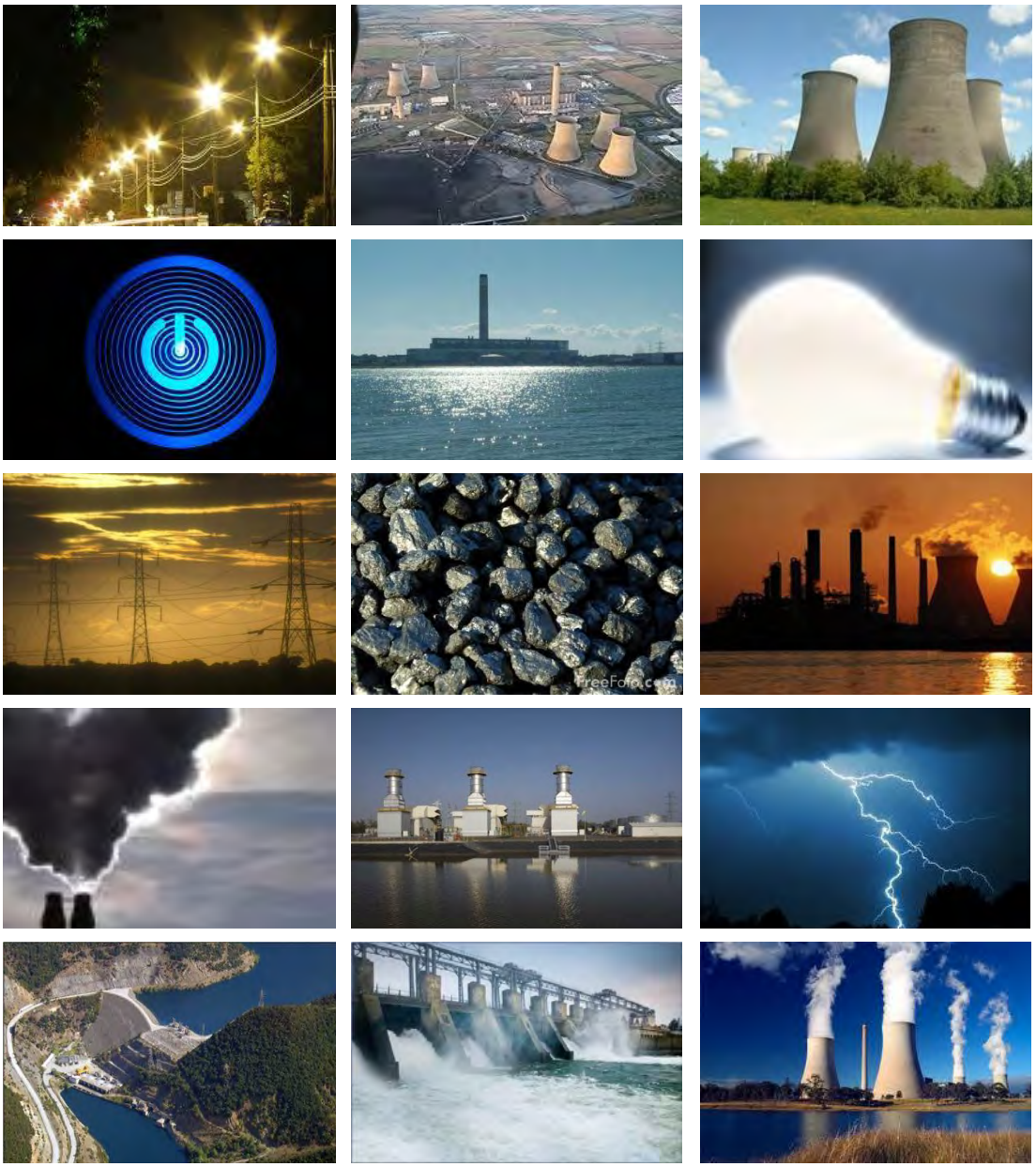
Macquarie Generation



COMMERCIAL IN CONFIDENCE

Macquarie Generation – Project Symphony

Liddell Power Station

Preliminary Environmental Site Assessment

Ref: 0213879RP02_DRAFT Rev02

October 2013

The world's leading sustainability consultancy

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Liddell Power Station

Preliminary Environmental Site Assessment

Macquarie Generation - Project Symphony

October 2013

Approved by:	Joseph Ferring
Position:	*Project Manager*
Signed:	*DRAFT*
Date:	18 October, 2013
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Date:	18 October, 2013

Environmental Resources Management Australia Pty Ltd Quality System

0213879RP02 DRAFT Rev02

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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

Australia and New Zealand Environmental and Conservation Council (ANZECC) (2000). *Australia and New Zealand Guidelines for Fresh and Marine Water Quality*

Bennett, John (Macquarie Generation) (2013). *Liddell Power Station, Review of Waste Material Locations.* First draft. Document reference: JMB 14 6 2013.

