sealed zip lock bag and screened in accordance with ERM Standard Operating Procedures (SOPs - available upon request) using a Photo Ionisation Detector (PID) fitted with a 10.6 eV lamp, calibrated at the beginning of each working day. Where the presence of VOCs or other impact is indicated by field screening, additional laboratory analysis may be undertaken.

Groundwater

Prior to sampling or gauging each monitoring well, the well cap will be partially removed to allow the headspace to be screened using a calibrated PID over a period of one minute. The presence of odours will also be noted following removal of the well cap and described by reference to their intensity and character. Following a period of no pumping (24 hours as a minimum) all wells will be dipped to gauge the depth to groundwater and, if necessary, the presence and thickness of Non-aqueous Phase Liquids (NAPLs). Wells will be purged using a thoroughly decontaminated peristaltic pump under low flow conditions where conditions allow. During this process, a calibrated water quality parameter meter will be used to record field measurements of pH, conductivity, redox potential, temperature and dissolved oxygen.

7.3.2 *Laboratory Analysis*

Primary samples will be couriered under chain of custody documentation to ALS Environmental Pty Ltd (ALS), a NATA accredited analytical laboratory. Inter-laboratory duplicate samples will be couriered under chain of custody documentation to Envirolab Services Pty Ltd (Envirolab) also a NATA accredited analytical laboratory.

Soil and groundwater samples will be analysed for the primary COPCs listed below along with additional COPCs associated with activities undertaken in that area.

- metals and metalloids (arsenic, boron, cadmium, chromium, copper, molybdenum, nickel, lead, mercury, selenium, thallium and zinc);
- major cations and anions (including sulfate and chloride);
- Total Recoverable Hydrocarbons (TRH);
- BTEX - benzene, toluene, ethylbenzene and xylenes -BTEX);
- Polycyclic Aromatic Hydrocarbons (PAHs) and Phenols;
- Polychlorinated biphenyls (PCBs);
- Perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA); and
- asbestos (presence / absence).

Additional COPCs may also be analysed if required based on observations made in the field. Leachate analysis will be undertaken on soil samples based on observations made in the field and preliminary laboratory results. The Australian Standard Leachate Procedure (ASLP) is the preferred analytical method and is considered to be more representative of site conditions than the Toxicity Characteristic Leaching Procedure (TCLP).

8 CONCLUSIONS

The Preliminary ESA undertaken by ERM has identified that limited previous intrusive ESAs appear to have been completed on the site and a number of potential areas of environmental concern have been identified based on the understanding of current and historic operations undertaken. These include:

- Hunter Valley Gas Turbines (diesel and oil leaks);
- bulk fuel storage and transfer (potential and historical leaks);
- power generating units (potential and historical leaks);
- transformer road (numerous transformer units with oils);
- ammonia plant (potential and historical leaks);
- oil and grit trap (accumulation of variety of contaminants from potential failure of system or leaks from holding tanks);
- site drainage network (direct discharge to Lake Liddell and seepage to soil/groundwater through damaged pipework);
- dangerous goods, flammable liquids and northern stores compounds no.1-no.3 (seepage to ground or discharge to drains);
- asbestos (diffuse source due to large amount of asbestos material known to have been on site);
- water treatment/demineralisation plant (direct discharge to Lake Liddell via site drainage and seepage to soil/groundwater through damaged pipework);
- landfills (composition of waste streams not entirely known, leachate generation may be occurring);
- TransGrid Switchyard (potential and historic leaks);
- fill material (site levelling and shoreline expansion using uncontrolled fill);
- maintenance workshop, foam generator and unofficial laydown area (potential and historical leaks);
- ash placement (seepage to groundwater and surface water receptors);
- current and former coal storage areas (runoff or seepage to groundwater and surface water receptors;

- machinery Graveyard (potential and historic leaks);
- water intake and pump station (potential and historic leaks); and
- former construction workshop and storage area (historic leaks).

Based on the results of the Preliminary ESA and consideration of Government's intended approach to establishing a baseline of soil and groundwater contamination, a programme of intrusive (Stage 2) assessment of potential soil and groundwater contamination issues is provided. The most appropriate sampling design is considered to be a judgemental (targeted) sampling of soil and groundwater at the established AEC for the site, which is also considered to provide suitable spatial coverage to act as a baseline assessment.

Based on the information available at the time of preparation of this report ERM has not identified any contamination issues which are currently undergoing or likely to require material remediation, assuming ongoing industrial land use as a coal fired power plant. A number of potential material issues were identified, which will be assessed during Stage 2 investigation works.

9 *LIMITATIONS*

This report is based solely on the scope of work described in *Section 1.3* and performed pursuant to a contract between ERM and Macquarie Generation ("Scope of Work"). The findings of this report are solely based on, and the information provided in this report is strictly limited to the information covered by, the Scope of Work.

In preparing this report for the Client, ERM has not considered any question, nor provides any information, beyond the Scope of Work.

This report was prepared between 15 August 2013 and 18 October 2013 and is based on conditions encountered and information reviewed at the time of preparation. The report does not, and cannot, take into account changes in law, factual circumstances, applicable regulatory instruments or any other future matter. ERM does not, and will not, provide any on-going advice on the impact of any future matters unless it has agreed with the Client to amend the Scope of Work or has entered into a new engagement to provide a further report.

Unless this report expressly states to the contrary, ERM's Scope of Work was limited strictly to identifying typical environmental conditions associated with the subject site(s) and does not evaluate structural conditions of any buildings on the subject property, nor any other issues. Although normal standards of professional practice have been applied, the absence of any identified hazardous or toxic materials or any identified impacted soil or groundwater on the site(s) should not be interpreted as a guarantee that such materials or impacts do not exist.

This report is based on one or more site inspections conducted by ERM personnel and information provided by the Client or third parties (including regulatory agencies). All conclusions and recommendations made in the report are the professional opinions of the ERM personnel involved. Whilst normal checking of data accuracy was undertaken, except to the extent expressly set out in this report ERM:

a) did not, nor was able to, make further enquiries to assess the reliability of the information or independently verify information provided by;

b) assumes no responsibility or liability for errors in data obtained from, the Client, any third parties or external sources (including regulatory agencies).

Although the data that has been used in compiling this report is generally based on actual circumstances, if the report refers to hypothetical examples those examples may, or may not, represent actual existing circumstances.

Only the environmental conditions and or potential contaminants specifically referred to in this report have been considered. To the extent permitted by law and except as is specifically stated in this report, ERM makes no warranty or representation about:

a) the suitability of the site(s) for any purpose or the permissibility of any use;

b) the presence, absence or otherwise of any environmental conditions or contaminants at the site(s) or elsewhere; or

c) the presence, absence or otherwise of asbestos, asbestos containing materials or any hazardous materials on the site(s).

Use of the site for any purpose may require planning and other approvals and, in some cases, environmental regulator and accredited Site Auditor approvals. ERM offers no opinion as to the likelihood of obtaining any such approvals, or the conditions and obligations which such approvals may impose, which may include the requirement for additional environmental works.

The ongoing use of the site or use of the site for a different purpose may require the management of or remediation of site conditions, such as contamination and other conditions, including but not limited to conditions referred to in this report.

This report should be read in full and no excerpts are to be taken as representative of the whole report. To ensure its contextual integrity, the report is not to be copied, distributed or referred to in part only. No responsibility or liability is accepted by ERM for use of any part of this report in any other context.

This report:

a) has been prepared and is intended only for the Client and any party that ERM has agreed with the Client in the Scope of Work may use the report;

b) has not been prepared nor is intended for the purpose of advertising, sales, promoting or endorsing any client interests including raising investment capital, recommending investment decisions, or other publicity purposes;

c) does not purport to recommend or induce a decision to make (or not make) any purchase, disposal, investment, divestment, financial commitment or otherwise in or in relation to the site(s); and

d) does not purport to provide, nor should be construed as, legal advice.

10 REFERENCES

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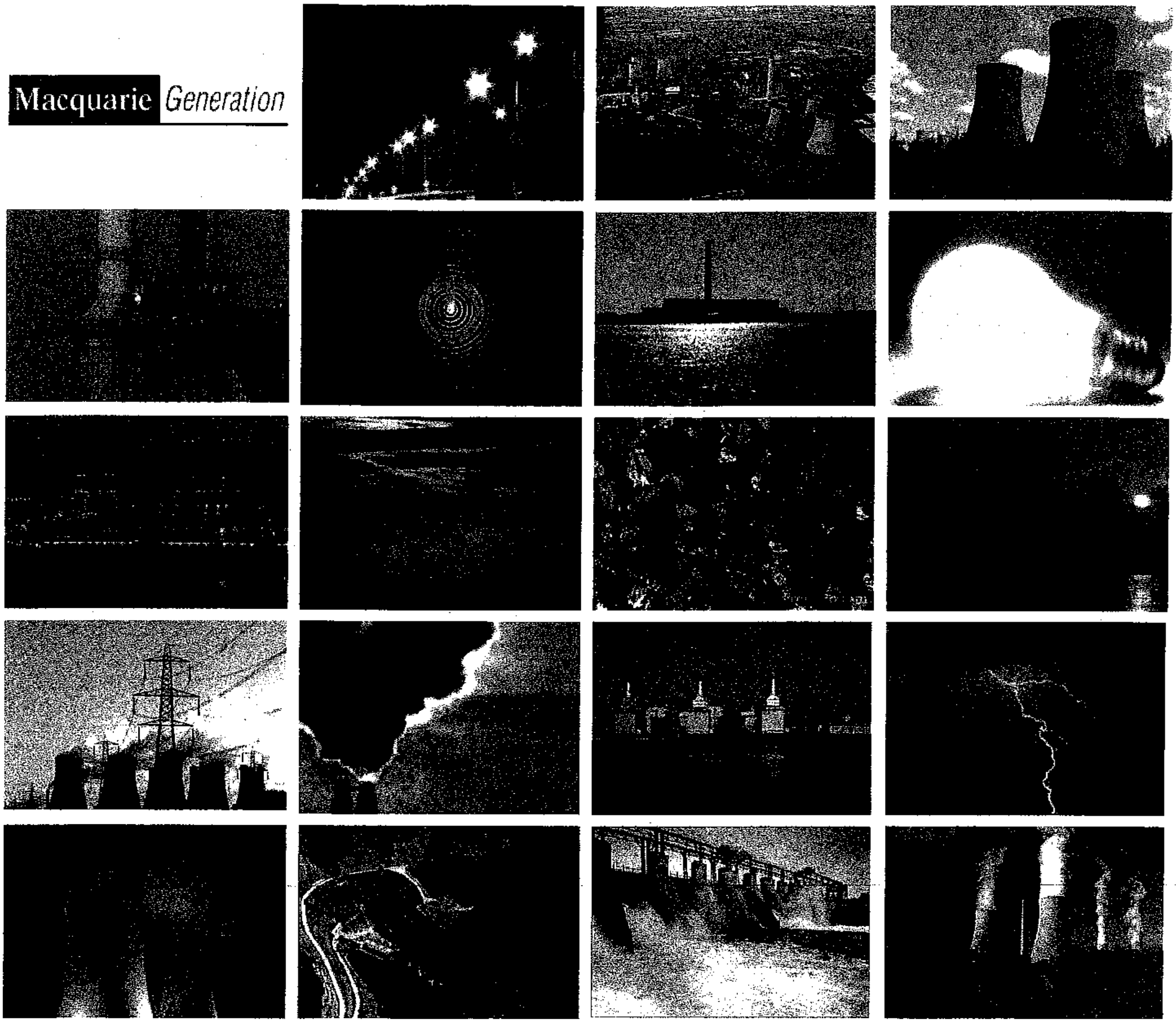
DOCUMENT 3b

Liddell Power Station

Stage 2 Environmental Site Assessment – Part 1

Environmental Resources Management

31 January 2014



COMMERCIAL IN CONFIDENCE

Macquarie Generation

Project Symphony, Liddell Power Station

Stage 2 Environmental Site Assessment

Ref: 0224198RP02

31 January 2014

The world's leading sustainability consultancy

ERM

Approved by:	Peter Lavelle
Position:	*Technical Director*
Signed:	
Date:	31 January 2014
Approved by:	Matthew Klein
Position:	*Managing Partner – Asia Pacific Transaction Services*
Signed:	
Date:	31 January 2014

Environmental Resources Management Australia Pty Ltd Quality System

Project Symphony, Liddell Power Station

Stage 2 Environmental Site Assessment

Macquarie Generation

31 January 2014

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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Macquarie Generation to undertake a Stage 2 Environmental Site Assessment (Stage 2 ESA) at Liddell Power Station (herein referred to as the "Site") in accordance with the work scope presented in the Preliminary Environmental Site Assessment (Preliminary ESA; ERM Reference 0213879RP02, Draft Rev 02) prepared by ERM.

The primary objective for the Stage 2 ESA was to gather soil and groundwater data in order to develop a baseline assessment of environmental conditions at the Site (including groundwater and land), as at or near the time of the transaction. Data obtained during completion of this Stage 2 ESA may also be used to inform future management of contamination at the Site.

Investigation Methodology

To achieve the stated objectives, ERM collected soil and groundwater samples and submitted those collected samples to environmental laboratories for analysis of Constituents of Potential Concern (COPCs). A Conceptual Site Model (CSM) developed for the Site during the Preliminary ESA was further refined and the analytical data was compared against published environmental screening levels to assess potential risks to human health and the environment.

The following conclusions were made based on the data collected during the investigation.

Investigation Outcomes

The key impacts identified at the Site include asbestos present beneath the ACM pipelines to the Liddell Ash Dam, potential risks associated with inhalation of petroleum hydrocarbon vapour near the light vehicle refuelling area and potential migration of petroleum hydrocarbons from the bulk fuel storage areas towards Lake Liddell. It should be noted that the results of the assessment of sediment and surface water in Lake Liddell is included within ERM (2014) Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment.

Site Management and Remediation Requirements

- *No contamination issues were identified which would require material management or remediation based on the current and continued use of the Site as a Power Station with the exception of potential material issues associated with the identified asbestos impacts in soils surrounding the ACM pipelines to Liddell Ash Dam and water management issues related to Liddell Ash Dam that are the subject of a Pollution Reduction Program report currently being prepared.*

- *The preparation and implementation of a suitable Environmental Management Plan (EMP) by an appropriately qualified professional is recommended to mitigate the risk of exposure to asbestos associated with areas in close proximity to the ash dam ACM pipelines and across the site as a whole during excavation works.*

- *Whilst some further assessment may be required to address the hydrocarbon impacts in the bulk fuel storage areas and in the former and current maintenance stores, workshops, foam generator and unofficial lay-down areas, it is unlikely that costs related to this work would exceed the adopted material threshold for the purposes of this assessment.*

Requirements under the Contaminated Land Management (CLM) Act 1997

With regard to the duty to report contamination under the CLM Act (1997) and the potential for regulation, ERM notes the following:

- *ERM understands that Macquarie Generation is in the process of developing a management strategy in relation to the identified asbestos issues in the vicinity of the ACM pipelines. Further, ERM understands that access to these areas has been restricted to mitigate potential risks to human health in the short term and that further delineation and quantification of asbestos in soils in this area is being undertaken. It is recommended that the outcomes of this further assessment are reviewed prior to a decision relating to notification of NSW EPA under Sec. 60 of the CLM Act 1997. It is also noted that Macquarie Generation has notified WorkCover NSW of the broader asbestos pipeline issue (given that it relates predominantly to infrastructure and the soil impacts are secondary). It is therefore considered that they would likely be the key regulator for this issue rather than NSW EPA.*

- *The reporting to the NSW EPA of the concentrations of benzene, naphthalene and PCE measured in on-site groundwater may be warranted on the basis of exceedences of the notification triggers (based on NHMRC (2011) drinking water screening values) in order to maintain compliance with the CLM Act 1997. It would also be prudent to undertake an additional round of confirmatory groundwater sampling at the relevant locations to confirm the reported concentrations prior to preparing the notification. The concentrations of these contaminants are, however, considered unlikely in ERM's opinion to trigger a requirement for active management or remediation. It is considered most likely that regulation of these issues by NSW EPA would (if necessary) be undertaken under the existing Environment Protection Licence rather than under the CLM Act.*

- *Various metals were detected at concentrations above the human health (drinking water) and / or ecological screening values which were not attributable to background conditions in groundwater at a number of locations across the Site. In many instances however, these impacts are related to activities which are already regulated and monitored under the Site EPL. The identified impacts are also generally located well within the site boundaries and up gradient of Lake Liddell, the discharge from which is also monitored and regulated under the Site EPL. ERM considers that NSW EPA would most likely continue to manage this issue under the POEO Act via the Site Environment Protection Licence, and hence would not require formal notification of potential contamination under the CLM Act, however this approach should be confirmed with NSW EPA to ensure strict adherence to the NSW DECC (2009) guidelines.*

Additional Baseline Data Recommendations

The data presented in the ESA was generally considered to be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site and immediate surrounding receiving environments. On the basis of the outcomes of this investigation, some limited additional characterisation of the baseline conditions at the Site is considered to be required as follows;

- *Delineation of asbestos contamination in the vicinity of the ACM pipelines to the ash dam. Macquarie Generation is aware of the ACM issue at the pipelines and is currently further investigation and risk assessment (refer to Macquarie Generation (2013) Ash & Dust - Position Paper (Ref: 06.03.03.38 ENV.03.03.048)). It is recommended that this delineation be carried out in accordance with the methodology outlined in the ASC NEPM (2013) and should include more detailed inspections of these areas and the collection of soil samples for quantitative analysis.*

- *Further assessment of groundwater impacts from petroleum hydrocarbons in bulk fuel storage areas is recommended to clarify the potential for these contaminants to migrate to Lake Liddell. This could include fate and transport modelling and detailed risk assessment.*

- *Confirmatory groundwater sampling is recommended at the water intake and pump station to confirm the measured concentrations of benzene with specific reference to clarification of the duty to report contamination under Section 60 of the CLM Act 1997.*

- *Confirmatory groundwater sampling and ultra-trace laboratory analysis is also recommended at the former and current maintenance stores, workshops, foam generator and unofficial lay-down areas to assess whether vinyl chloride is present due to detection of PCE and other breakdown products.*

1 *INTRODUCTION*

1.1 *BACKGROUND*

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Macquarie Generation to undertake a Stage 2 Environmental Site Assessment (Stage 2 ESA) at Liddell Power Station. Liddell Power Station, herein referred to as the "Site", is situated on the New England Highway, approximately 10 kilometres (km) to the south-east of the township of Muswellbrook and approximately 25 km to the north-east of the township of Singleton, in New South Wales (NSW), Australia.

The works detailed herein were completed to support the potential sale of the business in accordance with the work scope presented in the ERM (2013) *Preliminary Environmental Site Assessment* (Preliminary ESA; ERM Reference 0213879RP02, Draft Rev 02).

A site location plan is presented as *Figure 1* of *Annex A*. The general Site layout is presented in *Figures* 2 and 3 of *Annex A*.

1.2 *OBJECTIVES*

The primary objective for the Stage 2 ESA was to gather soil and groundwater data in order to develop a baseline assessment of environmental conditions at the Site (including groundwater and land), as at or near the time of the transaction. Data obtained during completion of this Stage 2 ESA may also be used to inform future management of contamination at the Site.

1.3 *MATERIALITY THRESHOLD*

For the purposes of this report, a consistent approach regarding the materiality of a contamination issue has been adopted to that utilised in the Preliminary ESA (ERM, 2013b) which was as follows:

- ERM adopted a materiality threshold of AUD 0.5 M (+ GST if applicable) per contamination source.

- Material costs are those costs for that item to meet relevant requirements of NSW EPA under its current land use to remediate or manage the contamination issue. Remediation or management includes additional assessment, environmental monitoring, management, containment or other remediation measures.

In addition, any issue that ERM considers could have the potential to lead to prosecution by the regulatory authorities that could lead to significant business disruption or reputational impact will be considered material.

1.4 *APPROACH AND SCOPE OF WORK*

The investigation approach and scope of works for the Stage 2 ESA comprised the general tasks described in the following sections, in accordance with the work plans set out in the Preliminary ESA (ERM, 2013b). It is noted that this Liddell assessment was undertaken concurrently with a similar assessment at Bayswater Power Station, but the results are reported in two separate reports.

Preliminaries

- preparation of a site-specific Health and Safety Plan (HASP), Environmental Management Plan (EMP) and overarching Site Management Plan (SMP);
- assessment of whether suitable monitoring wells exist at the Site, and whether they could be sampled as part of this investigation;
- identification of areas and constituents of potential concern additional to those identified during the Preliminary ESA (ERM, 2013b);
- revision and amendment of the *Sampling, Analysis and Quality Plan* presented in the Preliminary ESA (ERM, 2013b), as necessary;
- engagement of subcontractors including underground utility locator, drillers, laboratories and surveyors;
- scheduling of Site works with Macquarie Generation; and
- completion of site-specific inductions and permitting, as required.

Site Works

- ground-truthing of proposed sampling locations including clearance of underground services as noted below;
- identification of above and below ground services in the vicinity of drilling locations by reviewing publically available Dial Before You Dig (DBYD) plans and site engineering drawings, and engaging a qualified underground service locator.
- intrusive drilling works and environmental sampling, including soil and groundwater sampling, in accordance with the requirements of the *SAQP*. Final investigation locations are presented in *Figures 4.1 to 4.5* of *Annex A;*
- laboratory analysis of select soil and groundwater samples for particular constituents of potential concern (COPC) in accordance with the requirements of the Preliminary ESA (ERM, 2013b) and as outlined in *Section 4.6;*

- completion of a visual inspection of exposed pipework known or suspected to contain asbestos. Where necessary, sampling of underlying surface soils was undertaken; and
- the survey of newly installed monitoring wells by a registered surveyor to Australian Height Datum (AHD) and Map Grid of Australia (MGA).

Reporting

- Preparation and submission of weekly progress reports to Macquarie Generation;
- Preparation and submission of an interim report with available data; and
- preparation and submission of this Stage 2 ESA report at the completion of works.

1.5 REPORT STRUCTURE

This Stage 2 ESA report has been prepared in accordance with the NSW Office of Environment and Heritage (2011) *Guidelines for Consultants Reporting on Contaminated Sites,* as follows:

- *Section 1* - Introduction, background, objectives and scope of works;
- *Section 2* - Site setting including a summary of the Site history and Site conditions;
- *Section 3* - Data quality objectives (DQOs) for the works conducted;
- *Section 4* - Sampling and works methodologies for completing the investigation;
- *Section 5* - Results of the Stage 2 ESA works and Site-specific discussions and recommendations; and
- *Section 6* - Conclusions.

Other key guidelines utilised during completion of this Stage 2 ESA included, but were not limited to:

- Australian Standard AS 4482.1-2005 (2005) *Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 1 – Non-volatile and Semi-volatile Compounds;*

- Australian Standard AS 4482.2-1999 (1999) *Guide to the Sampling and Investigation of Potentially Contaminated Soil. Part 2 –Volatile Substances;*

- Australia and New Zealand Environmental and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australia and New Zealand Guidelines for Fresh and Marine Water Quality*; and

- National Environment Protection Council (NEPC) (April 2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999, NEPC, Canberra,* hereafter referred to as *ASC NEPM* (2013).

A full list of all references is also appended to this report.

1.6 LIMITATIONS

The findings of this report are based on the client-approved sampling plan outlined in the Preliminary ESA (ERM, 2013b) and the scope of work summarised in *Section 1.4* of this report. ERM performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment profession. No warranties, express or implied, are made.

Although normal standards of professional practice have been applied, the absence of any identified hazardous or toxic materials on the subject Site should not be interpreted as a guarantee that such materials do not exist on the Site.

This assessment is based on Site inspections conducted by ERM personnel, sampling and analyses described in the report, and information provided by people with knowledge of Site conditions.