Chelace GIS (2013). *Proposed Liddell & Bayswater B Subdivision*. Figure dated 29 August 2013.

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

CRC CARE (2011). *Technical Report No. 10, Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater*

Department of Mineral Resources (1993). Hunter Coalfield Regional Geology, 1:100 000 Geology Map. Geological Series Sheet 9033 and part of 9133, 9032 and 9132. Second Edition.

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

NSW Department of Mineral Resources *Muswellbrook 1:25,000 Geological Sheet 9033-II-N*

NSW Department of Mineral Resources *Jerry Plains Geological Series Sheet 9033-11-S (Edition 1) 1987*

National Environment Protection Council (2013). *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)*

NHMRC and NRMMC (2011). *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy.*

NSW EPA (1994). *Guidelines for Assessing Service Station Sites*

NSW DEC (2006). *Guidelines for the NSW Site Auditor Scheme (2nd edition)*

NSW EPA (2008). *Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation*

NSWOEH (2011). *Guidelines for Consultants Reporting on Contaminated Sites.*

New South Wales Government *Natural Resource Atlas:* online database accessed 29 August 2013

Annex A

Figures

Legend

- Bayswater_Site_Boundary_260913
- Site Boundary

DRAFT

0 5 10km

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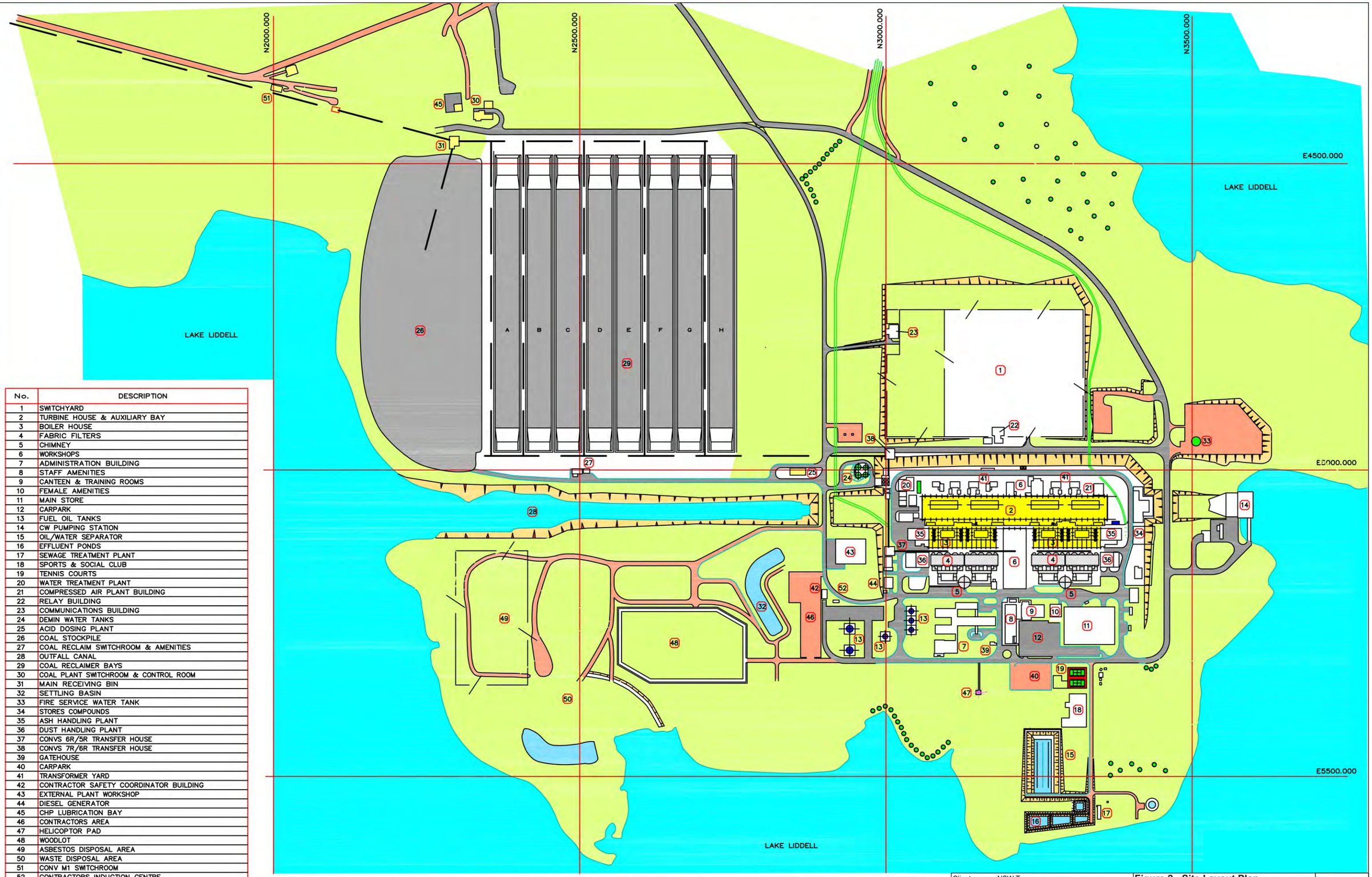
Client:	NSW Treasury		**Figure 1 - Site Locality**
Drawing No:	0213879s_L_PESA_G001_R1.mxd		
Date:	27/09/2013	Drawing Size: A4	Project Symphony - Liddell
Drawn By:	GC	Reviewed By: JF	Stage 1 - Preliminary Environmental Site Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM



No.	DESCRIPTION
1	SWITCHYARD
2	TURBINE HOUSE & AUXILIARY BAY
3	BOILER HOUSE
4	FABRIC FILTERS
5	CHIMNEY
6	WORKSHOPS
7	ADMINISTRATION BUILDING
8	STAFF AMENITIES
9	CANTEEN & TRAINING ROOMS
10	FEMALE AMENITIES
11	MAIN STORE
12	CARPARK
13	FUEL OIL TANKS
14	CW PUMPING STATION
15	OIL/WATER SEPARATOR
16	EFFLUENT PONDS
17	SEWAGE TREATMENT PLANT
18	SPORTS & SOCIAL CLUB
19	TENNIS COURTS
20	WATER TREATMENT PLANT
21	COMPRESSED AIR PLANT BUILDING
22	RELAY BUILDING
23	COMMUNICATIONS BUILDING
24	DEMIN WATER TANKS
25	ACID DOSING PLANT
26	COAL STOCKPILE
27	COAL RECLAIM SWITCHROOM & AMENITIES
28	OUTFALL CANAL
29	COAL RECLAIMER BAYS
30	COAL PLANT SWITCHROOM & CONTROL ROOM
31	MAIN RECEIVING BIN
32	SETTLING BASIN
33	FIRE SERVICE WATER TANK
34	STORES COMPOUNDS
35	ASH HANDLING PLANT
36	DUST HANDLING PLANT
37	CONVS 6R/5R TRANSFER HOUSE
38	CONVS 7R/6R TRANSFER HOUSE
39	GATEHOUSE
40	CARPARK
41	TRANSFORMER YARD
42	CONTRACTOR SAFETY COORDINATOR BUILDING
43	EXTERNAL PLANT WORKSHOP
44	DIESEL GENERATOR
45	CHP LUBRICATION BAY
46	CONTRACTORS AREA
47	HELICOPTOR PAD
48	WOODLOT
49	ASBESTOS DISPOSAL AREA
50	WASTE DISPOSAL AREA
51	CONV M1 SWITCHROOM
52	CONTRACTORS INDUCTION CENTRE

Source:
© 2013 Pacific Power International,
Drawing No. LD636811, 20/06/1996.

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Client:	NSW Treasury		
Drawing No:	0213879s_L_PESA_C001_R0.cdr		
Date:	03/09/2013	Drawing size:	A3
Drawn by:	GC	Reviewed by:	MB

This figure may be based on third party data or data which has not been verified by ERM and it may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and ERM does not warrant its accuracy.

Figure 2 - Site Layout Plan (Operational Area)

Project Symphony - Liddell
Stage 1 - Preliminary Environmental Site Assessment

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ERM

Areas of Environmental Concern:

1. LA - Ammonia Plant
2. LB - Ash Dam
3. LC - Bulk Fuel Storage Light - Vehicle Refuelling
4. LD - Bulk Fuel Storage - Mobile Refuelling
5. LE - Bulk Fuel Storage - Fuel Oil Installation (Tanks A-F)
6. LF - Bulk Fuel Storage - Transformer Road ASTs and Waste Oil AST
7. LG - Bulk Fuel Storage - Turbine Oil AST
8. LH - Bulk Fuel Storage Waste Oil (LAF) and Emergency Generator AST
9. LI - Coal Storage
10. LJ - Dangerous Goods and Flammable Liquid Store
11. LK - Former Construction Workshops and Storage
12. LL - Hunter Valley Gas Turbine
13. LM - Machinery Graveyard
14. LN - Oil and Grit Trap
15. LO - Maintenance Workshops, Foam Generator and Unofficial Laydown Area
16. LP - Fill Material (Site Levelling and Shoreline Expansion)
17. LQ - Transformer Area
18. LR - Transgrid Switchyard
19. LS - Landfills (Waste Disposal and Borrow Pit)
20. LT - Water Intake and Pump Station
21. LU - Water Treatment Plant
22. LV - Buffer Land