All conclusions and recommendations made in the report are the professional opinions of the ERM personnel involved with the project and, while normal checking of the accuracy of data has been conducted, ERM assumes no responsibility or liability for errors in data obtained from regulatory agencies or any other external sources (with the exception of accredited laboratories engaged by ERM to undertake analysis as part of these works), nor from occurrences outside the scope of this project.

ERM is not engaged in environmental assessment and reporting for the purpose of advertising, sales promoting, or endorsement of any client interests, including raising investment capital, recommending investment decisions, or other publicity purposes. The client acknowledges that this report is for the exclusive use of the client, its representatives and advisors and any investors, lenders, underwriters and financiers who agree to execute a reliance letter, and the client agrees that ERM's report or correspondences will not be, except as set forth herein, used or reproduced in full or in parts for such promotional purposes, and may not be used or relied upon in any prospectus or offering circular.

2 *SITE SETTING*

Macquarie Generation owns and operates two large conventional coal-fired Power Stations in the Hunter Valley region of New South Wales. Liddell Power Station and Bayswater Power Station are located within 3 km of each other on either side of the New England Highway, approximately 10 km to the south-east of the township of Muswellbrook and approximately 25 km north-west of the township of Singleton. The two Power Stations share some infrastructure such as coal and water supply.

2.1 *SITE IDENTIFICATION*

Liddell Power Station is located approximately 1 km east of the New England Highway on the shore of Lake Liddell. The approximate coordinates of Liddell Power Station are 309693 m E and 6416597 m S. A site location plan is provided as *Figure 1* of *Annex A*.

The Site is composed of the following key features:

- Liddell Power Station's main power block including electricity generating units, auxiliary fuel storage, water treatment plant and associated infrastructure, workshops and stores;
- Liddell Ash Dam, located approximately 4 km (pipe run length) to the west across the New England Highway, and associated pipelines for carrying ash slurry and return water;
- coal storage area and conveyors transporting coal from the Antiene Rail Coal Unloader (RCU), Ravensworth RCU, Bayswater Power Station and nearby mines;
- a switchyard (33 kV), adjacent and to the west of the main power block. This switchyard is owned and operated by TransGrid, a State owned corporation. Whilst conditions around the boundary of this area were assessed as part of this Stage 2 ESA, assessment of conditions within the switchyard boundary was not part of the scope of works;
- Hunter Valley Gas Turbine (HVGT), located approximately two km south of the main power block; and
- buffer lands surrounding the infrastructure described above.

For the purposes of this assessment and based on the proposed separation of assets between Bayswater and Liddell Power Stations set out in *Proposed Liddell & Bayswater B Subdivision* (Chelace GIS, 2013), infrastructure shared by Bayswater and Liddell Power Stations has been allocated as follows:

- the land associated with the water transfer lines and coal transfer lines between the Power Stations have been separated by assessing the portions located within the boundaries of the respective sites as indicated on *Figure 3* of *Annex A;*
- the Antiene RCU and Ravensworth RCU have been assessed as part of Bayswater Power Station; and
- Lake Liddell has been assessed as part of Bayswater Power Station and reported in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

The total area of the Site is approximately 1500 hectares (ha). The Power Station operational area itself occupies approximately 700 ha and includes coal stockpiles and conveyors, electricity generation units (coal hoppers, bowl mills, feed systems, coal fired boilers, steam turbines, hydrogen cooled generators and transformers), air emission controls (fabric filters and chimney stack), bulk fuel storage and transfer infrastructure, cooling water processes (intakes, pre-treatment facilities, cooling towers and returns), wastewater holding ponds and treatment facilities, maintenance facilities and administration offices. A plan showing the layout of the operational area is provided as *Figure 2* of *Annex A*.

For the purpose of this assessment, the Site has been divided into 22 individual areas of environmental concern (AECs), according to usage and the presence of potential sources of contamination. These areas, listed in *Table 2.1*, are discussed in detail in the Preliminary ESA (ERM, 2013b).

Table 2.1 Summary of Areas of Environmental Concern

Identification	Work Area Description	Figure Reference
LA	Ammonia plant	Figure 4.3
LB	Ash Dam	Figure 4.2 and 4.3
LC	Bulk fuel storage – Light-vehicle refuelling area	Figure 4.3
LD	Bulk fuel storage – Mobile refuelling facility	Figure 4.4
LE	Bulk fuel storage – Fuel oil installation ASTs (A-F)	Figure 4.3
LF	Bulk fuel storage – Waste oil AST (Transformer Road) and former transformer oil ASTs	Figure 4.3
LG	Bulk fuel storage – Turbine oil AST	Figure 4.3
LH	Bulk fuel storage – Waste oil ASTs (liquid alternative fuels) and emergency generator AST	Figure 4.3

Identification	Work Area Description	Figure Reference
LI	Current and former coal storage area	Figure 4.4
LJ	Dangerous goods, flammable liquids and stores	Figure 4.3
LK	Former construction workshop and storage	Figure 4.3
LL	Hunter Valley gas turbines	Figure 4.5
LM	Machinery graveyard	Figure 4.3
LN	Oil and grit trap	Figure 4.3
LO	Former and current maintenance stores, workshops, foam generator and unofficial lay-down areas	Figure 4.3
LP	Fill material (Site levelling and Shoreline expansion)	Figure 4.3 and 4.4
LQ	Transformer operations/ transformer road	Figure 4.3
LR	TransGrid switchyard	Figure 4.3
LS	Landfills (waste disposal and borrow pit)	Figure 4.4
LT	Water intake and pump station	Figure 4.3
LU	Water treatment plant	Figure 4.3
LV	Buffer land	Figure 4.1, 4.2 and 4.4

2.2 *SITE HISTORY*

Construction of Liddell Power Station commenced in the late 1960s. The Power Station was commissioned in 1971. The first generator unit at the Site was completed in 1971, two more were completed in 1972 and a fourth and final generator unit was completed in 1973. The Power Station was constructed as a base load facility and for many years was the backbone of the NSW electricity system.

Liddell Power Station's proposed end of life is December 2022, however a Macquarie Generation engineering review concluded that an operational life to 2032 is feasible (*Liddell Asset Management Strategy*, 2010).

Further information regarding the history of the Site, including historical aerial photographs, zoning and environmental approvals, licenses and management is presented in the Preliminary ESA (ERM, 2013b).

2.3 *SURROUNDING ENVIRONMENT*

The Site is surrounded by areas used mainly for mining purposes with some grazing, bushland, viticulture and thoroughbred horse stud farms in the region.

Key industrial uses in the area include:

- Macquarie Generation's Bayswater Power Station (operational area) located approximately three km to the south-west of the Liddell Power Station; and
- existing and former coal mines in the area, including Drayton Coal Mine adjacent to the Liddell Ash Dam west of the Site, Liddell Colliery approximately 2 km south east of the Liddell Power Station operational area and the Ravensworth Rehabilitation Area approximately 7 km to the south of the Liddell Power Station operational area.

The closest residential areas to the Site include:

- Muswellbrook, approximately 10 km to the north-west;
- Jerrys Plains Village, approximately 15 km to the south-west;
- Singleton, approximately 25 km to the south-east; and
- rural residences that do not form part of residential centres.

2.4 *TOPOGRAPHY*

The Site lies within a broad river valley created by the Hunter River and its tributaries. Whilst the general slope in the area is towards the Hunter River in the south, the topography is characterized by undulating hills that leads to high variability in slope direction across the Site.

The operational area of the Liddell Power Station gently slopes to the east. The main power block is cut into the slope of the hill exposing natural bedrock (a conglomeratic sandstone). The TransGrid switchyard, to the west of the main power block and at the higher end of the slope, lies at an elevation of approximately 167 m AHD. From here, the ground surface drops down to the main power block which lies at an elevation of approximately 145 m AHD and declines to approximately 133 m AHD at the edge of Lake Liddell. There is evidence to suggest the site level at the boundary with Lake Liddell has been raised over time through in-filling.

2.5 *GEOLOGY*

Regional Geology

The Site is located on the northern section of the Sydney Geological Basin and the *1:100 000 Hunter Coalfield geological map* (Department of Mineral Resources 1993) indicates that the Liddell Power Station is underlain by Permian age conglomerate, sandstone, siltstone and claystone of the marine derived Maitland Group.

The 1:100 000 Hunter Coalfield geological map further indicates that Quaternary age alluvial sediments (consisting of silt, sand and gravel) are associated with the Bayswater Creek, Foy Creek and the Hunter River.

The *Muswellbrook 1:25 000 Geological Sheet 9033-II-N* (NSW Department of Mineral Resources) indicates that the Liddell Power Station and the areas adjacent to Lake Liddell to the north to be underlain by Permian Age, Maitland Group, Mulbring siltstone consisting of dark-grey shale and siltstone.

The *Jerry Plains 1:25 000 Geological Map, 9033-II-S* (Sniffin & Summerhayes, 1987) indicates that the geology in the area to the south of Lake Liddell consists of Permian Age, Singleton Super Group, Wittingham Coal Measures, Saltwater Creek formation, comprising sandstone and siltstone with thin lenticular coaly bands and marine siltstone intercalated towards base.

Local Geology

Limited information regarding the local geology was available for review. Borelogs presented in the DLA Environmental report, *UPSS Groundwater Monitoring Well Report* (2011), indicated that the light vehicle refuelling area (AEC LC), located to the east of the main power block, and is underlain by gravelly sands to depths of 2.5 – 5.2 m below ground level (bgl). Beneath this was sandstone bedrock proven to a maximum depth of 7.5 m bgl. Borelogs presented in this report pertaining to the mobile plant refuelling area (AEC LD), located to the south-west of the main power block, indicated that this area is underlain by clays to a maximum proved depth of 10 m bgl.

Local geological information recorded as part of this Stage 2 ESA are presented as borelogs in *Annex D* and summarised in *Section 5.1*.

Soil

The *Atlas of Australian Soils* (Northcote et al., 1960-68) categorises soil in the area as sodosol. Typical characteristics of these soils are high sodium contents, abrupt increases in clay content at depth, prone to crusting, unstable soil structure prone to erosion, with seasonally perched water tables.

2.6 *HYDROGEOLOGY*

Regional Hydrogeology

From a hydrogeological perspective, the sedimentary deposits can be categorised into the following units:

- low permeability conglomerate, sandstone, siltstone and mudstone that comprise the majority of the Permian sediments.

- low to moderately permeable coal seams, typically ranging in thickness from 2.5 m to 10 m, which are the prime water bearing strata within the Permian sequence.
- medium to highly permeable Quaternary alluvial sediments associated with the nearby Bayswater Creek, Foy Creek and the Hunter River.

Regional groundwater flow is expected to be towards the Hunter River located to the south of the site.

Local Hydrogeology

Due to the undulating nature of the topography, variation in localised groundwater flow directions are probable and groundwater flow is expected to follow topography in part with perched infiltrated water expected in some areas. Inferring localised groundwater flow from topography suggests a easterly to north easterly groundwater flow component at the Liddell Power Station towards Lake Liddell.

Limited information regarding the local hydrogeology was available for review. Borelogs presented in the *UPSS Groundwater Monitoring Well Report* (DLA Environmental, 2011), indicated that during drilling in the mobile plant refuelling area (AEC LD), soil became saturated at depths of between 8 and 9.5 m bgl. The report provided no further information about depth to groundwater.

Details of hydrogeological conditions encountered during this Stage 2 ESA are summarised in *Section 5.2* and presented in *Table 2* of *Annex B*.

2.7 *GROUNDWATER QUALITY AND USE*

The search for publically listed boreholes on the NSW Natural Resource Atlas (NRAtlas) presented in the Preliminary ESA (ERM, 2013b) identified eight groundwater bores located within a 5 km radius of the Site. These bores, listed in *Table 2.2* below, are registered for monitoring, testing and industrial uses.

Table 2.2 ***Registered Groundwater Bores in Proximity to the Site***

Bore ID	Distance from Site (km)	Direction from Site	Water Bearing Zones (m bgl)	Registered Use
GW201061	0.9	South-east	12-15.1	Monitoring bore
GW047486	4.8	North-west	15-25	Industrial
			28-40	
			43-70	

Bore ID	Distance from Site (km)	Direction from Site	Water Bearing Zones (m bgl)	Registered Use
			75-92	
GW080212	0.9	East	Not recorded	Monitoring bore
GW024022	1.2	West	3	Industrial
GW200743	4	West	Not recorded	Test bore
GW200746	4	West	Not recorded	Test bore
GW201062	0.8	South	14.5-17.4	Monitoring bore
GW053862	4.5	West	15-17	Industrial
			26-29	
			66-69	
			80-81	
			26-29	
			96-97	

Note: Multiple water bearing zones encountered in GW047486 and GW053862.

According to the Coffey International Ltd (Coffey) *Development Application for the proposed Extension to Ash Dam* (2011), regional groundwater in the area is considered to be of poor quality due to the relatively high salinity (approximately 3500 µg/L).

2.8 *HYDROLOGY*

The major hydrological feature in the Hunter Valley is the Hunter River, which passes through Muswellbrook, and runs approximately 11.5 km to the south of the Site.

In addition, several local waterways pass through Macquarie Generation lands:

- Maidswater Creek and an un-named fourth order stream (formally a tributary of Saltwater Creek, and currently known as Wykes Gully for internal monitoring purposes) flow into the Antiene Arm of Lake Liddell (a northern bay of Lake Liddell).
- Bayswater Creek and associated tributaries flow into Liddell Ash Dam and then into the western arm of Lake Liddell. Bayswater Creek then flows south from Lake Liddell to the Hunter River.
- an unnamed creek from the Ash Dam spillway (sometimes referred to as Skimmer Pond Creek);
- Tinkers Creek, which runs along the western boundary of the Bayswater Power Station and flows into Lake Liddell;

- tributaries of Tinkers Creek flow eastwards from Freshwater Dam (to the south-west of the main power block) into Lake Liddell to the west of Liddell Power Station.

- Chilcott Gully drains land to the north-east of Bayswater Power Station and flows into Lake Liddell in the south-west; and

- Pikes Creek drains the Pikes Gully (Bayswater) Ash Dam then flows to the north-east to Bayswater Creek, downstream of Lake Liddell.

2.8.1 *Lake Liddell*

It is noted that Lake Liddell is assessed as part of Bayswater Power Station and reported in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014), but discussion is provided herein due to the proximity of the Site to Lake Liddell.

Lake Liddell was constructed as water storage for the Power Stations and is located adjacent to the Liddell Power Station (to the east, north and south). The lake has a surface area of around 1 100 hectares ha and is up to 32 m deep (*Lake Liddell Hydrodynamic Modelling*, Worley Parsons, 2009).

The Lake supplies cooling water to Liddell Power Station and make-up water for the Bayswater Cooling Water Makeup Dam. It also accepts a range of treated discharges as discussed in the Preliminary ESA (ERM, 2013b).

The Lake is constructed in a natural valley at the confluence of Bayswater, Tinkers and Maidswater Creeks (Macquarie Generation, undated). The lake is dammed on the eastern side and is equipped with a spillway leading to a large holding pond.

Water is periodically discharged from Lake Liddell to manage salinity and level. The discharge point is at the dam wall, and discharges flow via Bayswater Creek to the Hunter River, approximately 13 km downstream.

Discharges are under the Hunter River Salinity Trading Scheme (regulated under Bayswater's Environment Protection Licence (EPL) 779) and are made at times of high river flows and low background salinity levels.

Lake Liddell is also used by the public for recreation. The Lake Liddell recreation area is situated on a northern reach of the lake off Hebden Road. It caters for day visitors and campers, and the area is used for water-skiing, sailing, swimming and fishing (NSW Government Visit NSW website 21 June 2013). The area is managed by the Lake Liddell Recreation Area Reserve Trust appointed by the NSW Government to manage Crown Land (NSW Government LPMA website 21 June 2013).

Lake Liddell is surrounded by buffer land to the north. The eastern side is bordered by an open cut coal mine (Liddell Colliery). The west and south are occupied by Liddell Power Station and Bayswater Power Station, respectively.

2.9 *SENSITIVE RECEPTORS*

The following sensitive receptors relevant to the Site were identified as part of the Preliminary ESA (ERM, 2013b):

- indoor and outdoor human health receptors in the form of industrial on-site and off-site users;
- intrusive maintenance workers both on and off-site;
- residential receptors and potential groundwater users in the vicinity of the site;
- recreational users of Lake Liddell;
- ecological receptors, including freshwater ecological receptors in the local creeks and Lake Liddell.

2.10 *POTENTIAL AND KNOWN SOURCES OF CONTAMINATION*

The following potential and known sources of contamination were identified as part of the Preliminary ESA (ERM, 2013b):

- Hunter Valley Gas Turbines (diesel leaks);
- bulk fuel storage and transfer (potential and historical leaks);
- power generating units (potential and historical leaks);
- Transformer Road (numerous transformer units with oils);
- the ammonia plant (potential and historical leaks);
- oil and grit traps (accumulation of variety of contaminants from potential failure of system or leaks from holding tanks);
- the Site drainage network (direct discharge to Lake Liddell and seepage to soil/groundwater through damaged pipework);
- dangerous goods, flammable liquids and northern store compounds (seepage to ground or discharge to drains);

- asbestos (diffuse source due to large amount of asbestos material known to have been historically used on site);
- the water treatment/demineralisation plant (direct discharge to Lake Liddell via site drainage and seepage to soil/groundwater through damaged pipework);
- landfills (composition of waste streams not entirely known, leachate generation may be occurring);
- the TransGrid switchyard (potential and historic leaks);
- fill material (site levelling and shoreline expansion using uncontrolled fill);
- the maintenance workshop, foam generator and unofficial laydown area (potential and historical leaks);
- the Ash Dam and associated pipelines (seepage to groundwater and surface water receptors and asbestos from pipelines);
- current and former coal storage areas (runoff or seepage to groundwater and surface water receptors;
- the machinery graveyard (potential and historic leaks);
- water intake and pump station (potential and historic leaks); and
- the former construction workshop and storage area (historic leaks).

3 *DATA QUALITY OBJECTIVES*

Data Quality Objectives (DQOs) were developed to define the type and quality of data required to achieve the project objectives outlined in *Section 1.2* of this report. The DQOs have been prepared in line with the seven-step approach outlined in NSW Department of Environment and Conservation (DEC) (2006) *Guidelines for the NSW Site Auditor Scheme (2nd Edition)*, and with reference to relevant guidelines published by the NSW EPA, ANZECC/ARMCANZ, and NEPC.

The DQO process is validated, in part, by the quality assurance and quality control (QA/QC) procedures and assessment, summarised in *Section 4.7* and presented as *Annex F* of this report.

The seven steps of the DQO process, and how they were applied to this assessment, are presented below in *Sections 3.1* to *3.7*.

3.1 *STEP ONE: STATE THE PROBLEM*

A statement of the problem is provided by the particular objectives of the assessment as stated in *Section 1.2*. Background information is provided by *Sections 1* and 2 of this report, and by the updated conceptual site model (CSM) presented in *Annex C* which was initially developed as part of the Preliminary ESA (ERM, 2013b).

3.2 *STEP TWO: IDENTIFY THE DECISIONS*

Decision Statements

The principal decision to be made is:

- Are there actual or potential material contamination issues relevant to the proposed sale of the Liddell Power Station?

Additional decisions to be made include:

- Is there sufficient data to provide an environmental baseline at the time of the transaction?
- What is the nature and extent of soil and groundwater impact on or beneath the Site?
- Does the impact at the Site represent a risk to human health, based on the current and continued use of the site?
- Is the impact at the Site likely to warrant notification and/or regulation under the *NSW Contaminated Land Management Act (CLM Act) 1997*?
- Is material remediation likely to be required?

Adopted screening values and waste classification guidelines which will assist in making some of these decisions are identified in *Section 3.5.2*.

3.3 *STEP 3: IDENTIFY INPUTS TO DECISION*

The inputs required to make the above decisions are:

- existing relevant environmental data, taking into consideration the number and location of existing soil and groundwater sampling locations, the construction of existing groundwater monitoring wells and the date of the most recent sampling events;
- direct measurement of environmental variables including soil type, soil gas concentrations, odours, staining, water strike, groundwater level and water quality parameters;
- collection and laboratory analysis of soil and groundwater samples for identified COPCs;
- field and laboratory QA/QC data; and
- comparison of data against adopted screening values (outlined in *Section 3.5.2*).

3.4 *STEP 4: DEFINE THE STUDY BOUNDARIES*

Spatial Boundaries

The Site location and description is provided in *Section 2*. The site boundary and investigation areas are presented in *Figure 1* and *Figure 3* of *Annex A*. The physical spatial boundaries of the proposed investigation include the surface and subsurface soils as well as groundwater beneath the site. Vertical boundaries of the investigation were limited to the depth of borehole or monitoring well advancement.

Temporal Boundaries

Temporally, the study is intended to provide a baseline assessment of the nature and extent of contamination at the Site, as at or near the time of completion of the transaction to the extent practicable.

Constraints within the Study Boundaries

Constraints on the delivery of the objectives of the Stage 2 ESA program within the study boundaries included:

- location of underground services or infrastructure;
- the condition of existing monitoring wells; and
- obtaining permission/access to difficult to access / remote areas (where deemed necessary.

3.5 *STEP FIVE: DEVELOP A DECISION RULE*

The DQOs were designed to facilitate the collection of adequate soil and groundwater data to address the decisions in Step 2 of the DQO process. During the course of the project, various constraints had varying impact on the implementation of the Stage 2 investigation program. Examples of these constraints included restrictions of citing investigations locations due to physical access or to the presence of sub-surface services and or depth constraints due to the presence of shallow bedrock or the absence of groundwater. Deviations from the Stage 2 program were tracked during the course of the investigation via the weekly progress spreadsheet and were communicated to the relevant project stakeholders. An extract of the weekly progress spreadsheet is provided below as *Table 3.1* which highlights locations proposed but abandoned during the course of the investigation.

Table 3.1 ***Completeness of Sampling Relative to the SAQP***

AEC	Location	Type	Total Depth (m bgl)	Comments
LB	LB_MW02	Monitoring Well	1	Monitoring well location attempted but abandoned due to the presence of mine spoil.
LB	LB_MW04	Monitoring Well	3	Monitoring well location attempted but abandoned due to the presence of mine spoil.
LB	LB_MW07	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LB	LB_MW09	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.

AEC	Location	Type	Total Depth (m bgl)	Comments
LB	LB_MW10	Monitoring Well	2.1	Monitoring well location abandoned due to time constraints (soil borehole completed).
LB	LB_MW12	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LB	LB_MW15	Monitoring Well	13	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LD	LD_MW03	Monitoring Well	--	Monitoring well location abandoned due to the potential for unmarked subsurface utilities to be present.
LD	LD_SB02	Soil Bore	--	Subsurface utilities identified during NDD works (stormwater). Soil bore terminated
LF	LF_MW01	Monitoring Well	19.5	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LF	LF_SB01	Soil Bore	0.5	Soil bore terminated due to the presence of a second concrete slab the proximity to other utilities and high-voltage equipment.
LJ	LJ_MW03	Monitoring Well	0.35	Monitoring well location abandoned due to physical access constraints (known subsurface utilities).
LJ	LJ_SB01	Soil Bore	--	Soil bore abandoned due to physical access constraints (proximity to known subsurface utilities).
LJ	LJ_SB05	Soil Bore	--	Soil bore abandoned due to physical access constraints (proximity to known subsurface utilities).
LK	LK_MW01	Monitoring Well	14	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LK	LK_MW02	Monitoring Well	14	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LK	LK_MW03	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.