Legend

- Site Boundary
- Monitoring Well
- Soil Bore
- Existing Well
- Sediment Sample

AECs:

- LA - Ammonia Plant
- LB - Ash Dam
- LC - Bulk Fuel Storage Light - Vehicle Refuelling
- LD - Bulk Fuel Storage - Mobile Refuelling
- LE - Bulk Fuel Storage - Fuel Oil Installation (Tanks A-F)
- LF - Bulk Fuel Storage - Transformer Road ASTs and Waste Oil AST
- LG - Bulk Fuel Storage - Turbine Oil AST
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- LM - Machinery Graveyard
- LN - Oil and Grit Trap
- LO - Maintenance Workshops, Foam Generator and Unofficial Laydown Area
- LP - Fill Material (Site Levelling and Shoreline Expansion)
- LQ - Transformer Area
- LR - Transgrid Switchyard
- LS - Landfills (Waste Disposal and Borrow Pit)
- LT - Water Intake and Pump Station
- LU - Water Treatment Plant
- LV - Buffer Land

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0 0.25 0.5 0.75km

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Client:	Macquarie Generation		**Figure 3 - Areas of Environmental Concern**
Drawing No:	0213879s_L_PESA_G002_R4.mxd		
Date:	27/09/2013	Drawing Size: A3	Project Symphony - Liddell
Drawn By:	KB	Reviewed By: JF	Stage 1 - Preliminary Environmental Site Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

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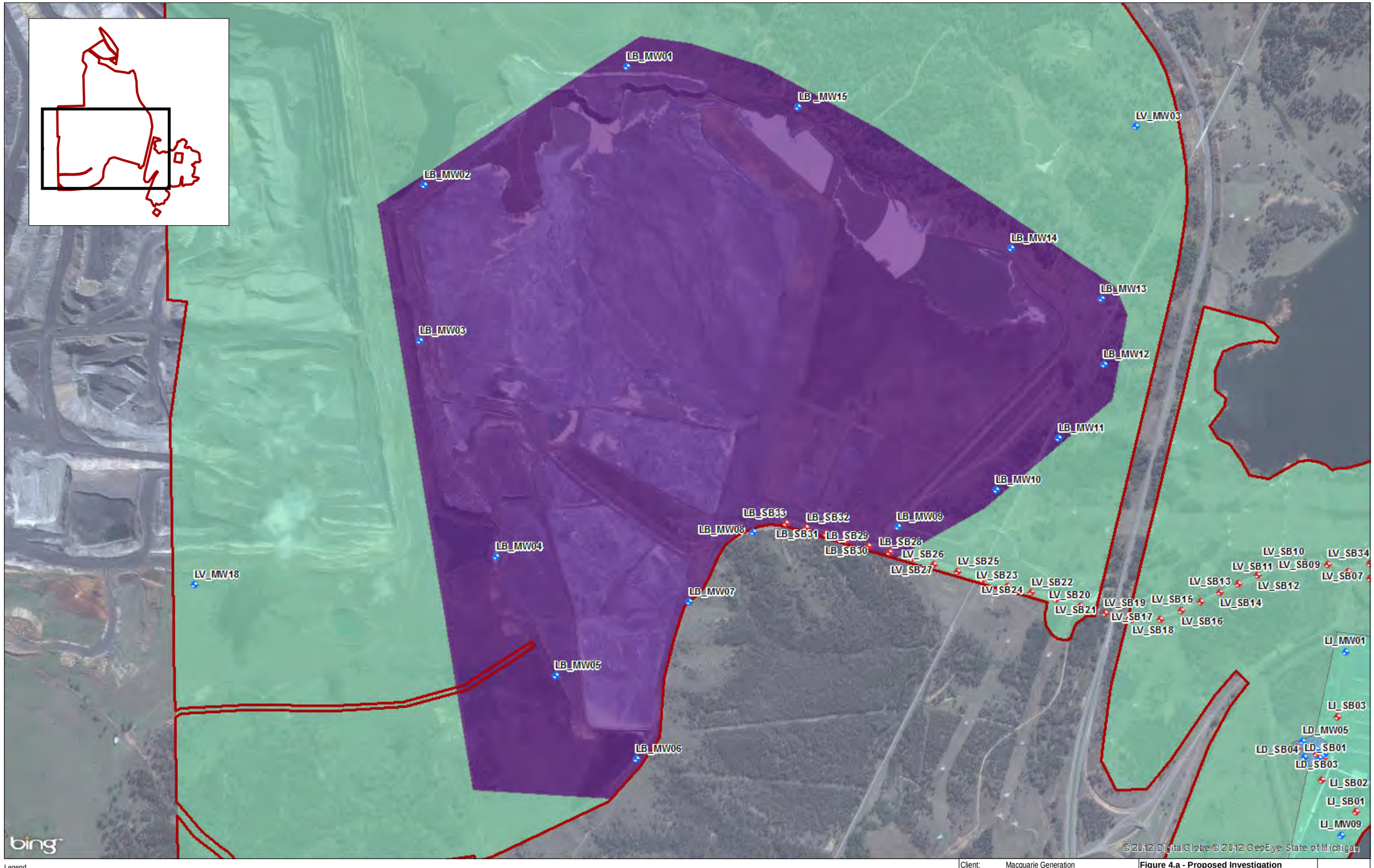

Legend

- Site Boundary
- Monitoring Well
- Soil Bore
- Existing Well
- Sediment Sample

AECs:

- LA - Ammonia Plant
- LB - Ash Dam
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- LN - Oil and Grit Trap
- LO - Maintenance Workshops, Foam Generator and Unofficial Laydown Area
- LP - Fill Material (Site Levelling and Shoreline Expansion)
- LQ - Transformer
- LR - Transgrid Switchyard
- LS - Landfills (Waste Disposal and Borrow Pit)
- LT - Water Intake and Pump Station
- LU - Water Treatment Plant
- LV - Buffer Land

DRAFT

0 100 200 300m

N

Client:	Macquarie Generation		
Drawing No:	0213879s_L_PESA_G003_R4.mxd		
Date:	27/09/2013	Drawing Size: A3	
Drawn By:	KB	Reviewed By: JF	

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Figure 4.a - Proposed Investigation Locations

Project Symphony - Liddell
Stage 1 - Preliminary Environmental Site Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

Legend

- Site Boundary
- Monitoring Well
- Soil Bore
- Existing Well
- Sediment Sample

AECs:

- LA - Ammonia Plant
- LB - Ash Dam
- LC - Bulk Fuel Storage Light - Vehicle Refuelling
- LD - Bulk Fuel Storage - Mobile Refuelling
- LE - Bulk Fuel Storage - Fuel Oil Installation (Tanks A-F)
- LF - Bulk Fuel Storage - Transformer Road ASTs and Waste Oil AST
- LG - Bulk Fuel Storage - Turbine Oil AST
- LH - Bulk Fuel Storage Waste Oil (LAF) and Emergency Generator AST
- LI - Coal Storage
- LJ - Dangerous Goods and Flammable Liquid Store
- LK - Former Construction Workshops and Storage
- LL - Hunter Valley Gas Turbine
- LM - Machinery Graveyard
- LN - Oil and Grit Trap
- LO - Maintenance Workshops, Foam Generator and Unofficial Laydown Area
- LP - Fill Material (Site Levelling and Shoreline Expansion)
- LQ - Transformer Area
- LR - Transgrid Switchyard
- LS - Landfills (Waste Disposal and Borrow Pit)
- LT - Water Intake and Pump Station
- LU - Water Treatment Plant
- LV - Buffer Land

DRAFT

0 50 100 150m

N

Client:	Macquarie Generation		
Drawing No:	0213879s_L_PESA_G004_R3.mxd		
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Figure 4.b - Proposed Investigation Locations

Project Symphony - Liddell
Stage 1 - Preliminary Environmental Site Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

Legend

- Site Boundary
- Monitoring Well
- Soil Bore
- Existing Well
- Sediment Sample

AECs:

- LA - Ammonia Plant
- LB - Ash Dam
- LC - Bulk Fuel Storage Light - Vehicle Refuelling
- LD - Bulk Fuel Storage - Mobile Refuelling
- LE - Bulk Fuel Storage - Fuel Oil Installation (Tanks A-F)
- LF - Bulk Fuel Storage - Transformer Road ASTs and Waste Oil AST
- LG - Bulk Fuel Storage - Turbine Oil AST
- LH - Bulk Fuel Storage Waste Oil (LAF) and Emergency Generator AST
- LI - Coal Storage
- LJ - Dangerous Goods and Flammable Liquid Store
- LK - Former Construction Workshops and Storage
- LL - Hunter Valley Gas Turbine
- LM - Machinery Graveyard
- LN - Oil and Grit Trap
- LO - Maintenance Workshops, Foam Generator and Unofficial Laydown Area
- LP - Fill Material (Site Levelling and Shoreline Expansion)
- LQ - Transformer Area
- LR - Transgrid Switchyard
- LS - Landfills (Waste Disposal and Borrow Pit)
- LT - Water Intake and Pump Station
- LU - Water Treatment Plant
- LV - Buffer Land