AEC	Location	Type	Total Depth (m bgl)	Comments
LL	LL_MW01	Monitoring Well	--	Original LL_MW01 location abandoned due to proximity of archaeological artefacts and an Endangered Ecological Community. LL_MW01 completed at location LL_SB06.
LL	LL_MW04	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LL	LL_MW05	Monitoring Well	20	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LL	LL_MW08	Monitoring Well	20	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LL	LL_SB08	Soil Bore	0.65	Soil bore abandoned due to proximity of known subsurface utilities.
LL	LL_SB16	Soil Bore	--	Soil bore abandoned due to proximity of known subsurface utilities.
LL	LL_SB17	Soil Bore	1.3	Soil bore terminated due to proximity of known subsurface utilities.
LM	LM_MW03	Monitoring Well	11.4	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LN	LN_MW03	Monitoring Well	1.5	Monitoring well abandoned due to inundation subsequent to NDD. Soil bore completed to 1.5 m bgl.
LO	LO_MW07	Monitoring Well	--	Monitoring well location abandoned due to physical access constraints (known subsurface utilities).
LO	LO_MW09	Monitoring Well	--	Monitoring well location abandoned due to physical access constraints (known subsurface utilities).
LQ	LQ_MW02	Monitoring Well	0.2	Monitoring well location abandoned due to physical access constraints (known subsurface utilities and the presence of a second concrete slab).
LQ	LQ_MW04	Monitoring Well	0.35	Monitoring well location abandoned due to physical access constraints (known subsurface utilities).

AEC	Location	Type	Total Depth (m bgl)	Comments
LQ	LQ_SB09	Soil Bore	--	Soil bore location abandoned due to physical access constraints (known subsurface utilities and the presence of a second concrete slab).
LQ	LQ_SB12	Soil Bore	--	Soil bore location abandoned due to physical access constraints (known subsurface utilities and the presence of a second concrete slab).
LR	LR_MW02	Monitoring Well	--	Monitoring well location abandoned due to the presence of overhead transmission lines.
LV	LV_MW01	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LV	LV_MW02	Monitoring Well	15	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LV	LV_MW06	Monitoring Well	10	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LV	LV_MW07	Monitoring Well	16	Hole left open for 72 hrs. No groundwater ingress noted. Open hole backfilled and monitoring well abandoned.
LV	LV_MW08	Monitoring Well	--	Abandoned due to proximity to Drayton Mine and the expected depth to groundwater (>100m)
LV	LV_MW09	Monitoring Well	--	Abandoned due to proximity to Drayton Mine and the expected depth to groundwater (>100m)

3.5.1 *Field and Laboratory QA/QC*

The reliability of soil and groundwater data was assessed based on comparison with acceptable limits for field and laboratory QA/QC samples outlined in relevant guidelines made or approved under the *CLM Act 1997,* including the *ASC NEPM* (2013).

In the event that acceptable QA/QC limits were not met, the field observations of the samples were reviewed and if no obvious source for the non-conformance was identified (such as an error in sampling, preservation of sample(s) or heterogeneity of sample(s), etc.) liaison with the laboratories was undertaken in an effort to identify the issue that had given rise to the non-conformance.

A summary of the QA/QC procedures and assessment is presented in *Section 4.7* and *Annex F* of this report.

3.5.2 *Assessment Criteria*

Individual soil and groundwater data, along with the maximum, minimum, mean, standard deviation and 95% Upper Confidence Limit (UCL) of the mean concentration (if required) were compared to adopted screening values.

Exceedence of adopted screening values does not necessarily indicate the requirement for remediation and/or a risk to human health and or the environment. If individual or 95% UCL concentrations exceed the adopted screening values, consideration of the extent of the impact, the potential for receptors to be exposed to the impact, and regulatory compliance was considered.

The adopted screening values have generally been sourced from guidelines made or approved under the *CLM Act 1997*, which includes the *ASC NEPM* (2013). Where alternative sources have been utilised, appropriate justification has been provided. A summary of the adopted screening values is provided in summary tables within *Annex B*.

Soil Assessment Criteria

Soil data will be assessed against investigation criteria published in the following document:

- NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)*, Schedule B1 - Guideline on Investigation Levels for Soil and Groundwater, Health Investigation Level (HIL) 'D' - Commercial/Industrial, HIL 'C' - Public Open Space and Ecological Investigation / Screening Levels (EILs/ESLs) (as applicable). It is noted that laboratory analysis for pH and CEC is required to establish site specific EILs/ESLs, and an assessment of background conditions may be necessary. The establishment of EILs/ESLs will be undertaken in preparation of the Stage 2 ESA report, and sample locations in up-gradient non-operational areas may be utilised in establishing background conditions. Further, it is noted that whilst the HIL 'C' screening values are generally not applicable to undeveloped, urban bushlands and reserves, they will be adopted at sampling locations in non-operational areas considered to present a more sensitive land use category.

Application of the HILs will be considered on a case by case basis in accordance with the NEPM 2013 amendment to reflect local conditions encountered at the time of the intrusive works. Health Screening Levels for Vapour Intrusion and Direct Soil Contact (HSL) 'D' – Commercial/Industrial and Health Screening Levels for Vapour Intrusion and Direct Soil Contact Intrusive Maintenance Worker (Shallow Trench) will also be adopted.

Groundwater Assessment Criteria

Water data will be assessed against investigation criteria published in NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)*, Schedule B1 - Guideline on Investigation Levels for Soil and Groundwater, which references the following guidance:

- *Australia and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC/ ARMCANZ, 2000). Trigger values for fresh water, level of protection 95% species and level of protection 99% species (for bioaccumulation of mercury and selenium);
- The National Health and Medical Research Council (NHMRC) and Natural Resource Management Ministerial Council (NRMMC) (2011) *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy;*
- NHMRC (2008) *Guidelines for Managing Risks in Recreational Waters* (note that these will be applied with reference to NHMRC and NRMMC 2011 - referenced above); and
- Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) *Technical Report No. 10, Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater* (2011). Health Screening Levels for Vapour Intrusion (HSL) 'D' - Commercial/Industrial and Health Screening Levels for Vapour Intrusion - Intrusive Maintenance Worker (Shallow Trench).

Waste Classification for Off-Site Disposal

Any excess soil or groundwater generated during the Stage 2 ESA program was classified in accordance with the NSW Department of Environment, Climate Change and Water *Waste Classification Guidelines, Part 1: Classifying Waste* (2009) and relevant associated Chemical Control Orders.

3.5.3 *Appropriateness of Laboratory Limit of Reporting*

Comparison of laboratory limits of reporting (LOR) to the screening values has been undertaken confirming that the screening values are less than the laboratory LOR with the exception of the following compounds:

- some volatile organic compounds in water (including vinyl chloride, chloromethane, bromomethane, 1,2-Dichloroethane, hexachlorobutadiene, 1,2,3-trichlorobenzene and 1,2-dibromomethane) and pentachlorophenol have LORs marginally above the adopted ecological protection criteria and/or above the drinking water guidelines. With the exception of vinyl chloride, it is noted that these contaminants are not regarded as key contaminants of concern and no drinking water receptors have been identified within the vicinity of the Site. In the event that a detection of these compounds is noted, further investigation and/or explanation may be required. As vinyl chloride is a breakdown product of PCE and TCE, detections of these compounds may trigger the need for further consideration; and

- Selenium and mercury in water have LORs marginally above the adopted 99% freshwater ecosystem protection guideline. This guideline has been adopted as a precautionary approach and it is noted that the LOR is below the 95% guideline value. A detection of either of these compounds may require further investigation and/or explanation.

3.6 *STEP 6: SPECIFY LIMITS ON DECISION ERRORS*

The acceptable limits on decision errors applied during the review of the results will be based on the data quality indicators (DQIs) of precision, accuracy, representativeness, comparability and completeness (PARCC) in accordance with NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013*, Schedule B3 - Guideline on Laboratory Analysis of Potentially Contaminated Soils.

The potential for significant decision errors were minimised by:

- completing a robust QA/QC assessment of the validation data and application of the probability that 95% of data will satisfy the DQIs, therefore a limit on the decision error would be 5% that a conclusive statement may be incorrect;

- assessing whether appropriate sampling and analytical density has been achieved for the purposes of providing a baseline of soil and groundwater conditions at the point of transaction; and

- ensuring that the criteria set was appropriate for the ongoing use of the site as a power generation facility.

3.7 *STEP 7: DEVELOP (OPTIMISE) THE PLAN FOR COMPLETING THE WORKS*

The DQOs were developed based on a review of existing data and discussions with Macquarie Generation. If data gathered during the assessment indicated that the objectives of the assessment programme were not being met, the sampling design (including sampling pattern, type of samples and analytes) was adjusted accordingly using feedback (where necessary) from project stakeholders.

4 *SAMPLING METHODOLOGY*

4.1 *RATIONALE*

Based on a review of the available data and the establishment of potential AECs, the most appropriate sampling design to achieve the stated project objectives was considered to be primarily based on a judgemental (targeted) sampling program, which in itself provides good coverage of operational areas, and minimal additional sampling undertaken to provide spatial coverage for low risk areas of the site (e.g. buffer lands) or to fill material data gaps within the CSM. It is noted that intrusive investigations were limited to areas where access and site activities enabled investigations to occur without unacceptable health and safety risks to personnel and/or unacceptable disruption to site operations. The sampling plan was discussed with site management prior to the commencement of works to assess this risk and was subject to minor alteration.

Given the scale of the Site, different sampling densities were adopted based on estimated contamination risk and logistical constraints of different areas of the site. The sampling approach was generally in accordance with the NSW EPA *Sampling Design Guidelines* (1995) which does not recommend a minimum number of sampling points for sites larger than 5.0 ha. As recommended in these guidelines, the Site was divided into smaller areas of concern based on a review of historical activities and identified potentially contaminating activities.

4.2 *SITE INSPECTION*

The work areas of the Site were inspected and the soil and groundwater sampling locations were marked out to target identified Site features and potential contamination sources. At the same time as clarifying the investigation locations, sub-surface utilities were marked out using an appropriately qualified service locator. Ground penetrating radar (GPR) and cable avoidance tool (CAT), along with DBYD plans and Site engineering drawings were utilised to identify underground services and utilities.

4.3 *SOIL INVESTIGATION*

4.3.1 *Soil Sampling Procedure*

Soil investigation and sampling works were undertaken in general accordance with ERM's Standard Operating Procedures (SOPs). The location and number of sampling locations are presented within *Figures 4.1 to 4.5* of *Annex A.*

Where practicable, all boreholes were advanced to an initial depth of 1.5 m bgl using hand augering and / or vacuum excavation techniques in accordance with ERM's Sub-Surface Clearance (SSC) procedures. Drilling and soil sampling of subsurface material beyond 1.5 m bgl, were undertaken using a Geoprobe® drilling rig with a continuous push tube sampler where conditions allowed. Other methods of borehole advancement included solid stem mechanical augering, and air rotary methods, where bedrock was encountered or subsurface material could not be penetrated using push tube methods.

Regardless of the drilling methodology adopted, soil sampling techniques which minimised the potential for loss of volatiles to the extent practicable were utilised. Where the collection of undisturbed samples was not possible (e.g. during hand augering) the potential for loss of volatiles was minimised by sampling from larger clods and minimising the duration between sample collection and placement into the sample container.

Field screening was conducted in accordance with ERM's SOPs using a Photo-Ionisation Detector (PID) fitted with a 10.6 eV lamp, calibrated at the beginning of each working day. Calibration certificates are presented in *Annex E*. Where practicable, soil was collected at 0.5 m depth intervals (or where significant changes in lithology were identified) to 2 m bgl and at 1 m depth intervals thereafter. Soil samples were placed in a zip lock bag, sealed and screened for the presence of ionisable volatile compounds. Where the presence of volatiles or other impact was suspected, additional samples were collected.

Soil properties were logged by an appropriately trained and experienced field scientist in general accordance with *Australian Standard AS 1726-1993, Geotechnical Site Investigations* (Australian Standards Committee, 1993). Representative soil samples were collected for laboratory analysis at selected locations, based on visual and/or olfactory evidence of the following:

- multiple layers of fill material;
- changes in the soil profile; and
- potential impact.

Soil samples were collected, to the extent practicable, in accordance with techniques described in *Australian Standard AS4482-2005* (Parts 1 and 2) to maintain the representativeness and integrity of the samples. Soil samples for laboratory analysis were collected from either the hand auger or directly from the push tube core. No samples were collected directly for laboratory analysis from solid flight augers, unless otherwise stated within borehole logs presented in *Annex D*. The frequency and nature of field QA/QC samples collected during the assessment works are summarised in *Annex F*.

Soil samples were generally labelled using the nomenclature presented in *Table 4.1* (below).

Table 4.1 *Sample Naming Protocol*

Sample	Identification
Surficial sample taken from SU01 within work area LB	LB_SU01
Sample taken from shallow hand auger soil bore or deeper soil bore, SB01 at depth of 0.5 m bgl, within work area LB	LB_SB01-0.5
Sample taken from depth of 5 m bgl from a soil bore to be installed as Monitoring Well MW07, within work area LB	LB_MW07-5.0
Sample taken from existing monitoring well MW01 within work area LB	LB_EW_MW01

Sample jars were sealed and immediately placed in an insulated cooler, on ice, and stored to minimise potential loss or degradation of volatile compounds. Samples were shipped under chain of custody documentation to the analytical laboratory. Trip blanks and field blanks were used to assess if cross contamination occurred during the sample collection process.

Soil samples were collected for asbestos analysis in general accordance with the *ASC NEPM* (2013) and the ERM *Assessment of Asbestos Impacted Areas SOP* (2012). If potential asbestos containing material (ACM) was identified, representative fragments were collected from the work area and placed in snap lock bags. These samples were submitted to the primary laboratory for analysis, to confirm the presence or absence of asbestos.

Where asbestos was not observed at the surface or during the investigation works, discrete 500 mg samples of soil were collected in snap lock bags. These samples were submitted to the laboratory for asbestos identification and (where identified) quantification (%w/w analysis) in accordance with the WA DOH (2009) guidelines.

4.3.2 *Decontamination Procedure*

Down-hole drilling and sampling equipment were decontaminated by initially removing any residual soil with a stiff brush and then washing the equipment in a 2% Decon 90 solution and rinsing with potable water.

4.3.3 *Soil Bore Reinstatement*

Upon completion, soil bores not scheduled to be converted to monitoring wells were backfilled and the surface covering reinstated to match existing.

4.3.4 *Waste Materials Generated During Drilling*

All non-liquid waste materials generated during drilling works were stored on-site in drums or other appropriate sealed containers at a designated staging area. If evidence of significant contamination is observed during drilling (e.g. staining or odour) an attempt will be made to store any potentially impacted wastes separately. All wastes were disposed off-site to an appropriately licenced landfill by an approved and appropriately licensed waste removal contractor.

4.4 *GROUNDWATER INVESTIGATION*

4.4.1 *Monitoring Well Construction*

Selected boreholes were converted to groundwater monitoring wells in accordance with ERMs SOPs. The groundwater monitoring well locations are presented in *Figures 4.1 to 4.5* of *Annex A*. The following methodology was implemented to install new monitoring wells:

- wells were constructed of heavy duty 50 mm diameter class 18 uPVC with factory slotted screen (0.4 mm slots) and plain well casing. Where practicable, the wells were screened within groundwater bearing strata in accordance with ERMs SOPs with consideration of potential regional and seasonal fluctuations of the water table and constructed to allow the potential ingress of non-aqueous phase liquids (NAPLs);

- following drilling, the well casing and screen were inserted into the drill casing. Washed and graded filter sand was poured into the annulus between the well screen and casing wall, ensuring that the sand covered the entire screened level and generally extended approximately 0.5 m above the top of the well screen;

- bentonite granules were then poured on top of the sand to an approximate thickness of 1 m and hydrated to effectively seal off the well from surface water or perched/shallow groundwater inflows; and

- the remaining annulus from the top of the seal to the base of the concrete was grouted with cement/bentonite grout to within 0.25 m of the surface and the final 0.25 m reinstated with concrete and a heavy duty well cover (flush gatic cover or raised monument as appropriate). The well casings were sealed with air-tight, lockable 'envirocaps'.

Following monitoring well installation, each well was developed using a submersible 12 V electric 'Typhoon' pump to remove any fine or granular materials or contaminants potentially introduced during drilling and to optimise hydraulic connectivity with the surrounding aquifer.

Wells were considered developed when either a minimum of 10 well volumes had been removed, when water quality parameters had stabilised or if the well was developed dry prior to this. Where sufficient well volumed could not be obtained, attempts were made to remove fines and construction material by purging the well over several days to allow for recharge.

Monitoring well construction details are presented within the borehole logs in *Annex D*.

4.4.2 *Groundwater Purging and Sampling Protocol*

Groundwater purging and the sampling of newly installed monitoring wells generally occurred at least one week following monitoring well installation and development, to allow subsurface conditions to stabilise. Both new and existing monitoring wells were purged and sampled as outlined below.

The presence of odours was noted, where applicable, following removal of the well cap and prior to purging. Any odours were described by reference to their intensity and character.

Following a period of no pumping (as a minimum 24 hours), wells were dipped to gauge the depth to groundwater, and the potential presence and depths of NAPLs.

Monitoring wells were purged using either a thoroughly decontaminated peristaltic or micro purge pump under low flow conditions, where hydrogeological conditions allowed, until sufficient water has been removed to obtain stabilised readings of pH, conductivity, redox potential, temperature and dissolved oxygen which was calibrated prior to use. The stabilisation criteria are as described below.

Table 4.2 ***Water quality parameter stabilisation criteria***

Parameter	Stabilisation criteria
pH	± 0.1 pH units
Electric Conductivity (EC)	± 3% (µS/cm or mS/cm)
Temperature	± 0.5°C
Oxidation Reduction Potential (ORP)	± 10 mV
Dissolved Oxygen (DO)	± 0.3 mg/L

It is noted that both ORP and DO are typically slower to stabilise than the other parameters. Where ORP and DO did not stabilise, therefore, greater weight was given to pH and EC as the stabilising parameters.

Low-flow sampling methodology was generally used to obtain samples that were representative of the local groundwater environment at the Site, with the exception of the use of bailers where well recharge was poor or insufficient groundwater was available for sampling using low flow methodology.

The inlet of the micro purge pump was placed approximately 50 cm from the base of the well in order to obtain a representative sample. Water samples were collected using equipment dedicated to each monitoring well to reduce the potential for cross-contamination between sampling locations.

The following order of sampling was adopted:

- samples to be analysed for volatile compounds placed into 40 mL amber vials;
- samples to be analysed for semi-volatile compounds placed into one 250 mL solvent washed amber bottles and two 1 litre solvent washed amber bottles;
- samples to be analysed for metals filtered through disposable 0.45 μm filters and placed in 125 mL plastic bottles preserved with nitric acid; and
- samples to be analysed for PFOS/PFOA placed into 125 mL plastic (Teflon free) unpreserved bottles.

No actual or suspected Non-Aqueous Phase Liquids (NAPLs) were observed during the groundwater monitoring and sampling event.

The containers were filled, where practical, to minimise headspace, before being sealed and appropriately labelled. Labels included the following information:

- sample identification number;
- sampler;
- job number; and
- date of collection.

Samples were sealed and immediately placed in a cooler on ice to minimise potential for degradation of the sample. All samples were shipped under chain of custody documentation to the analytical laboratories.

4.4.3 *Waste Material Generated During Groundwater Development/Purging*

Waste water from development and purging of groundwater monitoring wells was collected and stored in appropriately labelled intermediate bulk containers (IBCs) and was subsequently classified for off-site disposal at an appropriately licenced facility.

4.5 *SURVEYING*

All investigation locations were digitally located by field staff with a handheld Global Positioning System (GPS) unit. Additionally, all groundwater monitoring wells were surveyed by a registered surveyor (Tony Mexon and Associates) to AHD for elevation and MGA coordinates for location. The elevation of the highest point of the top of the uPVC well casing was surveyed to facilitate appropriate groundwater elevation calculations and groundwater flow direction interpretations.

4.6 *LABORATORY ANALYSIS*

The laboratories used for the investigations were accredited by the National Association of Testing Authorities (NATA), Australia. The primary laboratory used for soil and groundwater analysis was ALS Environmental Pty Ltd (ALS). Inter-laboratory duplicate samples were analysed by a secondary laboratory, Envirolab Services Pty Ltd (Envirolab). The analytical methods used by each laboratory are provided in the laboratory certificates in *Annex H.*

Soil and groundwater samples were analysed for the following COPCs:

- metals and metalloids (arsenic, cadmium, chromium, copper, nickel, lead, mercury, selenium and zinc);
- Total Recoverable Hydrocarbons (TRH);
- Polycyclic Aromatic Hydrocarbons (PAHs); and
- Benzene, Toluene, Ethylbenzene and Xylenes (BTEX).

Additional contaminants of concern were analysed on a sub-section of the soil and groundwater samples collected. These contaminants included:

- barium, beryllium, boron, cobalt, manganese, molybdenum, thallium, vanadium;
- asbestos (presence / absence, and quantification where asbestos was identified - soil only);
- Polychlorinated Biphenyls (PCBs) - related to use of PCB-containing transformer oils on site;
- Volatile Organic Compounds (VOCs); and
- Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) - to target areas where fire retardants may have been used or stored.

Selected soil samples were also analysed for the following to allow for adoption of appropriate screening levels:

- Total Organic Carbon (TOC);
- Particle Size Distribution (PSD);
- Electrical Conductivity (EC); and
- pH and Cation Exchange Capacity (CEC).

4.7 *QUALITY ASSURANCE / QUALITY CONTROL*

A detailed QA/QC report including field procedures, laboratory methods and an analysis of QA/QC results from the investigation is provided in *Annex F*. QA/QC information incorporating inter-laboratory and intra-laboratory duplicates, rinsate samples and trip spike/blank samples is also presented in *Annex F*.

There were some instances where the adopted screening levels were less than the laboratory LOR. These potential non-conformances have been discussed in *Section 3.5.3* of this report.

5 RESULTS AND DISCUSSION

5.1 SITE GEOLOGY OBSERVATIONS

A generalised description of the lithology encountered at the Site is presented in *Table 5.1*. Detailed descriptions of the Site geology as observed during the investigation are presented on the borehole logs in *Annex D*.

Within disturbed portions of the Site, subsurface soil conditions largely comprised filling or reworked natural weathered soils and rock overlying natural bedrock. The exception to this was areas to the east of the Power Station where various types of fill material were also placed to extend the shoreline (e.g. other virgin excavated material from across the site, waste stream materials such as coal fines, ash and material dredged from the oil and grit trap, and other general station rubbish).

Within undisturbed areas, native soils were present at shallow depths with varying degrees of weathering and some alluvial deposits observed adjacent to water courses. The depth to bedrock varied across the Site with topography but was generally within 1 m of the surface with outcropping of siltstone and sandstone bedrock observed at elevated areas.

Table 5.1 Generalised Field Lithology Descriptions

Lithological Unit	Description	Depth (m bgl) [1]
Hard standing (present in operational locations)	Concrete or bitumen, generally in good condition	0 - 0.4
Fill	Reworked silty clay, clay and/or gravel, brown or brown with orange or grey mottling, dry to moist, non-plastic	up to 2.5
Silty Clay	Orange-brown with grey mottling and light brown with grey mottling, moist, shale or siltstone gravel inclusions (weathered)	0.5 – 1.0
Bedrock	Siltstone, shale or sandstone bedrock, brown grading to grey with depth, generally dry, fine grained.	1.0 – 20

1. Given the variation in topography across the Site, depths and lithologies varied.

5.2 *GROUNDWATER FIELD OBSERVATIONS*

Existing groundwater monitoring wells on-site were gauged and sampled between 20 November 2013 and 25 November 2013. Due to access constraints, the existing wells could not be gauged in a single event on the same calendar day.

Newly installed monitoring wells were generally gauged and sampled at least 72 hours after well installation and development to allow subsurface conditions to stabilise. Groundwater gauging and sampling was completed between 25 November 2013 and 20 December 2013. During this time, a total of 63.3 mm of rain was recorded. Rainfall was largely recorded between 25 November and 6 December, 2013.