0 25 50 75m

DRAFT

N

Client:	Macquarie Generation		
Drawing No:	0213879s_L_PESA_G005_R4.mxd		
Date:	27/09/2013	Drawing Size: A3	
Drawn By:	KB	Reviewed By: JF	

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Figure 4.c - Proposed Investigation Locations

Project Symphony - Liddell
Stage 1 - Preliminary Environmental Site Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

Legend

- Site Boundary
- Monitoring Well
- Soil Bore
- Existing Well
- Sediment Sample

AECs:

- LA - Ammonia Plant
- LB - Ash Dam
- LC - Bulk Fuel Storage Light - Vehicle Refuelling
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- LE - Bulk Fuel Storage - Fuel Oil Installation (Tanks A-F)
- LF - Bulk Fuel Storage - Transformer Road ASTs and Waste Oil AST
- LG - Bulk Fuel Storage - Turbine Oil AST
- LH - Bulk Fuel Storage Waste Oil (LAF) and Emergency Generator AST
- LI - Coal Storage
- LJ - Dangerous Goods and Flammable Liquid Store
- LK - Former Construction Workshops and Storage
- LL - Hunter Valley Gas Turbine
- LM - Machinery Graveyard
- LN - Oil and Grit Trap
- LO - Maintenance Workshops, Foam Generator and Unofficial Laydown Area
- LP - Fill Material (Site Levelling and Shoreline Expansion)
- LQ - Transformer
- LR - Transgrid Switchyard
- LS - Landfills (Waste Disposal and Borrow Pit)
- LT - Water Intake and Pump Station
- LU - Water Treatment Plant
- LV - Buffer Land

DRAFT

0 50 100 150m

N

Client:	Macquarie Generation		
Drawing No:	0213879s_L_PESA_G007_R4.mxd		
Date:	27/09/2013	Drawing Size: A3	
Drawn By:	KB	Reviewed By: JF	

Figure 4.d - Proposed Investigation Locations

Project Symphony - Liddell
Stage 1 - Preliminary Environmental Site Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

Legend

- Site Boundary
- Monitoring Well
- Soil Bore
- Existing Well
- Sediment Sample

AECs:

- LA - Ammonia Plant
- LB - Ash Dam
- LC - Bulk Fuel Storage Light - Vehicle Refuelling
- LD - Bulk Fuel Storage - Mobile Refuelling
- LE - Bulk Fuel Storage - Fuel Oil Installation (Tanks A-F)
- LF - Bulk Fuel Storage - Transformer Road ASTs and Waste Oil AST
- LG - Bulk Fuel Storage - Turbine Oil AST
- LH - Bulk Fuel Storage Waste Oil (LAF) and Emergency Generator AST
- LI - Coal Storage
- LJ - Dangerous Goods and Flammable Liquid Store
- LK - Former Construction Workshops and Storage
- LL - Hunter Valley Gas Turbine
- LM - Machinery Graveyard
- LN - Oil and Grit Trap
- LO - Maintenance Workshops, Foam Generator and Unofficial Laydown Area
- LP - Fill Material (Site Levelling and Shoreline Expansion)
- LQ - Transformer Area
- LR - Transgrid Switchyard
- LS - Landfills (Waste Disposal and Borrow Pit)
- LT - Water Intake and Pump Station
- LU - Water Treatment Plant
- LV - Buffer Land

DRAFT

0 10 20 30m

N

Client:	Macquarie Generation		
Drawing No:	0213879s_L_PESA_G008_R4.mxd		
Date:	27/09/2013	Drawing Size: A3	
Drawn By:	KB	Reviewed By: JF	

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Figure 4.e - Proposed Investigation Locations

Project Symphony - Liddell
Stage 1 - Preliminary Environmental Site Assessment

Environmental Resources Management ANZ

Auckland, Brisbane, Canberra, Christchurch, Hunter Valley, Melbourne, Perth, Port Macquarie, Sydney

ERM

Annex B

Photographs

Photograph 1

View of Liddell Power Station looking north east – Lake Liddell in middle ground.

Photograph 2

Power block – Generator Transformer.

Photograph 3

Power block – Water Treatment Plant.

Photograph 4

Power Block – Turbine Oil Storage Tank.

Photograph 5

Stores Compound.

Photograph 6

Elevation difference between Power Block and Switchyard above. Conglomeratic

Photograph 7

Cooling Water Intake – Former Chlorination Plant.

Photograph 8

Oil and Grit Trap.