Groundwater gauging data is presented in *Table 2* of *Annex B*. Groundwater was encountered at depths of between 0.54 m bgl and 14.58 m bgl.

Field records for groundwater well development and sampling are presented in *Annex E*. Groundwater field parameters recorded during purging of wells, prior to sampling, are presented in *Table 3* of *Annex B*.

5.3 *AREAS OF ENVIRONMENTAL CONCERN (AEC) SUMMARY*

5.3.1 *Area LA – Ammonia Plant*

Background

The ammonia plant is located approximately 100 m to the south west of the main power block. Anhydrous ammonia (stored in bullets) is mixed into solution within the plant. The mixing tank within this area is externally water cooled as the reaction is exothermic. Pipelines then carry the aqueous ammonia to the demineralisation plant. Any discharges from the ammonia plant discharge directly to surface drains which flow into the Outfall Canal.

Anecdotal evidence provided by Site personnel during ERM's previous site visit indicated that a historical leak of an aqueous ammonia solution to ground occurred in this area. The date of the incident and the volume of aqueous ammonia solution involved were unknown to the personnel, however.

During the Site inspection (conducted on 19 and 20 August, 2013 by ERM as part of the Preliminary ESA), a building was identified within this area which was believed to contain asbestos and exhibited signs of building material deterioration.

Based on the site inspections and site history, potential issues pertaining to this area were considered to be possible contamination of shallow soils by asbestos and/or aqueous ammonia solution and contamination of groundwater with aqueous ammonia solution.

Further information regarding the Ammonia Plant is provided in the Preliminary ESA (ERM, 2013b).

AEC Investigation Methodology and Field Observations

A total of five soil investigation bores, of which three were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Figure 3* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted during drilling works within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.3 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.2*.

Table 5.2 ***Field Observations Summary - AEC LA***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence of Contamination	PID Range (ppm)
LA_SB01	3.2	None	0.0 - 0.1
LA_SB02	3.2	None	0.0
LA_MW01	10.0	None	0.0 - 0.3
LA_MW02	8.0	None	0.0
LA_MW03	10.0	None	0.0

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range, with electrical conductivity readings indicating that groundwater conditions were saline.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. An organic odour was observed during sampling, but is not considered to be indicative of potential contamination. A summary of field observations from the groundwater sampling works are presented within *Table 3 of Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC, with the exception of detections of some metals within groundwater across this AEC.

Cadmium, copper, manganese, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

All monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, manganese, nickel and zinc. Concentrations of cadmium and nickel in excess of the adopted human health (drinking water) screening values were also detected in a number of samples.

As the groundwater in this area is generally unsuitable for beneficial use and there no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself.

The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.2 *Area LB – Ash Dam*

Background

The Liddell Ash Dam is located approximately four km to the west of the main power block. The western boundary adjoins the Drayton Coal Mine. The Ash Dam is in the upper catchment of Bayswater Creek and was constructed by damming a natural valley. The dam has been in use since Liddell Power Station commenced operation and has been progressively expanded under various planning instruments resulting in a surface area of approximately 2.7 km^2 (Coffey 2012). At the time of the site inspection carried out as part of the Preliminary ESA (ERM, 2013b), works were underway to further increase the capacity of the dam by increasing the height of the dam walls.

The Ash Dam currently accepts approximately 1 million cubic metres (m^3) of fly and bottom ash from the Liddell Power Station per year, along with sand filter backwash and treated water from the sewage treatment plant. Macquarie Generation personnel also indicated that fabric filter bags and bonded asbestos cement pipe sections have previously been disposed of in the Ash Dam. Further, pipework that connects this area to the main power block contains asbestos cement.

There are several potential water discharge points from the Ash Dam area. These are the Ash Skimmer Dam, seepage through the Ash Dam wall itself, seepage through the base to groundwater and Tinkers Creek. Tinkers Creek is situated downstream from the ash dam area and acts as a potential contaminant pathway as it flows into Lake Liddell. A settling pond is located between the dam and Tinkers Creek to provide some control on the particulate discharge to the creek.

The Ash Dam is considered an AEC based on the potential inputs to, and migration from the dam, including specific contaminants such as metals and petroleum hydrocarbons, as well as the saline nature of the water that may potentially seep or discharge from the dam to receiving environments (primarily Lake Liddell and associated tributaries).

Given the limited availability of previous environmental characterisation works and sampling infrastructure, the potential COPCs identified, further investigation was considered to be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

Potential issues pertaining to this area were considered to be contamination of soil, groundwater and sediment from seepage/leachate or overflow.

AEC Investigation Methodology and Field Observations

A total of fifteen soil investigation bores, of which eight were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 1.1 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.3*.

Table 5.3 ***Field Observations Summary – AEC LB***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence of Contamination	PID Range (ppm)
LB_MW01	11	None	0.0 – 0.1
LB_MW02	1	None	-
LB_MW03	2	None	-
LB_MW04	3	None	0
LB_MW05	5.5	None	0.1 – 0.5
LB_MW06	3.5	None	0.2 – 0.5
LB_MW07	15	None	0.0 – 0.3
LB_MW08	10	None	0.2 – 0.7
LB_MW09	15	None	-
LB_MW10	2.1	None	0.2 – 0.7
LB_MW11	7.5	None	0.0 – 0.2
LB_MW12	10	None	0.0 – 0.5
LB_MW13	7	None	0.0 – 0.07
LB_MW14	5.5	None	0.0 – 1.1
LB_MW15	13	None	0.0 – 0.9
LB_SU01	0.1	None	N/A
LB_SU02	0.1	None	N/A
LB_SU03	0.1	None	N/A
LB_SU04	0.1	None	N/A
LB_SU05	0.1	None	N/A

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence of Contamination	PID Range (ppm)
LB_SU06	0.1	None	N/A
LB_SU07	0.1	None	N/A
LB_SU08	0.1	None	N/A
LB_SU09	0.1	None	N/A
LB_SU10	0.1	None	N/A
LB_SU11	0.1	None	N/A
LB_SU12	0.1	None	N/A
LB_SU13	0.1	None	N/A
LB_SU14	0.1	None	N/A
LB_SU15	0.1	None	N/A
LB_SU16	0.1	None	N/A
LB_SU17	0.1	Fragment of fibrous cement pipe	N/A
LB_SU18	0.1	Fragment of fibrous cement pipe	N/A
LB_SU19	0.1	Fragment of fibrous cement pipe	N/A
LB_SU20	0.1	None	N/A
LB_SU21	0.1	None	N/A
LB_SU22	0.1	None	N/A
LB_SU23	0.1	None	N/A
LB_SU24	0.1	None	N/A
LB_SU25	0.1	None	N/A
LB_SU26	0.1	None	N/A
LB_SU27	0.1	None	N/A

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence of Contamination	PID Range (ppm)
LB_SU28	0.1	None	N/A
LB_SU29	0.1	None	N/A
LB_SU30	0.1	None	N/A
LB_SU31	0.1	None	N/A
LB_SU32	0.1	None	N/A
LB_SU33	0.1	None	N/A
LB_SU34	0.1	None	N/A
LB_SU35	0.1	None	N/A
LB_SU36	0.1	None	N/A
LB_SU37	0.1	None	N/A
LB_SU38	0.1	None	N/A
LB_SU39	0.1	None	N/A
LB_SU40	0.1	None	N/A
LB_SU41	0.1	Fibrous cement fragment (2mm x 20mm x 20mm)	N/A
LB_SU42	0.1	None	N/A
LB_SU43	0.1	None	N/A
LB_SU44	0.1	Possible fibres	N/A
LB_SU45	0.1	Possible fibres	N/A
LB_SU46	0.1	Fragment of fibrous cement pipe	N/A

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B.* Field parameters were generally within the expected range, with electrical conductivity readings indicating that groundwater conditions were saline at LB_MW02 and LB_MW03. Electrical conductivity readings collected at LB_MW01 (121.2 µS/cm) indicated fresh water conditions; however it is considered possible that this reading was erroneous due to the saline groundwater observed in other wells in this area.

No indications of contamination, such as sheens or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table* 3 of *Annex B.*

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B.*

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC; however all concentrations were below the adopted screening values.

Asbestos was detected in surface soils collected from several locations beneath the ash and dust disposal pipeline bench leading from the main operational area of the power plant to the ash dam. Of the forty-six sampling locations beneath these pipelines, asbestos was detected in sixteen locations in surface soils (a combination of chrysotile and / or amosite). Asbestos quantification results were reported above the human health screening criteria for three of the sixteen samples where asbestos was identified..

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 3 of Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A.*

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC and TRH C_{10}-C_{14} equal to or marginally above the laboratory LOR in groundwater collected from LB_MW03 and LB_MW11.

Boron, cadmium, copper, manganese, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of asbestos in surface soils beneath the ash and dust and return water pipelines from the main operational area to the ash dam. The asbestos quantification results for thirteen samples collected from BE_MW01 were below the screening criteria. Given that these samples were collected at the ground surface and asbestos was detected, further consideration is warranted in accordance with guidance. These detections of asbestos in surface soils are likely to be due to the deterioration of the ash and dust and return water pipelines over time, which are constructed of ACM. Although various sections of these pipelines were sealed between 2001 and 2010, the protective coating may have degraded (Macquarie Generation, 2013). If left unmanaged, this asbestos could present a potential health risk to workers and other users of the site in the vicinity of the pipelines.

All samples collected from monitoring wells within this AEC were reported with metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included boron, cadmium, copper, lead, manganese, mercury, nickel, selenium and zinc. Concentrations of lead, nickel and selenium in excess of the adopted human health (drinking water and/or recreational) screening values were also detected in a number of samples. The NSW EPA has required a Pollution Reduction Program report to be developed in relation to managing surface and groundwater issues in the vicinity of Liddell Ash Dam, with a reporting deadline of 31 January 2014.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself.

The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.3 *Area LC – Bulk Fuel Storage – Light-Vehicle Refuelling Area*

Background

This area contains an unleaded and a diesel UST with a shed containing two fuel dispensers. There are also associated underground fuel lines, plus fill points and vents. Integrity tests completed in February 2013 indicated that Diesel Tank 1 passed, but that Unleaded Petrol (ULP) Tank 1 failed the ullage test and had a visibly leaking riser (Leighton O'Brien Field Services Pty Ltd, 2013).The results of a follow-up test in November 2013 following repairs to ULP Tank 1 indicated that there were no integrity test failures.

The area has been previously investigated as per the requirements of the *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008* (the 'UPSS Regulation'), with four monitoring wells installed. Sampling of these wells indicated detectable concentrations of COPCs. Interviews with Macquarie Generation personnel also revealed that two USTs have previously been removed from this area, with each reported by Macquarie Generation personnel to be observed in poor condition, including suspected holes within associated fuel lines during removal. No tank removal/destruction certificates were available for review.

While previous environmental characterisation work has been undertaken to investigate this potential source, based on the results obtained and complications relating to the assessment of groundwater flow direction and recharge rates, further investigation in the form of resampling of these wells and additional investigation locations in the broader area was considered warranted to assess potential contamination of soil and groundwater within the area.

AEC Investigation Methodology and Field Observations

ERM did not conduct any intrusive works within AEC LC as this area had previously been investigated by DLA Environmental (2011).

Table 5.4 ***Field Observations Summary – AEC LC***

Existing Well ID	Visual or Olfactory Evidence of Contamination
LC_EW_L1	Hydrocarbon odour observed during groundwater sampling
LC_EW_L2	Hydrocarbon odour observed during groundwater sampling
LC_EW_L3	Hydrocarbon odour observed during groundwater sampling
LC_EW_L4	Hydrocarbon odour observed during groundwater sampling

Groundwater field parameter readings collected during the sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range, with the exception of electrical conductivity, which were low at all wells sampled within this AEC (between 0.1 and 31.8 µs/cm). Taking into account the saline groundwater observed in other wells in the vicinity, it is unlikely that these readings were accurate and may be indicative of a malfunctioning water quality probe.

Hydrocarbon odour was observed during groundwater sampling at all wells within this AEC; however no sheen or NAPL was observed. A summary of field observations from the groundwater sampling works are presented within Table 3 of Annex B.

Soil Analytical Results

No soil samples were collected from within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of a number of COPCs were above the laboratory LOR in groundwater samples collected from within this AEC. These included concentrations of dissolved phase hydrocarbons detected in groundwater sampled from all monitoring wells within this AEC.

Concentrations of benzene, toluene, ethylbenzene, xylene, naphthalene and TRH (C_6-C_{10} minus BTEX) in excess of the adopted screening values were detected in a number of groundwater samples collected from the wells within this AEC.

Copper, mercury, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

Groundwater samples from three of the four monitoring wells within this AEC were found to contain concentrations of dissolved phase hydrocarbons that exceeded adopted screening values including human health (vapour intrusion - commercial workers and intrusive maintenance workers, drinking water and recreational) and ecological screening values.

Dissolved phase hydrocarbons of concern included benzene, toluene, ethylbenzene, xylene, naphthalene and TRH (C6-C10 minus BTEX). Due to the unsealed nature of the area where the USTs are located, and the presence of an enclosed stores building nearby, there is some potential risk to commercial workers from inhalation of vapours from these contaminants. Further assessment may therefore be required.

Based on the concentrations of hydrocarbons observed in groundwater and the distance of approximately 190 metres to Lake Liddell's nearest point, it is possible that migration of contaminants from this area to Lake Liddell may result in potential risk to ecological and human (recreational) users of the lake. Further assessment may therefore be required.

Samples collected from all monitoring wells within this AEC were reported with metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included copper, mercury, nickel, and zinc. Concentrations of nickel in excess of the adopted human health (drinking water) screening values were also detected in a number of samples.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.4 *Area LD – Bulk Fuel Storage – Mobile Refuelling Area*

Background

The mobile refuelling area is located to the south-west of the main power block and immediately to the west of the coal storage facility.

A number of potential contamination sources, both current and historic, were identified during the Preliminary ESA (ERM, 2013b):

- A former UST (100 000 L), now removed, and associated fuel lines, remote fill point and oil water separator that remain in-situ. The tank removal/destruction certificate was not available for review. Anecdotal evidence provided by Macquarie Generation personnel indicated that the tank was observed to be in poor condition upon removal.

- An existing self-contained diesel AST where a spill was recently reported by Macquarie Generation personnel during refuelling. According to information provided by Macquarie Generation, visually impacted soil is understood to have been removed; however no investigation of groundwater impact was previously undertaken. It was also observed during the previous ERM site visit that the pipework connecting the tank to the refuelling bay (routed around the external walls of the workshop building) had a number of elbow joints which showed signs of staining, indicating that leaks may have occurred.

- An existing waste oil UST located on the eastern side of the maintenance workshop with evidence of staining within the bund. It was also observed during the previous ERM site visit that a bund overflow valve was present which, if opened, may allow discharges to ground outside the bund.

- Lubricant Bay and Maintenance Workshop with observations of heavy staining within the drainage system, which suggests historic leakage or spills in this area.

While previous environmental characterisation work was undertaken to remove the UST and achieve compliance with NSW UPSS Regulations, based on the aggregation of potential sources in this location, further investigation in the form of resampling of these wells and additional intrusive investigation works within the AEC were considered warranted to assess potential soil and groundwater contamination.

AEC Investigation Methodology and Field Observations

A total of eight soil investigation boreholes, of which four were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.3 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.5*.

Table 5.5 *Field Observations Summary – AEC LD*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence of Contamination	PID Range (ppm)
LD_SB01	3.2	None	0.0
LD_SB02	1.0	None	0.0
LD_SB03	3.2	None	0.0
LD_SB04	3.0	None	0.0
LD_MW01	9.0	None	0.0
LD_MW02	7.5	None	0.0 – 0.2
LD_MW04	8.7	None	0.0 – 0.3
LD_MW05	9.5	None	0.0 – 0.14
LD_EW_MW01	N/A	None	N/A
LD_EW_MW02	N/A	None	N/A
LD_EW_MW03	N/A	None	N/A
LD_EW_MW04	N/A	None	N/A

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range, with the exception of electrical conductivity, which were low at several wells sampled within this AEC (between 0.7 and 18.5 µs/cm). Based on the saline nature of other wells in this AEC and in surrounding areas, these abnormally low electrical conductivity readings may be erroneous.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A slight organic odour was observed at LD_MW04, which was not considered indicative of potential contamination. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of TRH fractions, BTEX, PAHs and phenols were detected in the majority of soil samples collected from within this AEC. All concentrations were below adopted screening values with the exception of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} in a number of samples, which exceeded adopted ESLs.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC; however all concentrations were below the adopted screening values. Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across the AEC.

Cadmium, copper, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

Soil samples collected from a number of locations within this AEC were reported with concentrations of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} in excess of adopted ESLs. All concentrations, however, were below adopted human health screening values. Given that the highest concentrations of petroleum hydrocarbons were reported for samples collected at 0.1 m bgl, it is considered likely that aboveground releases were responsible for the observed impacts in soil within this AEC. As this area is predominantly covered in hard standing or compacted gravel, the ecological value of the area for growth of terrestrial flora is considered to be low and therefore the application of the ESLs are considered overly conservative.

All groundwater samples collected from monitoring wells within this AEC contained concentrations of metals greater than adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, nickel and zinc. Concentrations of nickel in excess of adopted human health (drinking water) screening values were also reported in a number of wells.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.5 *Area LE - Bulk Fuel Storage - Fuel Oil Installation ASTs*

Background

The Fuel Oil Installation stores large quantities of fuel (primarily diesel) for boiler ignition and is located on the south-east corner of the power block. The tanks in this area contain four active tanks (A-D) and two disused tanks (E-F) with the latter likely to contain residual sludge. Documents reviewed and information provided by Macquarie Generation during the previous site visit indicate there have been historical underground and above ground pipework leakages. Spills in the bunded sections of this area or at the refuelling points or vehicle wash down bays are routed to a blind sump which is pumped out regularly. Integrity testing of the tanks and wet stock reconciliation information is understood to be undertaken but was not available for review.

Given the absence of previous environmental characterisation work, and based on the history of fuel storage and potential release, further investigation was considered to be required to provide a baseline for contamination in this area.

AEC Investigation Methodology and Field Observations

A total of sixteen soil investigation bores, of which nine were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

Staining was observed at LE_SB06, LE_SB07, LE_MW03 and LE_MW04 while hydrocarbon odours were observed at the majority of locations in this AEC as detailed in *Table 5.6*. Some elevated concentrations of ionisable volatile compounds measured via headspace analysis up to 374.4 ppm v (isobutylene equivalent) were identified in soil samples collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.6*.

Table 5.6 ***Field Observations Summary - AEC LE***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence of Contamination	PID Range (ppm)
LE_SB02/LE_MW09	7.0	HC odour (1.35 - 7.0 m bgl)	0.0 - 12.3
LE_SB03	2.6	HC odour (1.5 - 2.6 m bgl)	5.9 - 37.2
LE_SB04	3.2	HC odour (2.0 - 2.2 m bgl)	0.0 - 12.76
LE_SB05	3.2	None	0.0 - 0.1
LE_SB06	3.2	HC odour and staining (0.85 - 2.9 m bgl)	0.0 - 272.9
LE_SB07	3.2	HC odour and staining (1.5 - 2.0 m bgl)	0.0 - 103.0
LE_SB08	3.2	None	0.0
LE_SB09	3.6	None	112 - 215
LE_MW01	6.3	None	0.0 - 1.0
LE_MW02	7.0	None	0.0

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence of Contamination	PID Range (ppm)
LE_MW03	5.7	HC odour and staining (1.7 - 2.7 m bgl)	0.0 - 84.3
LE_MW04	7.3	HC odour (0.3 m bgl); HC odour and staining (1.5 - 2.0 m bgl)	0.0 - 374.4
LE_MW05	7.0	Hydrocarbon odour during groundwater sampling	0.0
LE_MW06	5.5	Hydrocarbon odour during groundwater sampling	0.0 - 0.1
LE_MW07	7.0	'Oily' odour (2.0 m bgl; 4.3 - 7.0 m bgl)	0.2 - 121.4
LE_MW08	7.0	Hydrocarbon odour during groundwater sampling	0.0

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range, with the exception of pH being generally low across the majority of wells within this AEC. The lowest pH reading recorded was for LE_MW02 (pH 3.42).

Hydrocarbon odour was noted during the sampling of several wells within this AEC (LE_MW03, LE_MW04, LE_MW05, LE_MW06, LE_MW07 and LE_MW08); however no sheen or NAPL was observed. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of hydrocarbons including TRH fractions, BTEX, PAHs and phenols were detected in a number of soil samples collected from within this AEC. All concentrations were below adopted screening values with the exception of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} in a number of samples, which exceeded the adopted ESLs.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of various COPCs were above the laboratory LOR in a number of groundwater samples collected from within this AEC. These included concentrations of dissolved phase hydrocarbons detected in five groundwater monitoring wells sampled from within this AEC. These concentrations were below the adopted screening values, with the exception of benzene in LE_MW04, LE_MW07 and LE_MW08 and naphthalene in LE_MW07, which exceeded the adopted human health and/or ecological screening values.

Metals in excess of laboratory LORs were detected in all monitoring wells across this AEC. Arsenic, cadmium, copper, lead, manganese, nickel, selenium and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

Soil samples collected from a number of locations within this AEC were reported with concentrations of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} in excess of adopted ESLs. All concentrations, however, were below adopted human health screening values. As this area is predominantly covered in hard standing or compacted gravel, with the exception of some minor grassed areas, the ecological value of the area for growth of terrestrial flora is considered to be low and therefore the application of the ESLs is therefore considered to be overly conservative.

Groundwater collected from three monitoring wells within this AEC contained concentrations of benzene that exceeded the adopted human health screening values. At LE_MW07 and LE_MW08 these concentrations exceeded the human health (drinking water) screening values. The concentration of benzene at LE_MW07 also exceeded recreational screening values. At this well the concentration of naphthalene detected also exceeded the adopted ecological screening values.

All groundwater samples collected from monitoring wells within this AEC contained concentrations of metals greater than adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, nickel, selenium and zinc. Concentrations of arsenic, cadmium, lead, nickel and selenium in excess of adopted human health (drinking water and/or recreational) screening values were also reported in a number of wells.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

Based on the concentrations of hydrocarbons observed in groundwater and the distance of approximately 50 metres to Lake Liddell's nearest point, it is possible that migration of contaminants from this area to Lake Liddell may result in a potential risk to ecological and human (recreational) users of the lake. Further assessment may therefore be required.

5.3.6 *Area LF – Bulk Fuel Storage – Waste Oil AST (Transformer Road) and Former Transformer Oil ASTs*

Background

The waste oil AST is understood to be fed by a drainage system that collects waste oil from the turbine units. Information provided by Macquarie Generation personnel during the previous site visit indicated that the tank and associated bund was overfilled in 2012 with oil lost to the ground surface, reaching the drainage network, and flowing to the oil and grit trap. It is likely that some of the released oil reached ground beneath the area. It is unclear if other release events have occurred from this potential contamination source historically.

Given the absence of previous environmental characterisation work, and based on the history of oil storage and the known release event, further investigation was considered to be required to investigate potential contamination in this area.

AEC Investigation Methodology and Field Observations

A total of five soil investigation bores were installed within this AEC. No groundwater was encountered during drilling and no groundwater monitoring wells were installed. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile.

Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.7.*

Table 5.7 ***Field Observations Summary – AEC LF***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LF_SB01	0.5	None	0
LF_SB02	0.6	None	-
LF_SB03	0.3	None	0
LF_SB04	0.6	None	0
LF_MW01	10.0	None	0

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B.*

The majority of measured concentrations of COPCs were below or close to the corresponding laboratory LOR in all samples collected from within this AEC. TRH fractions were detected in soil collected from LF_SB01 at a depth of 0.1 m bgl. These concentrations did not exceed adopted screening values with the exception of TRH C_{16}-C_{34}, which exceeded the ESL.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in all soil samples collected from within this AEC; however all metals concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

No groundwater samples were collected from within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of TRH C_{16}-C_{34} in soil collected from 0.1 m bgl at LF_SB01, which exceeded the adopted ESL. As this area is covered in hard standing, the ecological value of the area for growth of terrestrial flora is considered to be low and therefore the application of the ESLs is conservative.

5.3.7 *Area LG – Bulk Fuel Storage – Turbine Oil AST*

Background

The bulk fuel storage area is situated north of the Main Power Block within a concrete block bund. Pipework inside the bund beneath the fill point showed staining, suggesting periodic leaks are likely to have occurred. Drains are located immediately outside the bund. Soil and groundwater in this area has not previously been investigated and further investigation was considered to be required to assess potential contamination

AEC Investigation Methodology and Field Observations

A total of three soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were observed within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.4 ppm v (isobutylene equivalent) in the soil samples collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.8*.

Table 5.8 ***Field Observations Summary – AEC LG***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LG_MW01	6.0	None	0.0
LG_MW02	8.0	H_2S odour during groundwater sampling	0.0
LG_MW03	8.0	H_2S odour during groundwater sampling	0.4

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A hydrogen sulfide odour was observed at LG_MW02 and LG_MW03. A summary of field observations from the groundwater sampling works are presented within Table 3 of Annex B.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Samples for asbestos analysis were not collected within this AEC; however no suspected asbestos materials were observed during drilling.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC.

Arsenic, copper, lead, and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

All monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included copper, lead, and zinc. Concentrations of arsenic and lead in excess of the adopted human health (drinking water) screening values were also detected in a number of samples.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself.

The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.8 *Area LH – Bulk Fuel Storage – Waste Oil ASTs (Liquid Alternative Fuels) and Emergency Generator AST*

Background

Three 55 000 L tanks containing waste oil are located on the south-east portion of the power block. While appearing in visually good condition, several in-bund sumps were observed to contain oil, indicating that there may have been releases from the primary storage units.

Given the absence of previous environmental characterisation work, and based on the history of fuel/oil storage and likelihood of release, further investigation was considered to be required to assess potential contamination.

AEC Investigation Methodology and Field Observations

A total of four soil investigation bores, of which three were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation, were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.0 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.9*.

Table 5.9 ***Field Observations Summary – AEC LH***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LH_SB01	2.0	None	-
LH_MW01	8.0	None	0.0
LH_MW02	8.0	None	0.0
LH_MW03	8.0	None	0.0

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC; however all concentrations were below the adopted screening values.

Samples for asbestos analysis were not collected within this AEC; however no suspected asbestos was observed during drilling.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC.

Cadmium, copper, nickel, and zinc were detected at concentrations in excess of the adopted ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Groundwater samples collected from all monitoring wells within this AEC were reported with dissolved metals concentrations greater than the adopted ecological screening values.

Metals exceeding the adopted ecological screening values included copper, lead, and zinc. Concentrations of metals were below the adopted human health (drinking water and recreational) screening values.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.9 *Area LI – Current and Former Coal Storage Area*

Background

This area is defined as the current Coal Stockpile and former Coal Stockpile which extended further south along the shores of Lake Liddell. The primary concern in the current Coal Stockpile is the potential transport of coal fines via surface water run-off into drainage channels and ultimately into Lake Liddell.

It is recognised that the coal conveyor system and associated sediment ponds may represent an AEC (related to mechanical operations (oils) and coal fines that may migration to Lake Liddell), however these have not been considered to warrant targeted environmental investigation. It is considered unlikely that coal conveyors would represent a significant contamination issue in the context of the site-wide assessment; however, based on the lack of investigation data for this AEC, further investigation was considered to be required to provide a baseline for soil and groundwater conditions in this area.

AEC Investigation Methodology and Field Observations

A total of fourteen soil investigation bores, of which nine were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.8 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.10*.

Table 5.10 *Field Observations Summary – AEC LI*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LI_SB01	3.0	None	0.1 – 0.5
LI_SB02	1.6	None	0.0 – 0.1
LI_SB03	10.0	None	0.0
LI_SB04	1.4	None	0.0 – 0.1
LI_SB05	3.1	None	0.0 – 0.1
LI_MW01	10.0	None	0.0
LI_MW02	10.0	None	0.0 - 0.2
LI_MW03	6.0	None	0.0 - 0.6
LI_MW04	6.0	None	0.0 - 0.8
LI_MW05			
LI_MW06	8.0	None	0.0
LI_MW07	8.0	Hydrogen sulfide odour during groundwater sampling	0.0 – 0.3
LI_MW08	10.0	None	0.0
LI_MW09	8.5	None	0.0 – 0.2

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B.* Field parameters were generally within the expected range in this AEC, with the exception of low pH at the majority of wells. The lowest pH reading was recorded at LI_MW04 (pH 4.00). No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC, with the exception of a hydrogen sulfide odour at LI_MW07. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B.*

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B.*

Measured concentrations of COPCs were below the adopted screening values in the soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC; however all concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC.

Arsenic, boron, cadmium, copper, lead, manganese, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Samples collected from all monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included boron, cadmium, copper, lead, manganese, nickel and zinc. Concentrations of arsenic and nickel in excess of the adopted human health (drinking water and/or recreational) screening values were also detected in a number of samples.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.10 *Area LJ – Dangerous Goods, Flammable Liquids and Stores*

Background

These areas have been treated as a single aggregated source area based upon an understood commonality of location and type of potential contamination sources on the northern boundary of the Main Power Block area.

The eastern end of this AEC contains the flammable liquids store. This contains small quantities of ethanol, acetone, methyl ethyl ketone, xylenes and petrol in a locked storage shed. It is unclear what other products have historically been stored in this area, including upon the open ground that surrounds the store.

The western end of this area contains Stores Compounds No.1, No. 2 and No.3, which were observed to be concrete sealed during the previous site visit. Stores Compound No.1 and No.2 were observed to contain little by way of COPCs, being mostly parts storage areas at the time of the site visit. Store Compound No.3, however, contained drum storage and disused transformers (which may contain oils). Observed chemical storage included the following (with typical volumes).

- hypochlorite solution: 2000 L
- hydrazine hydrate: 4000 L
- acrylic acid: 1500 L
- ammonia solution: 4000 L
- tetrachloroethene (PCE): 2000 L
- chlorophenols: 800 L
- potassium bromate: 125 L

Given the absence of previous environmental characterisation work, and the current and historic storage of a variety of COPCs, further investigation was considered to be required to assess potential contamination in this area.

AEC Investigation Methodology and Field Observations

A total of fourteen soil investigation bores, of which four were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. Hydrocarbon odours were observed at LJ_SB02 between 0.3 and 2.5 m bgl and at LJ_MW02 between 1.5 and 3.5 m bgl. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 37.8 ppm v (isobutylene equivalent) in any soil samples collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.11*.

Table 5.11 *Field Observations Summary – AEC LJ*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LJ_SB02	3.3	Hydrocarbon odour from 0.3 – 2.5	0.0 – 37.8
LJ_SB03	3.3	None	0.0
LJ_SB04	2.1	None	0.0
LJ_SB06	1.55	None	0.0
LJ_SB07	0.85	None	0.0 – 0.1
LJ_SB08	1.2	None	0.0
LJ_SB09	1.3	None	0.0
LJ_SB10	1.2	None	0.0
LJ_SB11	3.0	None	0.0
LJ_SB12	0.0	None	0.0
LJ_MW01	5.0	Hydrogen sulfide odour during groundwater sampling	0.0
LJ_MW02	4.35	Hydrocarbon odour from 1.5 – 3.5	0.1 – 27.4
LJ_MW03	0.35	None	0.0
LJ_MW04	10.0	None	0.0 – 0.1

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC, with the exception of a hydrogen sulfide odour at LJ_MW01. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

The majority of measured concentrations of COPCs were below or close to the corresponding laboratory LOR in all samples collected from within this AEC. TRH fractions were detected in a number of soil samples collected from LJ_MW02 and LJ_SB02. These concentrations did not exceed adopted screening values with the exception of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} in soil collected from LJ_SB02, which exceeded the adopted ESLs.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in all soil samples collected from within this AEC however all metals concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC with the exception of a detection of potential ACM in the sample collected from LJ_MW02 at 0.5 m (unidentified asbestiform mineral fibres).. The asbestos quantification result for this sample was reported above the human health screening criteria.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. TRH fractions above the laboratory LOR were detected in groundwater collected from LJ_MW02. These concentrations were below adopted screening values.

Concentrations of metals above the laboratory LOR were also detected in all groundwater samples. Cadmium, copper, lead, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} in soil collected from LJ_SB02, which exceeded the adopted ESLs, and a detection of potential ACM at LJ_MW02. As this area is predominantly covered in hard standing or compacted gravel, the ecological value of the area for growth of terrestrial flora is considered to be low and therefore the application of the ESLs are conservative. The potential ACM detection was isolated and, given that concrete hard standing covers this location, it is not considered that this represents a potential risk to human health so long as the hard standing is not removed and excavation is not undertaken without appropriate controls in place.

All monitoring wells within this AEC contained concentrations of metals greater than adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, nickel and zinc. Concentrations of lead and nickel in excess of adopted human health (drinking water and/or recreational) screening values were detected in a number of samples.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.11 *Area LK – Former Construction Workshop and Storage*

Background

Information provided by Macquarie Generation personnel during the previous site visit indicated that a workshop area, storage yard, vehicle parking and administration offices were established to the north west of the Power Block area, immediately west of the Water Intake and Pump Station during construction of the Liddell Power Station. Limited details were available on the exact nature of operations or materials stored here during the construction period; however it is possible that there may have been temporary storage of potentially contaminating materials.

Given the absence of previous environmental characterisation work at this location, further investigation was considered to be required to assess the potential for contamination to be present.

AEC Investigation Methodology and Field Observations

A total of five soil investigation bores were installed within this AEC. Groundwater was not encountered during drilling and no groundwater monitoring wells were installed. Soil bores were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.6 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.12*.

Table 5.12 *Field Observations Summary – AEC LK*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LK_SB01	3.0	None	0.0
LK_SB02	3.0	None	0.0 – 0.6
LK_MW01	14.0	None	0.0 – 0.2
LK_MW02	14.0	None	0.0 – 0.6
LK_MW03	12.0	None	0.0 – 0.2

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC; however all concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

No groundwater samples were collected from this AEC as groundwater was not encountered during drilling.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC and groundwater was not encountered during the investigation.

5.3.12 *Area LL – Hunter Valley Gas Turbines*

Background

The HVGT provides black start capability to the Power Station, with potential contamination sources including bulk fuel (diesel) storage and fuels and oils associated with turbine and transformer activity. Numerous hydrocarbon releases have been documented in the past, including a 30 000L release in 1990 which resulted in migration of contaminants to a nearby tributary of Lake Liddell.

It is understood some remedial works were completed around the time of the incident but no information was available for review. Significant surface staining was observed around the turbines and fuel storage area, including upon areas of open ground or concrete of poor integrity. It was also observed that the drainage network and bund arrangement within the facility is poorly maintained with potential for direct release to underlying soil.

It is understood that the HVGT drainage system has previously been through a cleaning, inspection and upgrade process. Interceptors installed at the down gradient boundary of the facility also showed evidence of leakages, indicating interceptors may have been overtopped.

Given the limited availability of documentation regarding previous environmental characterisation or remediation works, the historical use of the facility including the storage of fuels and hydrocarbons, the known release events and visual evidence of staining and concrete/bund integrity, further investigation was considered to be required to assess potential contamination issues in this area.

AEC Investigation Methodology and Field Observations

A total of twenty-three soil investigation bores, of which nine were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

Field indicators of contamination, including visible staining and sheens in drains, as described above, were noted within this AEC. No staining was detected through the sampled soil profile; however hydrocarbon odours were observed at LL_SB10 at 0.4 m bgl, at LL_MW01 during well installation and at LL_MW09 from 3.0 to 20.0 m bgl. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 25.5 ppm v (isobutylene equivalent) in the soil samples collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.13*.

Table 5.13 ***Field Observations Summary - AEC LL***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LL_SB01	3.2	None	0.0
LL_SB02	0.85	None	0.0
LL_SB03	1.6	None	0.0
LL_SB07	0.7	None	0.0
LL_SB08	0.65	None	0.0
LL_SB09	1.8	None	0.0 - 0.1
LL_SB10	2.0	Hydrocarbon odour at 0.4 m	0.0 - 0.1
LL_SB11	2.2	None	0.0
LL_SB12	2.2	None	0.0 - 0.1
LL_SB13	1.9	None	0.0
LL_SB14	1.4	None	0.0 - 0.1
LL_SB15	2.5	None	0.0 - 0.1

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LL_SB17	1.3	None	0.0
LL_SB18	3.2	None	0.2 – 0.3
LL_MW01	10.0	Very faint hydrocarbon odour during well install	0.2 – 0.6
LL_MW02	20.0	None	0.0 – 5.5
LL_MW03	20.0	None	0.0 – 9.2
LL_MW04	20.0	None	0.0
LL_MW05	15.0	None	0.0 – 0.7
LL_MW06	11.0	None	0.2 – 0.5
LL_MW07	11.5	None	0.0
LL_MW08	20.0	None	0.2 – 0.4
LL_MW09	11.0	Faint hydrocarbon odour from 3.0 to 20.0 m	0.0 – 25.5

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range, with the exception of electrical conductivity recorded at LL_MW02 (114 300 µS/cm). Although groundwater in surrounding wells was observed to be saline during sampling, the electrical conductivity reading at this well is indicative of extremely saline conditions and is considered to be potentially inaccurate. No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. An organic odour was observed at LL_MW03, which was not considered indicative of potential contamination. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

The majority of measured concentrations of COPCs were below or close to the corresponding laboratory LOR in all samples collected from within this AEC. Hydrocarbons, including TRH fractions, PAHs and phenols, were detected in a number of soil samples collected from this AEC. These concentrations did not exceed adopted screening values with the exception of TRH C_{16}-C_{34} in soil collected from LL_SB07 (0.1 m bgl) and benzo(a)pyrene in soil collected from LL_MW03 (1.9 m bgl) and LL_MW09 (4.0 m bgl), which exceeded the adopted ESLs.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in all soil samples collected from within this AEC; however all metals concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. Dissolved phase hydrocarbons above laboratory LORs were detected in groundwater collected from LL_MW02 and LL_MW03. These concentrations were below adopted screening values with the exception of benzene, which exceeded the adopted human health (drinking water) screening values at both of these locations. No hydrocarbon results in groundwater exceeded the adopted ecological screening values.

Concentrations of metals above the laboratory LOR were also detected in all groundwater samples. Arsenic, cadmium, copper, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of TRH C_{16}-C_{34} and benzo(a)pyrene in a number of soil samples, which exceeded the adopted ESLs. As these boreholes are located in areas covered in concrete hard standing or compacted gravel (roadway), the ecological value of the area for growth of terrestrial flora is considered to be low and therefore the application of the ESLs are considered to be conservative.

Groundwater samples collected from two monitoring wells within this AEC were reported with concentrations of benzene that exceeded the adopted human health (drinking water) screening values.

All monitoring wells within this AEC contained metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, nickel and zinc. Concentrations of arsenic and nickel in excess of adopted human health (drinking water) screening values were detected in a number of samples.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself.

The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.13 *Area LM – Machinery Graveyard*

Background

The Machinery Graveyard is located to the south of the exit road to the gatehouse (and north of the Coal Reclaimer Bays) and is used for the storage of redundant machinery and scrap. The area is unpaved and due to the potential for disused machinery to contain residual oils or chemicals which have the potential to seep/leak to ground or asbestos, it has been considered an AEC.

Given the absence of previous environmental characterisation work at this location, further investigation was considered warranted to provide a baseline for this area and to assess potential issues associated with soil and groundwater contamination.

AEC Investigation Methodology and Field Observations

A total of four soil investigation bores, of which two were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.1 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.14*.

Table 5.14 ***Field Observations Summary – AEC LM***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LM_SB01	1.7	None	0 – 0.1
LM_MW01	9.0	None	0 – 0.1
LM_MW02	10.0	None	0
LM_MW03	11.4	None	0

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC, with electrical conductivity readings indicating saline groundwater. No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC; however all concentrations were below the adopted screening values.

Samples for asbestos analysis were not collected within this AEC; however no suspected asbestos was observed during drilling.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC.

Cadmium, copper, lead, nickel, selenium and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Samples collected from all monitoring wells within this AEC were reported with metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included boron, cadmium, copper, lead, nickel, selenium and zinc. Concentrations of lead and nickel in excess of the adopted human health (drinking water) screening values were also detected in a number of samples.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.14 *Area LN- Oil and Grit Trap*

Background

The Oil and Grit Trap, located adjacent to the shoreline of Lake Liddell, receives the majority of drainage from the Site. The Oil and Grit Trap receives potentially contaminated waters from across the operational area of the site, including the Power Generating Units. Numerous historical spills have been reported to have direct impacts to the Oil and Grit Trap, including the transport and collection of significant amounts of fuels, oils, ash and coal. The associated oil water separator and sump may also have experienced over-topping during its operations. Verbal information supplied by Macquarie Generation indicated that the intention of the system was to act as a sedimentation pond, not a contaminated water treatment system.

Given the absence of previous environmental characterisation work, the uncertainty associated with the volume of potential contaminants received during its operation and the potential for seepage from the system, further investigation was considered to be required to assess potential contamination within this area.

AEC Investigation Methodology and Field Observations

A total of seven soil investigation bores, of which six were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC.

No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.7 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.15*.

Table 5.15 ***Field Observations Summary – AEC LN***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LN_MW01	10.0	None	0.0 - 0.1
LN_MW02	8.5	None	0.0
LN_MW03	1.5	None	0.0
LN_MW04	4.0	None	0.0 - 0.2
LN_MW05	10.5	None	0.0 - 0.2
LN_MW06	10.2	None	0.0 - 0.3
LN_MW07	8.0	None	0.0 - 0.7

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC, with electrical conductivity readings indicating saline groundwater.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC; however all concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC.

Cadmium, copper, nickel, and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

All monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, nickel, and zinc. The concentration of nickel in groundwater collected from LN_MW01 also exceeded the adopted human health (drinking water) screening values.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.15 *Area LO – Former and Current Maintenance Stores, Workshops, Foam Generator and Unofficial Lay-Down Areas*

Background

Various workshops are located around the site. During ERM's previous site visit, these workshops were found to contain small scale chemical storage, with generally good housekeeping practices in place, and were not considered to pose a significant risk of soil and groundwater contamination. The External Plant Workshop located to the south of the Power Block was found to contain comparatively larger scale storage (approximately twenty 205 L drums of oil) and had a vehicle wash down bay and oil/water interceptor.

In addition to the maintenance areas, a foam generator used for fire suppression purposes (no information was available on whether fire training may have historically been undertaken on the site) and an unofficial (and unsealed) laydown area adjacent to the northern stack were identified as potential AECs for the site, and based on their proximity to the Main and Apprentice Workshops have been grouped together for assessment purposes.

Given the absence of previous environmental characterisation work, and the uncertainty around previous practices and potential storage of solvents (including chlorinated solvents), the workshops, foam generator and laydown area have been aggregated into an AEC for investigation to assess potential contamination in these areas.

AEC Investigation Methodology and Field Observations

A total of twenty five soil investigation bores, of which fourteen were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted at the surface within this AEC. Staining was observed at LO_SB05 at a depth of 0.2-0.3 m bgl. Hydrocarbon odours were detected at LO_SB05, LO_MW04, LO_MW05 and LO_MW06 at depths of 0.2-0.3 m bgl, 3.5 m bgl, 2.5 m bgl and 4.0 m bgl, respectively. Measured concentrations of ionisable volatile compounds via headspace analysis were identified up to a maximum of 79.2 ppm v (isobutylene equivalent) in soil samples collected from this AEC.

A summary of field observations from the drilling works is presented within *Table 5.16*.

Table 5.16 ***Field Observations Summary - AEC LO***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LO_SB01	1.3	None	0.0
LO_SB02	2.4	None	0.0
LO_SB03	3.5	None	0.0 - 2.3
LO_SB04	3.5	None	0.0 - 2.7
LO_SB05	1.9	Hydrocarbon odour and staining from 0.2 - 0.3 m bgl	0.0 - 13.4
LO_SB06	3.2	None	0.0 - 0.1
LO_SB06A	0.6	None	0.0
LO_SB07	3.2	None	0.0 - 0.4
LO_SB08	3.9	None	0.0 - 0.2
LO_SB09	3.2	None	0.2 - 0.6
LO_MW01	10.0	None	0.0
LO_MW02	6.0	Hydrocarbon odour during groundwater sampling	0.0 - 2.0

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LO_MW03	5.0	Hydrocarbon odour during groundwater sampling	0.0 - 1.4
LO_MW04	5.0	Hydrocarbon odour at 3.5m	0.0 - 38.9
LO_MW05	6.0	Hydrocarbon odour during groundwater sampling	0.0 - 77.7
LO_MW06	7.0	Hydrocarbon odour during groundwater sampling	0.0 - 79.2
LO_MW08	10.0	None	0.0 - 0.4
LO_MW10	6.0	None	0.0
LO_MW11	5.0	None	2.3
LO_MW12	5.0	None	0.0
LO_MW13	9.0	None	0.0
LO_MW14	14.0	None	0.0
LO_MW15	9.0	None	0.0 - 0.5
LO_MW16	10.0	None	0.0 - 0.1
LO_MW17	6.0	None	0.6 - 1.1

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range. The exception to this was for pH at LO_MW10 (pH 4.2). Electrical conductivity readings indicated saline groundwater.

Hydrocarbon odours were observed during purging and sampling at LO_MW02, LO_MW03, LO_MW05 and LO_MW06. No NAPL was observed, but a potential sheen was observed at LO_MW05 and LO_MW06. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC with the exception of the sample collected from LO_SB08 at 04.-0.5 m bgl. Laboratory analysis identified chrysotile asbestos in this sample. The asbestos quantification result for this sample was reported above the human health screening criteria.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. Dissolved phase hydrocarbons above laboratory LORs were detected in groundwater collected from a number of samples. These concentrations were below adopted screening values with the exception of benzene in groundwater collected from LO_MW05, which exceeded the adopted human health (drinking water and recreational) screening values and naphthalene in groundwater collected from LO_MW05 and LO_MW06, which exceeded the adopted ecological screening values. Chlorinated hydrocarbons were also detected in groundwater samples collected from LO_MW03 and LO_MW04. This included concentrations of tetrachloroethene in excess of the adopted human health (drinking water) screening values at both locations.

Concentrations of metals above the laboratory LOR were also detected in all groundwater samples. Arsenic, cadmium, copper, lead, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC, with the exception of identification of chrysotile asbestos at one location (LO_SB08) at 0.4-0.5 m bgl. The detection of asbestos was isolated and, given that concrete hard standing covers this location, it is not considered that this represents a potential risk to human health so long as the hard standing is not removed and excavation is not undertaken without appropriate controls in place.

Dissolved phase hydrocarbons were detected in excess of adopted screening values within groundwater collected from two locations within this AEC. The concentration of benzene in groundwater collected from LO_MW05 exceeded the adopted human health (drinking water and recreational) screening values but was below the adopted ecological screening values.

The concentration of naphthalene detected in groundwater collected from LO_MW05 and LO_MW06 exceeded the adopted ecological screening values but did not exceed adopted human health screening values. The concentration of tetrachloroethene detected in groundwater collected from LO_MW03 and LO_MW04 exceeded the adopted human health (drinking water) screening values.