Photograph 9

Discharge Point to Lake Liddell.

Photograph 10

Power Block – Fuel Oil Tank Area, with Tank D in foreground, Tanks A and B visible in

Photograph 11

Power Block – Fuel Oil Tank D – Remote fill point showing staining associated with former

Photograph 12

Power Block - Liquid Recycled Fuel Tanks

Photograph 13

Power Block – Vehicle Washdown Area

Photograph 14

External Plant Workshop – Drum Storage and cleaning

Photograph 15

External Plant Workshop – Interior Drum Storage

Photograph 16

Entry to the Asbestos Dump

Photograph 17

View east from top of Asbestos Dump. Further areas of landfilling believed to be in

Photograph 18

Former ammonia tank -site of historical leak. Current ammonia/water dosing tank to the left.

Photograph 19

Ferric chloride fill point – surrounding road showed iron staining following slope

Photograph 20

Power Block – Light Vehicle Refuelling Area, underground fuel tanks beneath grass.

Photograph 21

Mobile Plant Refuelling Area – Current diesel AST which had recent spill during dispensing.

Photograph 22

Mobile Plant Refuelling Area – Former UST area. Monitoring well stick-up cover visible in grass in background.

Photograph 23

Hunter Valley Gas Turbines – retaining wall separates upper and lower areas – potential residual diesel from spill behind wall. vegetation in background.

Photograph 24

Hunter Valley Gas Turbines – typical staining visible in much of HVGT gravelled areas.

Photograph 25

Hunter Valley Gas Turbines – staining in interceptor area. Surface water lies just beyond long grass at top right of picture. Known historical spill in this area.

Photograph 26

Liddell Ash Dam.

Photograph 27

Antiene Coal Unloader – Separator in foreground, bulk storage in background. Unloader is in green building.

Annex C

Registered Titles

Lot	DP	Registered Owner	Local Govt. Area
1	135548	Macquarie Generation	MUSWELLBROOK
1	199669	Macquarie Generation	MUSWELLBROOK
1	214241	Macquarie Generation	MUSWELLBROOK
1	236869	Macquarie Generation	MUSWELLBROOK
1	238862	Macquarie Generation	MUSWELLBROOK
1	247944	Macquarie Generation	MUSWELLBROOK
1	434523	The Electricity Commission of NSW	MUSWELLBROOK
1	556370	Macquarie Generation	MUSWELLBROOK
1	574166	Macquarie Generation	MUSWELLBROOK
1	645240	Pacific Power	SINGLETON
1	790994	Macquarie Generation	MUSWELLBROOK
1	1095515	Macquarie Generation	MUSWELLBROOK
1	1104230	Macquarie Generation	MUSWELLBROOK
1	1106490	Macquarie Generation	MUSWELLBROOK
1	1126279	Macquarie Generation	MUSWELLBROOK
1	1135603	Macquarie Generation	MUSWELLBROOK
2	247944	Macquarie Generation	MUSWELLBROOK
2	556370	Macquarie Generation	MUSWELLBROOK
2	752486	Macquarie Generation	MUSWELLBROOK
2	774681	Macquarie Generation	MUSWELLBROOK
2	929149	Macquarie Generation	MUSWELLBROOK
2	966589	Macquarie Generation	MUSWELLBROOK
2	1022827	Macquarie Generation	MUSWELLBROOK
2	1095515	Macquarie Generation	MUSWELLBROOK
2	1135606	Macquarie Generation	MUSWELLBROOK
3	247944	Macquarie Generation	MUSWELLBROOK
3	252529	Macquarie Generation	MUSWELLBROOK
3	556370	Macquarie Generation	MUSWELLBROOK
3	752486	The Electricity Commission of NSW	MUSWELLBROOK
3	1105210	Macquarie Generation	MUSWELLBROOK
4	201211	Macquarie Generation	MUSWELLBROOK
4	238862	Macquarie Generation	MUSWELLBROOK
4	247944	Macquarie Generation	MUSWELLBROOK
4	252529	Macquarie Generation	MUSWELLBROOK
4	774680	Macquarie Generation	MUSWELLBROOK
5	247944	Macquarie Generation	MUSWELLBROOK
5	252529	Macquarie Generation	MUSWELLBROOK
5	1140127	Macquarie Generation	MUSWELLBROOK
6	238862	Macquarie Generation	MUSWELLBROOK
6	252529	Macquarie Generation	MUSWELLBROOK
6	258548	Macquarie Generation	MUSWELLBROOK
6	1140127	Macquarie Generation	MUSWELLBROOK
6	1175270	Macquarie Generation	MUSWELLBROOK
8	247944	Macquarie Generation	MUSWELLBROOK
8	250890	Macquarie Generation	MUSWELLBROOK
10	250890	Macquarie Generation	MUSWELLBROOK
10	1105152	Macquarie Generation	MUSWELLBROOK
11	247944	Macquarie Generation	MUSWELLBROOK
11	250890	Macquarie Generation	MUSWELLBROOK
11	1105152	Macquarie Generation	MUSWELLBROOK
11	1151798	Macquarie Generation	MUSWELLBROOK
12	1151798	Macquarie Generation	MUSWELLBROOK