Based on the concentrations of hydrocarbons observed in groundwater and the distance of approximately 180 metres to Lake Liddell's nearest point, it is possible that migration of contaminants from this area to Lake Liddell may result in potential risks to ecological receptors and human (recreational) users of the lake. Further assessment may be required.

All monitoring wells within this AEC reported metals concentrations greater than the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, nickel, and zinc. Concentrations of arsenic, lead and nickel in excess of the adopted human health (drinking water and/or recreational) screening values were also detected in a number of samples.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.16 Area LP – Fill Material (Site Levelling and Shoreline Expansion)

Background

Interviews with site personnel revealed that the shoreline to the east of the Power Station has been extended over time through the placement of fill material. It is understood that the fill materials used as part of this process include the material 'cut' during development of the Power Plant itself, other virgin excavated material from across the site, waste stream materials such as coal fines, ash and material dredged from the oil and grit trap, and other station rubbish material. Anecdotal evidence exists with respect to possible placement locations, but no formal records are known to have been kept.

Given the absence of previous environmental characterisation work, limited records or tracking of waste disposal practices associated with the shoreline expansion, and the uncertainty associated with the content of the fill material used, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination and to assist with the identification and delineation of areas of infilling.

AEC Investigation Methodology and Field Observations

A total of twenty soil investigation bores, of which six were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.6 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.17*.

Table 5.17 Field Observations Summary – AEC LP

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LP_SB01	2.7	None	0.0 – 0.5
LP_SB02	2.6	None	0.0 – 0.2
LP_SB03	3.0	None	0.0 – 0.1
LP_SB04	3.2	None	0.0 – 0.6
LP_SB05	3.5	None	0.0
LP_SB06	1.9	None	0.0
LP_SB07	3.0	None	0.0 – 0.3
LP_SB08	3.0	None	0.0 – 0.4
LP_SB09	3.0	None	0.0 – 0.1
LP_SB10	3.0	None	0.0 – 0.1
LP_SB11	3.2	None	0.0 – 0.1
LP_SB12	3.2	None	0.0
LP_SB13	3.1	None	0.0
LP_SB14	2.8	None	0.0 – 0.1
LP_MW01	10.0	None	0.0 – 0.2
LP_MW02	7.0	None	0.0 – 0.4
LP_MW03	5.2	None	0.0 – 0.4
LP_MW04	4.0	None	0.0 – 0.3
LP_MW05	8.5	None	0.0 – 0.7
LP_MW06	4.0	None	0.0

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range. The exception to this was for pH at LP_MW02 (pH 4.41). Electrical conductivity readings indicated saline groundwater. No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. An organic odour was observed at LP_MW04, which was not considered indicative of potential contamination. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

The majority of measured concentrations of COPCs were below or close to the corresponding laboratory LOR in all samples collected from within this AEC. Hydrocarbons were detected in a number of soil samples collected from within this AEC. These concentrations were below the adopted screening values with the exception of benzo(a)pyrene in soil collected from LP_SB05 (0.1 m bgl) which exceeded the adopted ESL.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in all soil samples collected from within this AEC; however all metals concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC and naphthalene above the laboratory LOR (but below adopted screening values) in groundwater collected from LP_MW03.

Arsenic, boron, cadmium, copper, lead, manganese, nickel, selenium and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of benzo(a)pyrene in soil at one location (LP_SB05, 0.1 m bgl), which exceeded the adopted ESL. As this location in located in an area covered by hardstand, the ecological value of the area for growth of terrestrial flora is considered to be low and therefore the application of the ESLs are considered overly conservative.

All monitoring wells with the exception of LP_MW02 and LP_MW05 contained metals concentrations that exceeded the adopted ecological screening values. Metals exceeding the adopted ecological screening values included boron, cadmium, copper, lead, manganese, nickel, selenium and zinc. Concentrations of arsenic, cadmium, lead, nickel and selenium in excess of the adopted human health (drinking water and/or recreational) screening values were detected in a number of samples collected from within this AEC. There was no known source of the low pH reading recorded during groundwater sampling at LP_MW02, which is located approximately 10 m from the Lake Liddell shoreline. Groundwater pH readings in other wells in the vicinity of LP_MW02 did not indicate a widespread issue. Field measurement of pH in surface water from Lake Liddell in close proximity to this well indicated that pH was above 8. It is considered that the low pH recorded in groundwater at LP_MW02 is not impacting Lake Liddell.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.17 *Area LQ – Transformer Operations/ Transformer Road*

Background

Transformer Road, located immediately west of the main power block, contains two station transformers and four power unit transformers. The potential contamination source exists in the significant volumes (68 000 L) of transformer oil contained within each transformer, with several of the bunds surrounding the units observed to be stained and in poor condition.

Given the absence of previous environmental characterisation work, and based on the history of oil storage and evidence of historical releases, further investigation was considered to be required to assess potential contamination.

AEC Investigation Methodology and Field Observations

A total of eighteen soil investigation bores, of which five were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 3.0 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.18.*

Table 5.18 *Field Observations Summary – AEC LQ*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LQ_SB01	1.0	None	0.0
LQ_SB02	1.4	None	0.0
LQ_SB03	1.2	None	-
LQ_SB04	0.75	None	0.0
LQ_SB05	1.2	None	0.0
LQ_SB06	1.1	None	0.0
LQ_SB07	1.2	None	0.0
LQ_SB08	0.7	None	0.0
LQ_SB09	0.4	None	-
LQ_SB10	0.2	None	0.0
LQ_SB11	1.4	None	0.2
LQ_MW01	5.0	None	0.0
LQ_MW02	0.2	None	0.0
LQ_MW03	0.8	None	0.0
LQ_MW04	0.35	None	-
LQ_MW05	10.0	None	3.0
LQ_MW06	10.0	None	-
LQ_MW07	10.0	None	0.0

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated saline groundwater.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A slight 'fish-like' odour was noted in several wells. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B.*

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

The majority of measured concentrations of COPCs were below or close to the corresponding laboratory LOR in all samples collected from within this AEC. Hydrocarbons were detected in two soil samples (LQ_SB01_1.6 and LQ_SB07_1.0). These concentrations were below the adopted screening values with the exception of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} in soil collected from LQ_SB07 (1.0 m bgl) which exceeded the adopted ESLs.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in all soil samples collected from within this AEC however all metals concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC.

Arsenic, cadmium, copper, lead, nickel, and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of TRH C_{10}-C_{16} and TRH C_{16}-C_{34} in soil collected from LQ_SB07 (1.0 m bgl) which exceeded the adopted ESLs. As this area is predominantly covered in concrete hard standing, the ecological value of the area for growth of terrestrial flora is considered to be low and therefore the application of the ESLs is considered to be overly conservative.

All monitoring wells within this AEC contained metals concentrations that exceeded the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, nickel, and zinc. Concentrations of arsenic and nickel in excess of the adopted human health (drinking water) screening values were detected in a number of samples collected from within this AEC.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.18 *Area LR – Transgrid Switchyard*

Background

The TransGrid Switchyard, although not owned by Macquarie Generation, is a potential AEC due to the storage/use of transformer oil which may have historically contained PCBs. Given the slope of the site there is potential for leaks from the switchyard to migrate toward the Main Power Block area as an offsite source.

Given the absence of previous environmental characterisation work and the potential for PCBs and hydrocarbons to be present, further investigation was considered to be required to assess potential contamination surrounding the switchyard (investigation was not proposed within TransGrid owned land due to access and safety issues).

AEC Investigation Methodology and Field Observations

A total of three soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the perimeter of the AEC on land owned by Macquarie Generation as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.7 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.19*.

Table 5.19 *Field Observations Summary - AEC LR*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LR_MW01	14.9	None	0.0
LR_MW03	10.0	None	0.2
LR_MW04	10.0	None	0.0 - 0.7

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated saline groundwater.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A slight organic odour was observed at LR_MW03, which was not considered indicative of potential contamination. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC; however all concentrations were below the adopted screening values.

Samples for asbestos analysis were not collected within this AEC; however no suspected asbestos was observed during drilling.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC.

Arsenic, cadmium, copper, nickel, and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

All monitoring wells within this AEC contained metals concentrations that exceeded the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, nickel, and zinc. Concentrations of arsenic and nickel were detected in excess of the adopted human health (drinking water) screening values in a number of samples collected from within this AEC.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.19 *Area LS - Landfills (Waste Disposal and Burrow Pit)*

Background

Landfill areas include areas of station rubbish and asbestos landfilling to the south of the Main Power Block. Only limited information with respect to survey plans and content was available for review.

Given the absence of previous environmental characterisation work, and the absence of specific information on landfill content and scale, further investigation was considered to be required to assess potential contamination in this area, particularly any leachate that may be present from previously constructed cells.

AEC Investigation Methodology and Field Observations

A total of six soil investigation bores, of which two were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.2 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.20.*

Table 5.20 ***Field Observations Summary - AEC LS***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LS_SB01	3.2	None	0.0 - 0.1
LS_SB02	0.85	None	0.0 - 0.1
LS_SB03	2.9	None	0.0 - 0.1
LS_SB04	3.8	None	0.0 - 0.2
LS_MW01	4.0	None	0.0
LS_MW02	4.0	None	0.0

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range, with the exception of low pH at LS_MW01 (pH 4.64) and LS_MW02 (pH 4.60). Electrical conductivity readings indicated saline groundwater.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A slight organic odour was observed at LR_MW03, which was not considered indicative of potential contamination. A summary of field observations from the groundwater sampling works are presented within Table 3 of Annex B.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

The majority of measured concentrations of COPCs were below or close to the corresponding laboratory LOR in all samples collected from within this AEC.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in all soil samples collected from within this AEC. All metals concentrations were below the adopted screening values with the exception of copper and zinc in soil collected from LS_SB04 (2.7 m bgl) which exceeded the adopted EIL.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC.

Arsenic, cadmium, copper, nickel, and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of copper and zinc in soil collected from LS_SB04 (2.7 m bgl), which exceeded the adopted site-specific EILs for these analytes. As this borehole was located on the side of an active roadway where the ground surface was primarily comprised of compacted gravel, the ecological value of the area for growth of terrestrial flora is considered to be low. This sample was also collected from >2 m bgl and hence was outside the primary root zone and therefore the application of the EILs are considered to be overly conservative.

All monitoring wells within this AEC contained metals concentrations that exceeded the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper and nickel. Concentrations of arsenic, cadmium and nickel in excess of the adopted human health (drinking water and/or recreational) screening values were detected in a number of samples collected from within this AEC.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.20 Area LT – Water Intake and Pump Stations

Background

This AEC, located immediately adjacent to Lake Liddell, contains two transformers (A and B) which show some evidence of surface staining from oil discharge/release. The area also contains a disused chlorination plant formerly used to add chlorine to the cooling water to prevent fouling.

Given the absence of previous environmental characterisation work, further investigation would be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination, particularly given its proximity to Lake Liddell.

AEC Investigation Methodology and Field Observations

A total of four soil investigation bores, all of which were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC, with the exception of possible fibre cement fragments observed during drilling at LT_MW01 at depths between 0.1 and 0.6 m bgl. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.6 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.21*.

Table 5.21 ***Field Observations Summary - AEC LT***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LT_MW01	7.3	Possible fibre cement fragment	0.1
LT_MW02	8.0	None	0.1
LT_MW03	7.4	None	0.1
LT_MW04	5.0	None	0.6

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated saline groundwater. Hydrocarbon odour was observed during purging and sampling at LT_MW02, LT_MW03 and LT_MW04. No sheen or NAPL was observed.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. Dissolved phase hydrocarbons above laboratory LORs were detected in groundwater collected from LT_MW02 and LT_MW04. These concentrations were below adopted screening values with the exception of benzene in groundwater collected from LT_MW04 which exceeded the adopted human health (drinking water) screening values.

Concentrations of metals above the laboratory LOR were also detected in all groundwater samples. Boron, cadmium, manganese, nickel and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC. The possible asbestos cement fragments observed between depths of 0.1 and 0.6 m bgl during drilling at LT_MW01 did not result in detection of asbestos fibres by the laboratory. As such, it is considered that the fragments observed within fill material at this location are not likely to be ACM and do not warrant further consideration.

Concentrations of metals in excess of the adopted ecological screening values were detected in groundwater sampled from two of the four groundwater monitoring wells located within this AEC (LT_MW02 and LT_MW03). Metals exceeding the adopted ecological screening values included boron, cadmium, manganese, nickel and zinc. Concentrations of cadmium and nickel also exceeded the human health (drinking water or recreational) screening values.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.21 *Area LU – Water Treatment Plant*

Background

This AEC comprises two adjacent areas which are at separate elevations. The demineralisation plan is sited within the south western corner of the Main Power Block, which is cut into the bedrock. The Water Treatment Plant is located on the original ground surface level above the cutting and is approximately 8 -10 m higher.

Potential contamination sources include the two bulk ferric chloride ASTs which are located inside a Plant Room, although they sit within a bund at the same level as the Demineralisation Plant. The fill point is located on the road at the Water Treatment Plant Elevation and shows signs of spillage. There is also staining evident down slope to the south along the road which leads towards the Outfall Canal.

The Demineralisation Plant contains a number of bulk chemical ASTs. These are bunded; however external pipework and drains run through the area. A number of the drains which carry process water show signs of extensive corrosion due to the nature of the acids and alkalis they transport. There is potential for leakages to have occurred along these lines before their ultimate discharge point known as the 'water treatment plant discharge' which is direct to Lake Liddell.

Given the absence of previous environmental characterisation work, and based on the history of chemical storage and potential for releases having occurred, further investigation was considered to be required to assess possible contamination in this area.

AEC Investigation Methodology and Field Observations

A total of seven soil investigation bores, of which two were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.22*.

Table 5.22 ***Field Observations Summary - AEC LU***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LU_SB01	0.4	None	0.0
LU_SB02	0.7	None	0.0
LU_SB03	1.5	None	-
LU_SB04	0.7	None	0.0
LU_MW01	3.2	None	0.0
LU_MW02	12.0	None	0.0
LU_MW03	13.0	None	0.0

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated saline groundwater.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC; however all concentrations were below the adopted screening values.

Samples for asbestos analysis were not collected within this AEC; however no suspected asbestos was observed during drilling.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC.

Copper, nickel, and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Both monitoring wells within this AEC contained metals concentrations that exceeded the adopted ecological screening values. Metals exceeding the adopted ecological screening values included copper, nickel, and zinc. Nickel in excess of the adopted human health (drinking water) screening values was also detected in groundwater collected from LU_MW02.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.3.22 *Area LV - Buffer Land*

Background

The buffer lands define the extant boundary areas of the Site and were defined as a potential AEC to establish boundary conditions at the Site. The topography of the buffer lands is highly variable, as is the adjacent land use. Whist the layout of the surrounding buffer lands owned by Macquarie Generation has stayed largely consistent since the time of plant commissioning in the early 1970s, activities on neighbouring properties have changed considerably, including open cut coal mining operations located primarily to the east of Lake Liddell and to the west of the Liddell ash dam. The extreme eastern portion of Drayton Mine is located within the Liddell buffer lands. Whilst a portion of Drayton Mine is located on Macquarie Generation property, it was not considered further as a significant contamination source requiring investigation due to the expected depth of groundwater in this area (>80m bgl) and the known deeper regional water quality issues in the Upper Hunter Valley associated with coal mining operations.

The majority of the buffer land area has no infrastructure present (with the exception of Drayton mine, located directly west of the Liddell ash dam) and consists of relatively undisturbed vegetated areas. No significant contamination sources were identified within AEC LV; however investigations within this area provides information to fill material data gaps within the CSM and to provide background data for the Site conditions.

AEC Investigation Methodology and Field Observations

A total of seven soil investigation bores, of which three were completed as groundwater monitoring wells, were installed within this AEC. Soil bores and monitoring wells were distributed around the AEC as presented in *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 0.6 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.23*.

Table 5.23 ***Field Observations Summary – AEC LV***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
LV_MW01	10.0	None	0.0 - 0.1
LV_MW02	15.0	None	0.0 - 0.3
LV_MW03	8.0	None	0.1 - 0.3
LV_MW04	10.3	None	0.0 - 0.2
LV_MW05	5.6	None	0.1 - 0.6
LV_MW06	10.0	None	0.0
LV_MW07	15.0	None	0.0 - 0.1

Groundwater field parameter readings collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters were generally within the expected range in this AEC. Electrical conductivity readings indicated saline groundwater.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results are compared to the adopted human health and ecological screening values as presented in *Annex B*.

Measured concentrations of COPCs were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Annex B*. Exceedences of the adopted screening values are also graphically presented in *Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR in all groundwater samples collected from within this AEC. The exceptions to this were detections of some metals within groundwater across this AEC.

Cadmium, copper, lead, nickel, and zinc were detected at concentrations in excess of the adopted human health and/or ecological screening values in groundwater samples collected from the wells within this AEC.

Discussion

No exceedences of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC.

Samples collected from all monitoring wells within this AEC were reported with metals concentrations which exceeded the adopted ecological screening values. Metals exceeding the adopted ecological screening values included cadmium, copper, lead, nickel, and zinc. Concentrations of cadmium, lead and nickel in excess of the adopted human health (drinking water and/or recreational) screening values were also detected in a number of groundwater samples.

As the groundwater in this area is generally unsuitable for beneficial use and there were no registered groundwater extraction wells located in the vicinity of the Site, the groundwater is not considered a human health or ecological receptor in itself. The screening values were therefore adopted to evaluate potential risks associated with the discharge of groundwater into Lake Liddell, where it may affect recreational users or aquatic organisms. Metal impacts within Lake Liddell and its tributaries are discussed further in *Project Symphony - Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.4 DATA QUALITY

The data presented in the ESA was considered to generally be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site. Whilst some minor non-conformances have been identified in relation to field and laboratory QA/QC, these are not considered to have a material impact on the outcomes of this assessment.

With specific regard to the completeness of the assessment, it is noted that samples were collected from more than 90% of the proposed locations. A summary of the locations unable to be completed due to various reasons is provided in *Table 3.1*.

Whilst samples for asbestos laboratory analysis were not collected from a small number of AECs, no potential ACM was observed during investigation in these areas and, as such, this is not considered to represent a significant data gap. Electrical conductivity field readings appeared to be erroneously low in a small number of wells; however the saline nature of groundwater has been established across the Site and thus these minor data errors are not considered to affect the overall findings. An assessment of additional assessment works considered warranted is provided in *Section 5.5.5*.

5.5 *OVERALL DISCUSSION*

The primary objective of this Stage 2 ESA was to develop a baseline assessment of environmental conditions at the Site and within the immediate surrounding receiving environments at or near the time of the transaction. The results of the assessment have also been used to assess;

- The nature and extent of soil and/or groundwater impact on / beneath the Site and in relation to neighbouring sensitive receptors.
- Whether the impacts at the Site represent a risk to human health and/or the environment, based on the continuation of the current use.
- Whether the impact at the Site is likely to warrant notification /regulation under the *CLM Act 1997*.
- Whether material remediation is considered likely to be required.
- Whether the data collected during the assessment was of a suitable quality and completeness to provide a baseline of environmental conditions at the Site.

The overall results of the assessment are discussed herein, with reference to these objectives.

5.5.1 *Summary – The Nature and Extent of Soil, Sediment, Groundwater and Surface Water Impact*

A CSM was developed, which identified the following ecological and human receptors:

- onsite employees, including intrusive workers potentially labouring within shallow trenches/excavations;
- recreational users of Lake Liddell and the Hunter River;
- terrestrial ecological receptors within the open space areas both on and surrounding the Site; and
- freshwater aquatic organisms within Lake Liddell and the Hunter River.

Soil and groundwater data were compared against published environmental quality levels to provide a screening level assessment of potential risks to these identified receptors. Sediment and surface water quality within Lake Liddell and surrounding waterways was assessed in *Preliminary Environmental Site Assessment, Bayswater Power Station (ERM, 2013a)*. The findings of the screening process indicated that concentrations in soil and groundwater generally complied with the adopted screening levels, with the exceptions as discussed in the following sections.

Onsite Soil

- Asbestos was detected in surface soils beneath pipelines constructed of ACM within AEC LB (Liddell Ash Dam), at one location in AEC LJ (Dangerous Goods, Flammable Liquids and Stores) and at one location in AEC LO (Former and current maintenance stores, workshops, foam generator and unofficial lay-down areas).
- TRH were detected in excess of the Ecological Screening Levels in AECs LD (Bulk Fuel Storage - Mobile Plant Refuelling), LE (Bulk Fuel Storage - Fuel Oil Installation), LF (Bulk Fuel Storage - Transformer Road ASTs and Waste Oil AST), LJ (Dangerous Goods, Flammable Liquids and Stores), LL (Hunter Valley Gas Turbine) and LQ (Transformer operations / Transformer Road).
- Benzo(a)pyrene was detected in excess of the Ecological Screening Levels in AECs LL (Hunter Valley Gas Turbine) and LP (Fill Material (Site Levelling and Shoreline Expansion).
- Copper and zinc was detected at concentrations in excess of the Ecological Investigation Levels for commercial/industrial sites in soil samples collected from AEC LJ (Landfills - Waste Disposal and Borrow Pit).

Onsite Groundwater

- Metals including arsenic, cadmium, lead, nickel and selenium were detected at concentrations in excess of the NHMRC (2011) drinking water values in groundwater samples collected from various monitoring wells located across the Site. Lead, selenium and nickel also exceeded the NHMRC (2008) recreational water values in a smaller subset of those locations.

- Benzene was detected at concentrations in excess of the NHMRC (2011) drinking water values in groundwater samples collected from AECs LC (Bulk Fuel Storage - Light Vehicle Refuelling), LE (Bulk Fuel Storage - Fuel Oil Installation), LL (Hunter Valley Gas Turbine), LO (Former and current maintenance stores, workshops, foam generator and unofficial lay-down areas) and LT (Water Intake and Pump Station).

- Ethylbenzene, toluene and xylenes were detected at concentrations in excess of the NHMRC (2011) drinking water values in groundwater samples collected from AEC LC (Bulk Fuel Storage - Light Vehicle Refuelling).

- Tetrachloroethene (PCE) was detected at a concentration in excess of the NHMRC (2011) drinking water values in groundwater samples collected from AEC LO (Former and current maintenance stores, workshops, foam generator and unofficial lay-down areas).

- Benzene and xylene (ortho) were detected at concentrations in excess of the ecological screening levels for freshwater environments in groundwater samples collected from AEC LC (Bulk Fuel Storage - Light Vehicle Refuelling).

- Metals including boron, cadmium, copper, lead, manganese, mercury, nickel, selenium and zinc were detected at concentrations in excess of the ecological screening values for freshwater environments in groundwater samples collected from various monitoring wells located across the site.

General Observations

No free-phase product was observed at any of the sampling locations.

Potential asbestos fibre bundles and some fragments were observed in surface soils in the immediate vicinity of the pipework which runs between the power block and the Liddell Ash Dam (coinciding with many of the locations where asbestos fibres were detected in soil samples). Asbestos fibres were also detected within fill material (<0.5 m bgl) within AECs LJ (Dangerous Goods, Flammable Liquids and Stores) and LO (Former and current maintenance stores, workshops, foam generator and unofficial lay-down areas).

It is noted that the vertical boring of soils is not an ideal method via which to identify asbestos impacts in soils. The absence of asbestos within fill materials or upon surface soils in other areas across the Site therefore cannot be guaranteed on the basis of the results of this assessment. Similarly, as with any investigation of this nature, the potential exists for unidentified contamination to exist between the completed sampling locations both within and between AECs.

5.5.2 *Summary – Does the Identified Impact Represent a Risk to Human Health and/or the Environment?*

The approach to the screening of the data gathered in this assessment was to initially adopt the most conservative potential assessment values. The exceedences of the screening values outlined in *Section 3.5.2* were subsequently assessed on a case by case basis, in light of the specific characteristics of the individual samples and the AEC from which those samples were collected. The conclusions of these further assessments are presented in the following sections.

Onsite Soil

The asbestos impacts identified in soils beneath the pipelines within AEC LB (along with the pipelines) has been recognised by Macquarie Generation as an issue which represent a potential health risk and hence Macquarie Generation is in the process of developing a management strategy to appropriately mitigate these risks as set out in *Ash & Dust - Position Paper* -(Macquarie Generation, 2013).

Hydrocarbons (as TRH) were detected at concentrations exceeding the adopted ESLs in soil samples collected from AEC LD (Bulk Fuel Storage - Mobile Plant Refuelling), LE (Bulk Fuel Storage - Fuel Oil Installation), LF (Bulk Fuel Storage - Transformer Road ASTs and Waste Oil AST), LJ (Dangerous Goods, Flammable Liquids and Stores), LL (Hunter Valley Gas Turbine) and LQ (Transformer operations / Transformer Road). Benzo(a)pyrene was also detected in excess of the ESLs in AECs LL (Hunter Valley Gas Turbine) and LP (Fill Material (Site Levelling and Shoreline Expansion)). The detections in these areas are not considered significant as these operational areas are predominantly covered in concrete hardstand or compacted gravel. These areas were therefore not considered to have significant ecological value and thus the application of the ESLs is considered to be overly conservative. The identified exceedences of the ESLs are therefore not considered to be representative of a potential environmental risk.

Zinc and copper were detected at concentrations in excess of the adopted EILs in one sample collected from AEC LS (Landfills (Waste Disposal and Borrow Pit)). This sample was collected from a location on the side of an active roadway where the ground surface was primarily comprised of compacted gravel.

The ecological value of the area for growth of terrestrial flora is considered to be low and therefore the application of the EILs is considered to be conservative. This impact appears to be localised and is considered unlikely to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a Power Station.

On-site Groundwater

Groundwater beneath the Site is not extracted for potable use and a search of licensed groundwater bores has not identified any potential groundwater abstraction receptors in the vicinity of the Site. The saline groundwater conditions are also likely to reduce the opportunity for the potable or domestic use of groundwater in the vicinity of the Site in the future. Similarly, the groundwater beneath the Site is not considered to be an aquatic environment of significance for the purpose of this assessment.

The ANZECC (2000) freshwater ecological trigger values and NHMRC (2008) recreational screening levels were therefore adopted in this assessment to evaluate potential risks to the aquatic environment and recreational users of Lake Liddell and its tributaries. The NHMRC (2011) drinking water screening values were also adopted to evaluate the requirement to report groundwater contamination across the Site, in accordance with the DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (refer to *Section 5.5.3).*

Measured concentrations of metals in groundwater exceeded the ANZECC (2000) freshwater trigger values and NHMRC (2011) drinking water values in a large number of wells across the Site. Exceedences of the NHMRC (2008) recreational screening levels were also reported in a smaller number of wells.

Based on the topography and available hydrological information, all AECs at the Site were considered to ultimately discharge to Lake Liddell. It is also important to note that there are also direct and indirect discharges of storm, process and cooling waters to the Lake as described in *Section 2.*

Monitoring wells installed within the catchment of Lake Liddell reported concentrations of a wide range of metals at concentrations exceeding the adopted human health and / or ecological screening values as detailed in the summary of each AEC provided in *Section 5.* Given the widespread nature of these detections and since Lake Liddell represents the primary surface water receptor from both an ecological and human health (recreational) perspective, potential impacts to groundwater within this catchment should be assessed in that context, that is via direct assessment of the quality of surface water and sediment within the lake itself. The potential for risks to human health and the environment from groundwater impacts occurring within the catchment of Lake Liddell have been assessed and recommendations made in *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment* (ERM, 2014).

5.5.3 *Summary – Does the Impact Warrant Notification under the Contaminated Land Management Act 1997?*

Under section 60 of the *CLM Act 1997*, a person whose activities have contaminated land or a landowner whose land has been contaminated is required to notify NSW EPA when they become aware of the contamination. The DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*, state that a landowner or a person whose activities have contaminated land is required to notify NSW EPA that the land is contaminated if;

- the level of the contaminant exceeds the appropriate published screening level with respect to a current or approved use of the land, **and** people have been, or foreseeably will be, exposed to the contaminant; or
- the contamination meets a specific criterion prescribed by the regulations; or
- the contaminant has entered, or will foreseeably enter, neighbouring land, the atmosphere, groundwater or surface water, **and** the contamination exceeds, or will foreseeably exceed, an appropriate published screening value and will foreseeably continue to remain above that level.

The soil and groundwater results obtained in this assessment have been compared against the screening levels specified in NSW DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* and a number of exceedences have been identified.

Every exceedence of these screening levels is not, however, required to be reported to the NSW EPA. If the exceedence is representative of background conditions; or offsite migration of contamination to an adjoining property has not occurred and any onsite contamination has been adequately addressed under the Environmental Planning and Assessment Act then reporting under the CLM Act is not required. Further to this, in the case of onsite soil contamination, if no plausible exposure pathway to people or the environment is present, reporting is also not required.

On the basis of the discussions outlined in *Section 5.5.2*, the constituents that have been identified in onsite soil, sediment, surface water and groundwater are generally not exceeding the relevant screening values as cited in NSW DECC (2009).

The identified impacts which do exceed the relevant screening values and are considered to warrant further consideration with regards to whether a duty to report may exist under the CLM Act include the following:

- asbestos fines and fibres identified in surface soils beneath the asbestos pipelines within AEC LB;

- asbestos identified in soils in AECs LJ and LO;
- volatile TRH, BTEX and naphthalene detected in groundwater in AEC LC;
- benzene and naphthalene detected in groundwater in AEC LE;
- benzene, naphthalene and PCE detected in groundwater in AEC LO;
- metals detected at concentrations not attributable to background conditions in groundwater at various locations across the Site.

Each of these issues is discussed in further detail below.

Asbestos in Soils with AEC LB

Asbestos was identified in soils beneath the ACM pipelines within AEC LB. As noted previously, Macquarie Generation is in the process of developing a management strategy in relation to this issue as set out in Macquarie Generation (December 2013) *Ash & Dust - Position Paper*. Further, ERM understands that access to these areas has been restricted to mitigate potential risks to human health in the short term and that further delineation and quantification of asbestos in soils in this area is being undertaken. It is recommended that the outcomes of this further assessment are reviewed prior to a decision relating to notification of NSW EPA.

It is also noted that Macquarie Generation has stated that NSW Workcover is considered the relevant regulatory body in relation to this issue, given that there is no public access to the area and that the pipelines themselves represent a greater potential source of airborne fibres than the fibres identified within surface soils.

Asbestos in Soils in AEC LJ and LO

Asbestos was detected in soils within AECs LJ and LO. It is noted that neither of these detections were at surface and in both locations the soils were covered in hard standing across the local vicinity. Given the fact that the detected asbestos was not present at the ground surface and was beneath hard standing, a plausible exposure pathway would not exist unless penetration through the hard standing and excavation were to occur.

The preparation and implementation of a suitable Environmental Management Plan (EMP) by an appropriately qualified professional would therefore mitigate the risk of exposure and remove the need for notification of this issue. In the short term, the Engineering Manager has been notified of this issue such that any excavation works in these areas may be appropriately managed.

Volatile TRH, BTEX and naphthalene in groundwater in AEC LC

Volatile TRH, BTEX and naphthalene were identified in groundwater at concentrations exceeding the human health (drinking water) screening value in groundwater samples collected from the Light Vehicle Refuelling area (AEC LC). Benzene was also reported in excess of the HSL for vapour intrusion (2-<4 m bgl) at the Light Vehicle Refuelling area (AEC LC). Although the HSLs are not specifically referenced in NSW DECC (2009), notification to the NSW EPA is recommended for this area regardless, due to the concentrations of benzene in groundwater in relation to the notification triggers; however it would be prudent to undertake an additional round of confirmatory groundwater sampling at the relevant locations to confirm the reported concentrations prior to preparing the notification.

Benzene and Naphthalene in Groundwater - AEC LE

Benzene and naphthalene were detected in groundwater at concentrations exceeding the human health (drinking water) screening value and/or the ecological screening value in samples collected from the Fuel Oil Installation (AEC LE). Based on the magnitude of these exceedences in relation to the notification triggers, notification of groundwater contamination in the Fuel Oil Installation to the NSW EPA is recommended; however it would be prudent to undertake an additional round of confirmatory groundwater sampling at the relevant locations to confirm the reported concentrations prior to preparing the notification.

Benzene, naphthalene and PCE in groundwater - AEC LO

Benzene and naphthalene were detected in groundwater at concentrations exceeding the human health (drinking water) screening value and/or the ecological screening value and PCE was detected at a concentration exceeding the human health (drinking water) screening value in samples collected from the former and current maintenance stores, workshops, foam generator and unofficial lay-down areas (AEC LO). Based on the magnitude of these exceedences in relation to the notification triggers, notification of groundwater contamination in the Fuel Oil Installation to the NSW EPA is recommended; however it would be prudent to undertake an additional round of confirmatory groundwater sampling at the relevant locations to confirm the reported concentrations prior to preparing the notification.

Benzene in groundwater – AEC LT

Benzene was detected in groundwater at a concentration marginally exceeding the human health (drinking water) screening value in one sample collected from the Water Intake and Pump Station (AEC LT). Given that the detection within AEC LT was at a concentration near the laboratory LOR and marginally exceeding the screening value, it is suggested that an additional round of confirmatory sampling be undertaken to confirm this result and to assess the likelihood that the detected concentration will foreseeably remain above the human health (drinking water) screening value.

It is, however, considered unlikely that these impacts would be considered significant enough to warrant regulation by the NSW EPA given the absence of groundwater use on-site, it's saline nature and the proximity of the results to the screening value. A determination should be made following the completion of confirmatory sampling.

Metals in Groundwater

Various metals were detected at concentrations above the human health (drinking water) and / or ecological screening values which were not attributable to background conditions in groundwater at a number of locations across the Site. In the majority of instances, results from monitoring wells BY_MY24, BY_MW25 and BY_MW26 (located near the north eastern boundary of the Bayswater site on the north eastern side of Lake Liddell) were utilised in establishing background conditions in the absence of suitable locations on the Liddell site. It is noted that low pH was observed in groundwater at BY_MW24 which may have resulted in elevated concentrations of metals at this location and hence data from this well was utilised with caution when assessing results. In addition to the background monitoring wells, background values based on data presented in the *Hydrogeochemistry of the Upper Hunter River Valley* groundwater report (Kellett *et al*, 1987) have also been considered.

A summary of metals exceeding screening values with regard to the duty to report is provided in *Table 5.24* (over).

Table 5.24 Groundwater Screening in Relation to a Potential Duty to Report

Metal	Exceedences of Human Health (Drinking Water) or Ecological Screening Value	Relevant AECs
Arsenic	Yes, drinking water value exceeded. All except those in AECs LQ and LR were well within the same order of magnitude as background locations. The more significant exceedences in AECs LE, LQ and LR in particular may warrant reporting.	LE, LG, LI, LL, LO, LP, LQ, LR and LS.
Boron	Yes, ecological value exceeded and average background concentration reported in Kellett et al (1987) (0.17 mg/L) were both exceeded in some locations. It should be noted that the majority of the noted exceedences are in the vicinity of the Ash Dam which is regulated under the Site EPL. The remainder of the exceedences are related to wells which are likely to be representative of water within Lake Liddell where exceedences for boron were also noted (refer to *Project Symphony – Bayswater Power Station, Stage 2 Environmental Site Assessment (ERM, 2014)*).	LB, LI, LP and LT.
Cadmium	Yes, both ecological and drinking water were exceeded however background concentrations of 0.002 - 0.003 mg/L were recorded in Bayswater wells BY_MW25 and BY_MW24 respectively. The majority of exceedences were within this range and well within the same order of magnitude with the exception of wells within AECs LA, LE, LO and LS which may warrant reporting.	LA, LB, LD, LE, LH, LI, LJ, LL, LM, LN, LO, LP, LQ, LR, LS, LT and LV
Copper	Yes, ecological value exceeded however background concentrations of 0.0131 - 0.0601 mg/L were identified in Bayswater wells BY_MW26 and BY_MW24 (respectively) all of the observed results are within this range with the maximum concentration recorded being 0.028 mg/L in LS_MW02. Reporting of these exceedences is therefore not considered to be warranted.	LA, LB, LC, LD, LE, LG, LH, LI, LJ, LL, LM, LN, LO, LP, LQ, LR, LS, LU and LV
Lead	Yes, both ecological and drinking water values were exceeded however background concentrations of 0.0375 - 0.04 mg/L were identified in Bayswater wells BY_MW26 and BY_MW24 (respectively) several results exceed these values and hence may warrant reporting.	LB, LE, LG, LI, LJ, LM, LO, LP, LQ and LV.
Manganese	Yes, ecological value exceeded, and average background concentrations (1.13 mg/L) from literature are lower than the ecological screening value, hence the noted exceedences may warrant reporting.	LA, LB, LE, LI, LP and LT.
Mercury	Yes, two exceedences of the ecological value were identified within AECs LB and LC. Both results are close to the LOR, therefore suggest confirmatory samples to confirm result and assess the likelihood that the detected concentrations will foreseeably remain above the ecological screening value.	LB and LC.
Nickel	Yes, both ecological and drinking water values were exceeded however background concentration of 0.195 mg/L was identified in Bayswater well BY_MW25, several results exceed this value and hence may warrant reporting.	LA, LB, LC, LD, LE, LH, LI, LJ, LL, LM, LN, LO, LP, LQ, LR, LS, LT, LU and LV
Selenium	Yes, both ecological and drinking water values exceeded, it appears that background concentrations are lower than the screening values, hence the noted exceedences may warrant reporting (particularly within AEC LB). It should be noted that the highest concentration observed was immediately adjacent to the Ash Dam which is regulated under the Site EPL.	LB, LE, LP and LM.
Zinc	Yes, both ecological and drinking water values were exceeded however background concentrations of 0.142 mg/L were identified in Bayswater well BY_MW25 (which aligns closely with the literature background value of 0.15 mg/L). Several results exceed this value and hence may warrant reporting.	LA, LB, LC, LD, LE, LG, LH, LI, LJ, LL, LM, LN, LO, LP, LQ, LR, LS, LT, LU and LV

Whilst many of the metals exceedences can be related to background concentrations, some elevated concentrations which appear to be related to on-site sources have been identified. In many instances however, these impacts are related to activities which are already regulated and monitored under the Site EPL. The identified impacts are also generally located well within the site boundaries and up gradient of Lake Liddell, the discharge from which is also monitored and regulated under the Site EPL.

In ERM's professional experience it is NSW EPA's preference to regulate issues such as these under either the POEO Act or the CLM Act rather than both, and, in the case of licensed premises, it is usually the POEO Act which is preferred. ERM therefore considers that NSW EPA would most likely continue to manage this issue under the POEO Act via the Site EPL, and hence would not require formal notification under the CLM Act, however this approach should be confirmed with NSW EPA to ensure strict adherence to the NSW DECC (2009) guidelines. Given the similarities of issues with metals in groundwater and surface water at Bayswater Power Station, the discussion of this issue with NSW EPA is recommended to be undertaken at the same time for both sites.

In some cases where groundwater results appear anomalous and / or are close to the laboratory LOR / screening values an additional round of confirmatory sampling has been recommended to confirm result and assess the likelihood that the detected concentrations will foreseeably remain above the ecological screening value. If the results remain above the screening values then notification may then warrant further consideration.

5.5.4 *Summary – Is Material Remediation or Management Likely to be Required?*

Based on the results of this assessment, the issues where potentially material remediation or management on a per source basis is likely to be required relate to the identified asbestos impacts in soils surrounding the asbestos pipelines located within AEC LB and water management issues related to Liddell Ash Dam. Both of these issues are known to Macquarie Generation. Independently of this assessment, Macquarie Generation has been developing management approaches alongside independent professional experts and regulators.

Whilst some further assessment may be required to address the hydrocarbon impacts in the bulk fuel storage areas (AECs LC and LE) and in the former and current maintenance stores, workshops, foam generator and unofficial lay-down areas (AEC LO), it is unlikely that costs related to this work would exceed the material threshold.

The remediation of the identified asbestos impacts surrounding the pipelines is an issue which Macquarie Generation is in the process of engaging a contractor to manage / remediate.

Given that this issue has been identified specifically within the Sale and Purchase Agreement for the Site as pre-existing contamination and that a separate process is underway to address the issue, ERM has not prepared an estimate of the costs associated with the management / remediation of this issue since the actual costs will soon be known.

The NSW EPA has required a Pollution Reduction Program report to be developed in relation to managing surface and groundwater issues in the vicinity of Liddell Ash Dam, with a reporting deadline of 31 January 2014. At the time of reporting, the response to the Pollution Reduction Program was not yet available for review; however it is expected that this report will focus on reducing seepage rather than completing remediation. Whilst indicative costs to address this requirement at Liddell Ash Dam were not available for review at the time of reporting, it is expected that costs could potentially be material. It is understood that indicative cost estimates for completion of this work will be included in the Pollution Reduction Program report. .

Whilst some other issues have been identified which may warrant further assessment (as summarised in Section *5.5.5* below) it is not anticipated that any of these additional assessment works would be likely to constitute a potential material issue. Similarly it is not considered likely that any of these issues would proceed beyond the stages of quantitative risk assessment and / or the preparation and implementation of an appropriate environmental management plan to manage potential exposure, none of which are considered likely to constitute a material cost.

5.5.5 Summary - Is the Data Suitable to Provide a Baseline of Environmental Conditions at the Site and Immediate Surrounding Receiving Environments

The data presented in the ESA was considered to generally be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site as at or near the time of the transaction. It is noted that the majority of the locations proposed in the Preliminary ESA were able to be advanced.

Some limited additional characterisation of the baseline conditions at the Site is however considered to be required in the following areas, on the basis of the outcomes of this investigation;

Soils

- Asbestos - delineation of asbestos contamination in the vicinity of the asbestos containing pipelines within AEC LB. It is recommended that this delineation be carried out in accordance with the methodology outlined in the ASC NEPM (2013) and should include more detailed inspections of these areas and the collection of soil samples for quantitative analysis.

Groundwater

- Further assessment of groundwater impacts from petroleum hydrocarbons in AECs LC (Bulk Fuel Storage - Light Vehicle Refuelling), LE (Bulk Fuel Storage - Fuel Oil Installation) and LO (Former and current maintenance stores, workshops, foam generator and unofficial lay-down areas) is recommended to clarify the potential for these contaminants to migrate to Lake Liddell. This could include fate and transport modelling and detailed risk assessment.

- Additional characterisation at AEC LC is also recommended to assess the potential for vapour intrusion in relation to the Main Stores building. This work could include re-sampling of groundwater wells in the vicinity of this area, installation and sampling of soil vapour wells and/or sub-slab vapour points, and collection of indoor air samples from within the Main Stores building.

- Additional sampling of existing groundwater wells is recommended within AEC LT (Water Intake and Pump Station) to confirm the measured concentrations of benzene with specific reference to clarification of the duty to report contamination under Section 60 of the CLM Act.

- Confirmatory groundwater sampling of existing wells and ultra-trace laboratory analysis is also recommended within AEC LO (former and current maintenance stores, workshops, foam generator and unofficial lay-down areas) to assess whether vinyl chloride is present due to the detection of PCE and other breakdown products.

6 *CONCLUSIONS*

ERM completed a Stage 2 ESA at Liddell Power Station in order to develop a baseline assessment of environmental conditions at the Site as at or near the time of the transaction. Soil and groundwater data were compared against published environmental quality levels to provide a screening level assessment of potential risks to identified human and environmental receptors. The following conclusions were made based on the data collected during the investigation:

- *The key impacts identified at the Site include* asbestos present beneath the ACM pipelines to the Liddell Ash Dam, potential risks associated with inhalation of petroleum hydrocarbon vapours near the light vehicle refuelling area, potential migration of petroleum hydrocarbons from the bulk fuel storage areas towards Lake Liddell.

- No contamination issues were identified which would require material management or remediation based on the current and continued use of the Site as a Power Station with the exception of the potential material issues associated with identified asbestos impacts in soils surrounding the ACM pipelines to Liddell Ash Dam and water management issues related to Liddell Ash Dam that are the subject of a Pollution Reduction Program report currently being prepared. Whilst some further assessment may be required to address the hydrocarbon impacts in the bulk fuel storage areas and in the former and current maintenance stores, workshops, foam generator and unofficial lay-down areas, it is unlikely that costs related to this work would exceed the material threshold.

- With regard to the duty to report contamination under the CLM Act (1997) and the potential for regulation, ERM notes the following:

- The reporting of the concentrations of benzene, naphthalene and PCE measured in on-site groundwater to the NSW EPA is warranted on the basis of exceedences of the notification triggers (based on NHMRC (2011) drinking water screening values) in order to maintain compliance with the CLM Act 1997. It would however be prudent to undertake an additional round of confirmatory groundwater sampling at the relevant locations to confirm the reported concentrations prior to preparing the notification. The concentrations of these contaminants are, however, considered unlikely in ERM's opinion to trigger a requirement for active management or remediation. It is considered most likely that regulation of these issues by NSW EPA would (if necessary) be undertaken under the existing EPL rather than under the CLM Act.

- ERM understands that Macquarie Generation is in the process of developing a management strategy in relation to the identified asbestos issues in the vicinity of the ACM pipelines. Further, ERM understands that access to these areas has been restricted to mitigate potential risks to human health in the short term and that further delineation and quantification of asbestos in soils in this area is being undertaken. It is recommended that the outcomes of this further assessment are reviewed prior to a decision relating to notification of NSW EPA under Sec. 60 of the CLM Act 1997. It is also noted that Macquarie Generation has discussed the broader asbestos pipeline issue (given that it relates predominantly to infrastructure and the soil impacts are secondary) with WorkCover NSW. It is therefore considered that they would likely be the key regulator, if required, for this issue rather than NSW EPA.

- Various metals were detected at concentrations above the human health (drinking water) and / or ecological screening values which were not attributable to background conditions in groundwater at a number of locations across the Site. In many instances however, these impacts are related to activities which are already regulated and monitored under the Site EPL. The identified impacts are also generally located well within the site boundaries and up gradient of Lake Liddell, the discharge from which is also monitored and regulated under the Site EPL. ERM considers that NSW EPA would most likely continue to manage this issue under the POEO Act via the Site EPL, and hence the issue would not require formal notification under the CLM Act, however this approach should be confirmed with NSW EPA to ensure strict adherence to the NSW DECC (2009) guidelines.

- The preparation and implementation of a suitable Environmental Management Plan (EMP) by an appropriately qualified professional is recommended to mitigate the risk of exposure to asbestos associated with areas in close proximity to the ACM pipelines to the ash dam and relating to the potential for asbestos to occur in soils across the site as a whole.

- The data presented in the ESA was generally considered to be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site and immediate surrounding receiving environments. On the basis of the outcomes of this investigation, some limited additional characterisation of the baseline conditions at the Site is considered to be required as follows;

- Delineation of asbestos contamination in the vicinity of the ACM pipelines to the ash dam. Macquarie Generation is aware of the ACM issue at the pipelines and is currently further investigation and risk assessment (refer to Macquarie Generation (2013) *Ash & Dust - Position Paper* (Ref: 06.03.03.38 ENV.03.03.048)). It is recommended that this delineation be carried out in accordance with the methodology outlined in the ASC NEPM (2013) and should include more detailed inspections of these areas and the collection of soil samples for quantitative analysis.

- Further assessment of groundwater impacts from petroleum hydrocarbons in bulk fuel storage areas is recommended to clarify the potential for these contaminants to migrate to Lake Liddell. This could include fate and transport modelling and detailed risk assessment.