Lot	DP	Registered Owner	Local Govt. Area
16	241179	Macquarie Generation	MUSWELLBROOK
17	241179	Macquarie Generation	MUSWELLBROOK
17	247944	Macquarie Generation	MUSWELLBROOK
18	241179	Macquarie Generation	MUSWELLBROOK
18	247944	Macquarie Generation	MUSWELLBROOK
18	752486	Macquarie Generation	MUSWELLBROOK
19	241179	Macquarie Generation	MUSWELLBROOK
19	247944	Macquarie Generation	MUSWELLBROOK
19	752468	Macquarie Generation	SINGLETON
20	241179	Macquarie Generation	MUSWELLBROOK
21	241179	Macquarie Generation	MUSWELLBROOK
22	241179	The Electricity Commission of NSW	MUSWELLBROOK
23	241179	Macquarie Generation	MUSWELLBROOK
23	752486	Macquarie Generation	MUSWELLBROOK
24	241179	Macquarie Generation	MUSWELLBROOK
24	752486	Macquarie Generation	MUSWELLBROOK
25	241179	Macquarie Generation	MUSWELLBROOK
25	752486	Macquarie Generation	MUSWELLBROOK
26	241179	Macquarie Generation	MUSWELLBROOK
27	241179	Macquarie Generation	MUSWELLBROOK
28	241179	Macquarie Generation	MUSWELLBROOK
28	752486	Macquarie Generation	MUSWELLBROOK
29	241179	Macquarie Generation	MUSWELLBROOK
30	241179	Macquarie Generation	MUSWELLBROOK
31	241179	Macquarie Generation	MUSWELLBROOK
31	255215	Macquarie Generation	MUSWELLBROOK
32	255215	Macquarie Generation	MUSWELLBROOK
33	241179	Macquarie Generation	MUSWELLBROOK
33	255215	Macquarie Generation	MUSWELLBROOK
34	241179	Macquarie Generation	MUSWELLBROOK
34	255215	Macquarie Generation	MUSWELLBROOK
34	752486	Macquarie Generation	MUSWELLBROOK
35	255215	The Electricity Commission of NSW	MUSWELLBROOK
36	241179	Macquarie Generation	MUSWELLBROOK
36	255215	Macquarie Generation	MUSWELLBROOK
37	255215	Macquarie Generation	MUSWELLBROOK
38	241179	Macquarie Generation	MUSWELLBROOK
38	255215	Macquarie Generation	MUSWELLBROOK
39	241179	Macquarie Generation	MUSWELLBROOK
39	255215	Macquarie Generation	MUSWELLBROOK
40	241179	Macquarie Generation	MUSWELLBROOK
40	255215	Macquarie Generation	MUSWELLBROOK
41	241179	Macquarie Generation	MUSWELLBROOK
42	241179	Macquarie Generation	MUSWELLBROOK
43	241179	Macquarie Generation	MUSWELLBROOK
44	241179	Macquarie Generation	MUSWELLBROOK
45	241179	Macquarie Generation	MUSWELLBROOK
46	241179	Macquarie Generation	MUSWELLBROOK
74	752468	Macquarie Generation	SINGLETON
102	1053098	Macquarie Generation	MUSWELLBROOK
116	752486	Macquarie Generation	MUSWELLBROOK
125	752470	Macquarie Generation	MUSWELLBROOK
144	752486	Macquarie Generation	MUSWELLBROOK
145	752486	Macquarie Generation	MUSWELLBROOK
157	752486	Macquarie Generation	MUSWELLBROOK
160	752486	Macquarie Generation	MUSWELLBROOK
162	752486	Macquarie Generation	MUSWELLBROOK
163	752486	Macquarie Generation	MUSWELLBROOK
181	812852	Macquarie Generation	MUSWELLBROOK

Lot	DP	Registered Owner	Local Govt. Area
313	752486	Macquarie Generation	MUSWELLBROOK
320	752486	Macquarie Generation	MUSWELLBROOK
322	861090	Macquarie Generation	MUSWELLBROOK
601	1019325	Macquarie Generation	SINGLETON / MUSWELLBROOK

Source:
Baker & McKenzie (23 August 2013).

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