- Additional characterisation at the light vehicle refuelling area is also recommended to assess the potential for vapour intrusion in relation to the Main Stores building. This work could include re-sampling of groundwater wells in the vicinity of this area, installation and sampling of soil vapour wells and/or sub-slab vapour points, and collection of indoor air samples from within the Main Stores building.

- Confirmatory groundwater sampling is recommended at the water intake and pump station to confirm the measured concentrations of benzene with specific reference to clarification of the duty to report contamination under Section 60 of the CLM Act 1997.

- Confirmatory groundwater sampling and ultra-trace laboratory analysis is also recommended at the former and current maintenance stores, workshops, foam generator and unofficial lay-down areas to assess whether vinyl chloride is present due to detection of PCE and other breakdown products.

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DOCUMENT 3c

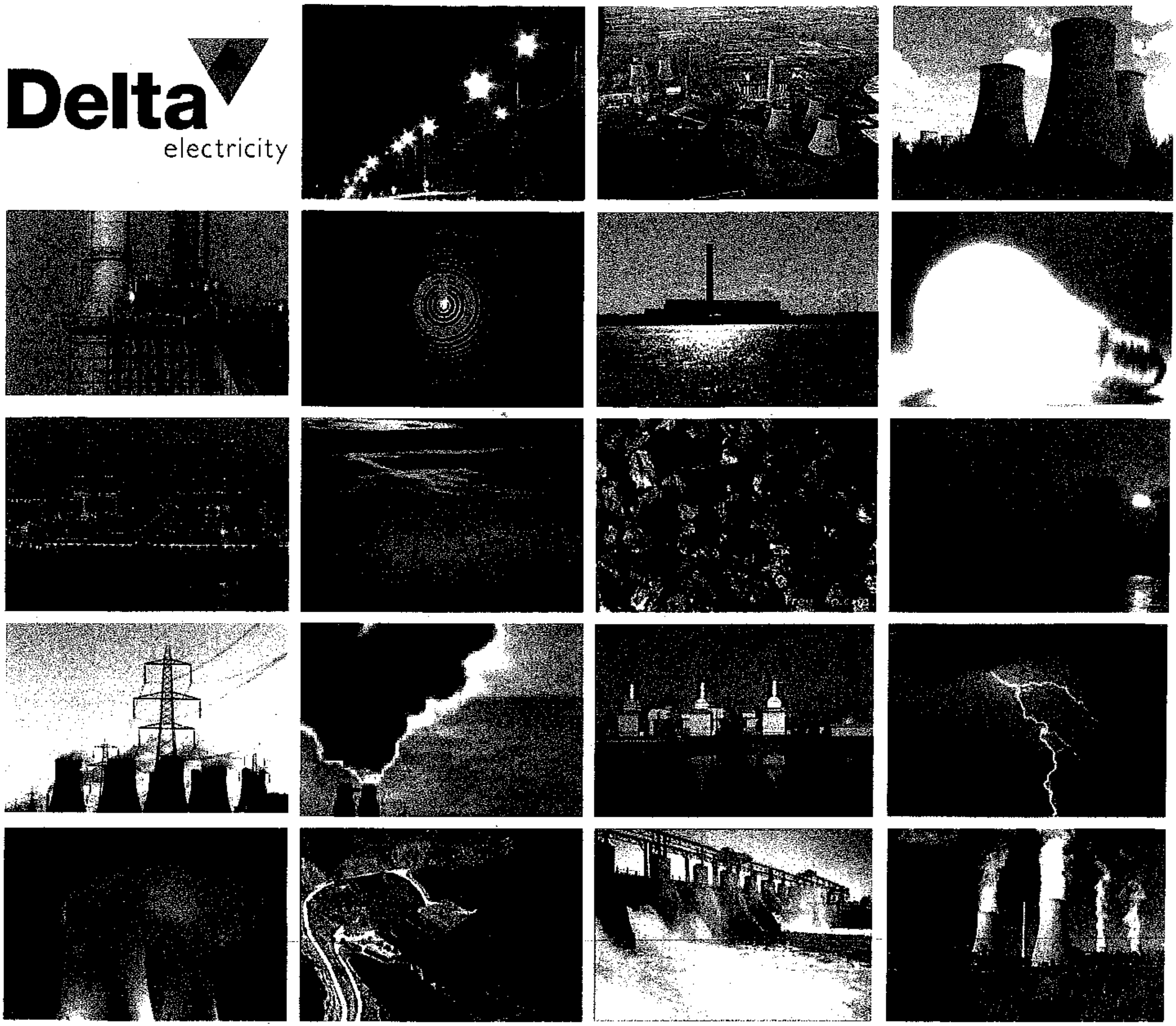
Liddell Power Station

Updated Groundwater Quality Assessment – Part 1

Environmental Resources Management

5 June 2015

Delta electricity



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Delta Electricity

Project Symphony – Vales Point Power Station

Updated Groundwater Quality Assessment

Final

Ref: 0300379

5 June 2015

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Project Symphony - Vales Point Power Station

Updated Groundwater Quality Assessment

Approved by:	John Ewing
Position:	*Project Manager*
Signed:	
Date:	5 June 2015
Approved by:	Peter Lavelle
Position:	*Partner*
Signed:	
Date:	5 June 2015

Environmental Resources Management Australia Pty Ltd Quality System

Delta Electricity - Project Symphony

5 June 2015

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CONTENTS

1 INTRODUCTION

Environmental Resources Management Australia Pty Ltd (ERM) was engaged by Delta Electricity (Delta) to undertake a review of the currency and validity of Environmental Due Diligence reports previously prepared by ERM in relation to the Vales Point Power Station (the Site). ERM understands that these additional works are required to be undertaken to support the potential sale of the Site.

The following reports were previously prepared by ERM in 2014 in relation to the Site and have been considered as part of this review:

- ERM, (5 February 2014), *Vales Point, Preliminary Environmental Site Assessment*
- ERM, (July 2014), *Vales Point Stage 2 Environmental Site Assessment*
- ERM, (September 2014), *A Station Environmental Site Assessment - Vales Pt*

Delta required ERM to undertake a review and confirm any changes to the findings of these reports given the passage of time between the date of the reports and now. In addition, an updated assessment of current groundwater conditions at the Site is required in order to provide an updated baseline assessment of groundwater conditions as at or near the time of the potential transaction.

2 SCOPE OF WORKS

In order to complete an assessment of the validity of the existing reports ERM completed the following scope of works:

Site Visit

ERM completed a one day site visit on Tuesday 12 May 2015 and met with key site personnel to gain an understanding of changes to the environmental conditions, regulatory requirements and / or management regime at the Site. This was undertaken in order to identify any material changes which may have occurred since completion of the previous reports.

Review of Additional Reports

ERM understood that additional reports had been prepared in relation to various contamination issues at the Site (refer to *Section 3.2*). Allowance was therefore made to undertake a review of these reports and summarise the key findings.

Preparation of Assessment of Validity

Upon completion of the above tasks, ERM prepared this report summarising the findings in the context of the previous ERM assessments and concluding with a statement as to the validity of the previous reports. This report also includes a summary of identified changes to the groundwater conditions (see *Section 4*).

3 RESULTS OF THE REVIEW

3.1 SUMMARY OF SITE VISIT

On 12 May 2015 ERM staff visited the Site and met with Randall Jitts (Acting Manager - Sustainability) and Kerrie Davis (Senior Environment Officer). The objectives of the assessment were discussed and a range of information from the period February 2014 to May 2015 was requested from Delta including:

- a copy of the most recent Annual Return for the site Environment Protection Licence (EPL) (No. 761);
- copies of any correspondence with the NSW EPA;
- copies of any environmental management plans;
- copies of any internal environmental reports or incident reporting; and
- copies of any recently completed environmental assessment or monitoring reports.

The Delta personnel involved were highly cooperative and forthcoming with all information requested. Much of the information requested was provided on the same day and the remainder was forwarded via email over coming days.

3.2 REVIEW OF INFORMATION PROVIDED

The information obtained indicated the following with regard to the period between preparation of the ERM PESA (5 Feb 2014) and May 2015:

3.2.1 *Incidents, Regulatory Compliance and Correspondence*

There were no reported significant environmental incidents (i.e. those likely to result in a potentially material issue) .The incident register provided to ERM for review is included as *Annex F*.

No breaches of the Site EPL were reported in the most recent annual return (to end June 14). Similarly, no non-conformances were noted within the monthly internal compliance summaries which have been prepared since then (note that monthly reporting summaries reviewed included the period July 2014 to end March 2015).

Correspondence with NSW EPA centred around the resolution of potential Duty to Report issues under *Section 60* of the *CLM Act 1997* following these being raised in ERM (July 2014). The outcome of this correspondence was that NSW EPA indicated via email correspondence that it has accepted Delta's decision not to formally notify the Site under *Section 60* of the *CLM Act 1997*. Copies of the correspondence reviewed are included in *Annex G*.

3.2.2 *Additional Environmental Reports Reviewed*

DLA Environmental 2014 and 2015

Two groundwater monitoring reports prepared by DLA Environmental (DLA) 'Groundwater Monitoring Report DLH1099_H00297' dated December 2014 'Groundwater Monitoring Report DLH1099_H00366' dated February 2015 were provided to ERM for review. Sampling locations monitored by DLA included 10 monitoring wells installed in the vicinity of the site's Underground Petroleum Storage Systems (UPSS) (referred to by ERM as VH_X_MW01 - VH_X_MW10) and one ERM installed monitoring well associated with the decommissioned asbestos landfill in the ash dam area (VP_MW01).

DLA's investigations were focused on potential hydrocarbon impacts associated with the UPSS and concluded that two monitoring wells (VH_X_MW08 and VH_X_MW06) reported measured concentrations of Total Recoverable Hydrocarbons (TRH) and/or BTEX compounds (benzene, toluene, ethylbenzene and xylenes) exceeding DLA's adopted screening criteria in both 2014 and 2015. DLA also reported that the sample collected from VP_MW01 (adjacent to the asbestos landfill) reported a concentration of benzene greater than the adopted drinking water guidelines in 2014 but the same location reported a concentration below the laboratory limit of detection during the 2015 monitoring round. DLA considered that benzene was therefore no longer an issue at this location.

ERM notes that there is no evidence of DLA having analysed trip blank or trip spike samples to assess potential for cross contamination and loss of volatiles (respectively). It is further noted that DLA collected groundwater samples using manual bailing (which may result in excessive loss of volatile analytes due to agitation of the water column). ERM would therefore, on the basis of these omissions of standard quality control measures, question DLA's conclusion that benzene is no longer a contaminant of potential concern (COPC) for VP_MW01. Taking these points into consideration ERM proposed to further assess groundwater in these areas for the relevant CoPCs during the updated groundwater quality assessment in May 2015 (described below).

Worley Parsons (2015)

ERM also reviewed the provided a copy of Worley Parsons (22 May 2015) *Independent Engineer's Report Vales Point Power Station Addendum*. No notable environmental issues were raised which would impact the conclusions of ERM's previous reports. A significant increase in atmospheric fluoride emissions was noted by Worley Parsons in the review although these emissions are not considered to significantly impact upon the outcomes of any of the reports previously prepared by ERM.

Worley Parsons (2015)

ERM was provided with a copy of Umwelt (February 2015) *Vales Point Power Station Ash Dam Groundwater Stage 2 Investigation Report* for review. This report collated and reviewed groundwater monitoring data from key wells located in the vicinity of the Vales Point Ash Dam in order to meet the requirements of Condition U1 of the Vales Point Power Station Environment Protection Licence (EPL No. 761). Umwelt concluded from their review that available data suggested that there was no notable evidence of the Ash Dam water "*unacceptably leaching trace elements to groundwater*". Umwelt did however note that 12 months of data were not available for all the bores and therefore recommended "*that in order to complete an analysis of at least a full 12 months of data for all groundwater baseline bores, the monthly groundwater monitoring program be extended to August 2015, and a supplementary report analysing the full data set be prepared to confirm the conclusions above.*" It is noted that the data collated by Umwelt generally report total rather than dissolved metals concentrations and utilised alternate sampling methods and thus is not directly comparable with data gathered as part of ERM's assessment.

Douglas Partners (in preparation)

It is noted that Douglas Partners has recently been engaged by Delta Electricity to review all groundwater monitoring reports conducted on the 10 UPSS wells sampled by DLA (as described above) and VP_MW01. Their field works were scheduled for completion during May 2015 and the groundwater monitoring report is still in preparation. Douglas Partners proposed to analyse for TRH, BTEX, PAHs and lead at all locations. Along with the monitoring works described, Douglas Partners has proposed to provide "*recommendations to Delta Electricity regarding the duty to report contamination under UPSS Regulation and Contaminated Land Management Act and recommendations for additional work, if required (e.g. remediation etc).*"

4 *ADDITIONAL GROUNDWATER MONITORING RESULTS*

4.1 *SAMPLING LOCATIONS AND METHODOLOGY*

Based on data obtained during the previous Stage 2 ESA (ERM, July 2014) the proposed sampling works were targeted at monitoring wells that fulfil one or more of the following criteria:

- Concentrations of Contaminants of Potential Concern (CoPC) were detected at concentrations that exceeded the adopted screening levels;
- Concentrations of CoPCs were greater than the maximum background concentrations by a factor of two or more;
- Monitoring wells that provide spatial coverage of the Site, including locations adjacent to site boundaries and sensitive receptors.

The scope of works included 39 monitoring wells located in 14 out of the 21 previously identified Areas of Environmental Concern (AECs) with the addition of one existing background/boundary monitoring wells (VPMG/D10). An additional background monitoring well (VPMG/D8) was scoped to be sampled however it was inaccessible at the time of the fieldwork. Site locality and site boundaries are detailed in *Figures 1 and 2* in *Annex A*. Locations of the groundwater monitoring wells in their respective AECs are presented in *Figures 5 to 6.6* in *Annex A*. A tabular summary of the additional sampling and analysis to be undertaken is presented in *Table 1* of *Annex B*.

Groundwater purging and sampling protocol was undertaken in accordance with the Data Quality Objectives and procedures as set out in *Section 4.4.2* of *"Project Symphony - Vales Point Power Station Stage 2 Environmental Site Assessment"* (ERM, July 2014). The only exception to well specific methodology was the use of a micro-purge pump in select monitoring wells where a peristaltic pump was employed in the past. The standing water level in these wells was slightly deeper than elsewhere and micro-purge was considered a more efficient low flow pump when the depth to water was greater than 8.0 m. The sampling method employed at each location is listed in *Table 3* of *Annex B*.

4.2 *RESULTS AND DISCUSSION*

4.2.1 *Overview*

Groundwater gauging and sampling was completed between 18h - 20 May 2015. Groundwater gauging data is presented in *Table 2* of *Annex B*. Field documentation for groundwater sampling, including equipment calibration sheets are presented in *Annex C*. Groundwater field parameters recorded during purging of the wells prior to sampling are presented in *Table 3* of *Annex B*.

Given the limited number of wells gauged during the 2015 monitoring event, it was considered that there was insufficient data to produce a representative groundwater contour figure. It is also noted that high rainfall in recent months is likely to have caused some variation in the groundwater regime.

Groundwater analytical results are presented in *Tables 4a to 4e* of *Annex B* and are compared to the relevant screening values as adopted during the Stage 2 ESA (ERM, July 2014). The rationale regarding selection of screening criteria is described in detail in *Section 4.10* of the Stage 2 ESA (ERM, July 2014).

Measured concentrations of the majority of the CoPCs were generally consistent with the previous results from the Stage 2 ESA (ERM, July 2014). The exceptions to these are discussed below.

4.2.2 *PFOS and PFOA*

Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA) (chemical's associated with firefighting foams) were detected in groundwater around the boundary of the former A Station Demolition Area in the Stage 2 ESA (ERM, July 2014). Four wells in which PFOS/PFOA was detected in 2014 were sampled in the May 2015 sampling event. Analytical results of these samples are displayed in *Table 4c* of *Annex B*. Measured concentrations of PFOS and PFOA were detected in all 4 groundwater samples collected. The concentrations of PFOA were below the adopted screening value for all four samples during both monitoring events. The concentrations of PFOS in groundwater at VB_MW01 and VB_MW02 exceeded the adopted human health screening value while the concentrations at VI_MW01 and VL_MW02 remained largely consistent and below the adopted human health screening value. Measured concentrations of PFOS at VB_MW02 have exceeded the adopted screening value in both monitoring events with the concentration remaining largely consistent. Whilst PFOS was detected at VB_MW01 during the 2014 Stage 2 ESA, the measured concentration was below the human health (drinking water) screening value. The measured concentration at this location has now increased by a factor of 2 to marginally exceed the screening value. However, on the basis that groundwater is not extracted for potable use within the vicinity of the operational area of the Site, these variations to the magnitude of the identified PFOS impact are not considered to represent a significant risk to human health.

4.2.3 *TRH And BTEX Compounds*

During the 2014 Stage 2 ESA, some of the key impacts identified included benzene in groundwater in the Vehicle Refuelling Area and down gradient of the Asbestos Landfill. All wells in which TRH and BTEX detections were identified were sampled in the May 2015 event along with several boundary wells. Results of all samples analysed for TRH, BTEX and VOC's are displayed in *Table 4e.* of *Annex B*.

TRH was detected in groundwater samples collected from several wells in the 2015 sampling event, which were generally consistent with the results from the 2014 Stage 2 ESA .There were no wells with new detections in 2015 and in general TRH concentrations have decreased since the 2014 Stage 2 ESA. TRH concentrations in groundwater from the wells sampled did not exceed the adopted screening values in any well across the power station site during any of the 2014 or 2015 sampling events.

The measured concentrations of benzene in groundwater samples collected from two locations in the vehicle refuelling area exceeded the adopted screening values for drinking water (VH_X_MW06) and recreational use of water (VH_X_MW08) in both the 2014 Stage 2 ESA and 2015 monitoring events. However, the measured concentration of benzene in groundwater at both locations was lower in the 2015 monitoring event. Benzene at concentrations exceeding the adopted drinking water screening values was detected in groundwater in the vicinity of the Asbestos landfill area (VP_MW01) during the 2015 monitoring event, consistent with the 2014 Stage 2 ESA (April, 2014) a subsequent groundwater monitoring event (May 2014). However, it was noted the measured concentration of benzene in groundwater in 2015 had reduced to equal the adopted drinking water screening values. It is noted that this provides an update to the DLA report dated February 2015 which indicated that benzene in groundwater at this location was below the limit of reporting. It is further noted that Douglas Partners have proposed to sample this well as part of their May 2015 works.

It should be noted that xylene was detected marginally above the LOR but below the adopted screening values in VK_MW02. Xylene had not previously been reported in groundwater at this location however the measured concentrations were 2 orders of magnitude lower than the adopted drinking water screening values. It is therefore considered that this detection does not indicate a risk to human health.

Metals

During the Stage 2 ESA (ERM, July 2014), various metals were identified in groundwater at concentrations in excess of the adopted screening values across the Site. Where metals were identified above background concentrations, impact generally appeared to be localised in distinct areas of the Site. The distinct areas identified in ERM (July 2014) included the Ash Dam and Coal Storage Area, where the creation of localised Acid Sulfate Soil (ASS) conditions through historical activities (an issue discussed in greater detail in that) may have contributed to the observed metal impacts in groundwater. ERM (July 2014) also indicated that localised acidic groundwater conditions in the vicinity of the Vehicle Refuelling Area also appear to have contributed to the presence of elevated metal concentrations in groundwater in that part of the Site.

A comparison of the metals concentrations in groundwater in the targeted wells for both the 2014 Stage 2 ESA and the 2015 monitoring event is presented in *Table 4a* of *Annex B*. Metals concentrations in groundwater have remained largely consistent between the two sampling events with the following exceptions:

- Measured concentrations of Arsenic at VH_X_MW01 were lower in 2015, and no longer exceed the adopted drinking water screening values.
- Measured concentrations of Arsenic across the VO AEC have reduced, and no longer exceed the adopted recreational screening values however several wells remain above the adopted drinking water screening values. This may be related to high rainfall in recent months causing a level of dilution.
- The measured concentration of Manganese at VO_X_MW03 has increased by 20%, and now exceeds the adopted recreational screening value. The measured concentration of Manganese at VH_X_MW03 has increased and now exceeds the adopted drinking water screening values. This was not the case in 2014. Measured concentrations of Manganese at VJ_MW09 have decreased and no longer exceed any of the adopted screening values.
- Measured concentrations of Nickel at VJ_MW09, VO_MW05 and VO_MW09 have decreased and no longer exceed the adopted drinking water screening values.
- Measured concentrations of Selenium at VH_X_MW03, VH_X_MW04, VH_X_MW08 and VO_MW18 have decreased and no longer exceed the adopted drinking water screening values. Decreases in Selenium concentrations have been noted throughout the VO AEC with monitoring wells VO_MW04, VO_MW05 and VO_MW06 no longer exceeding the adopted recreational use of water screening values, although they do remain greater than the adopted drinking water screening values.
- With the exception of Manganese (as mentioned above) the measured concentrations of metals have not increased between the 2014 Stage 2 ESA and the 2015 Groundwater Sample Event.

4.3 *QUALITY OF FIELD AND ANALYTICAL DATA GATHERED*

A detailed QA/QC report including field procedures, laboratory methods and an analysis of QA/QC results from the investigation is provided in *Annex D*. QA/QC information incorporating inter-laboratory and intra-laboratory duplicates, rinsate samples and trip spike/blank samples are also tabulated in *Annex D*.

In summary, the QA/QC data reported for soil and groundwater samples and field duplicate results were generally free of systematic and method biases and were assessed to be of sufficient quality for the purposes of this investigation.

5 ASSESSMENT OF VALIDITY AND CURRENCY

Overall the conclusions of ERM's previous Environmental Site Assessment reports in relation to the Vales Point Power Station (as listed in Section 1) remain valid and largely current. The works undertaken as part of this review have indicated the following key updates:

- No significant environmental incidents (i.e. those likely to result in a potentially material issue) have been reported (The incident register provided to ERM for review is included as *Annex F*);

- No breaches of the Site EPL were reported in the most recent annual return (to end June 14). Similarly, no non-conformances were noted within the monthly internal compliance summaries which have been prepared since then (July 2014 to end March 2015);

- Delta has engaged in correspondence with NSW EPA in relation to the Duty to Report under Section 60 of the CLM Act, with the outcome of this correspondence being that NSW EPA indicated (via email) that it has accepted Delta's decision not to formally notify the Site under Section 60 of the CLM Act. This provides a level of closure on a key component of ERM's previous conclusions in relation to the potential for a Duty to Report to exist.

- Delta has engaged consultants (DLA Environmental) to continue monitoring groundwater in the vicinity of the site's UPSS in order to meet their regulatory obligations. The results of these works have indicated an ongoing issue in relation to hydrocarbon and BTEX impacts, particularly in two monitoring locations. In response to the confirmation of these impacts (which were identified by ERM in July 2014) Delta has engaged Douglas Partners to further assess the issue and provide *"recommendations for additional work, if required (e.g. remediation etc)."* It is noted that this report has not yet been finalised, however it is clear that Delta is actively managing the issue which has been identified.

- The updated groundwater monitoring assessment indicated that whilst there have been a number of minor fluctuations in concentrations of various CoPC's, the results have not revealed any indications of significant new impacts.

6 *CONCLUDING STATEMENT*

Whilst some minor changes to conditions on the site have occurred in the period between completion of the previous assessments (February / September 2014) and the preparation of this review (May 2015) none of these significantly impact upon the key conclusions previously drawn by ERM.

With regards to the additional groundwater monitoring data gathered, this data is in no way intended to replace the data reported in ERM (July 2014) and ERM (September 2014). The additional data should be considered as additive to the baseline data set previously gathered by ERM as it provides a level of assessment of temporal variation at key locations and supports the above observation that no significant new impacts have occurred during the intervening period.