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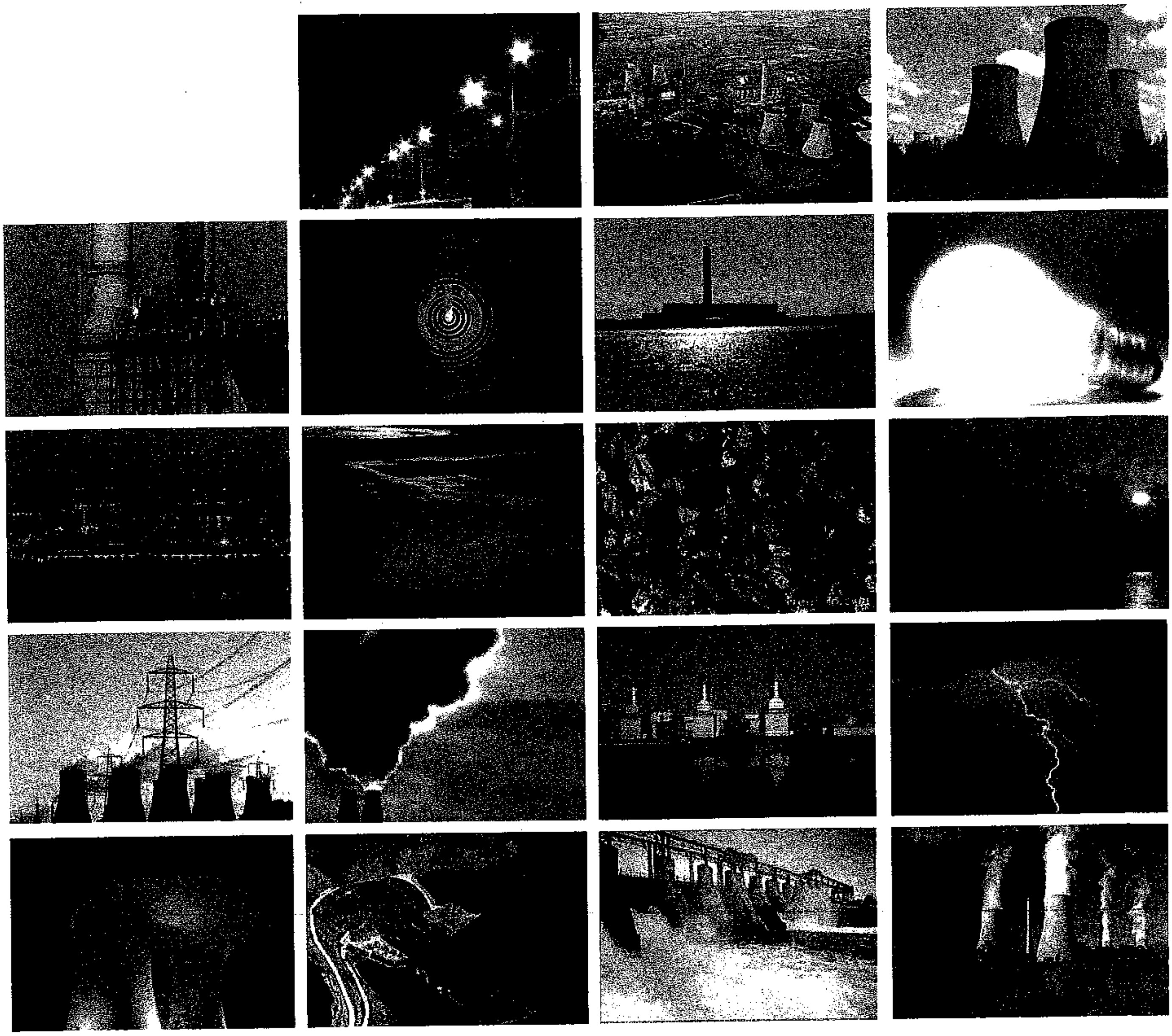
Vales Point Power Station

Preliminary Environmental Site Assessment – Part 1

Environmental Resources Management

5 February 2014



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Delta Electricity – Project Symphony

Vales Point Power Station

Preliminary Environmental Site Assessment

Ref: 0227637RP01_Final

5 February 2014

ERM

The world's leading sustainability consultancy

Vales Point Power Station

Preliminary Environmental Site Assessment

Delta Electricity - Project Symphony

5 February 2014

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Environmental Resources Management Australia Pty Ltd Quality System

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EXECUTIVE SUMMARY

ERM was engaged by Delta Electricity to provide advice in relation to potential soil and groundwater contamination issues which may be relevant to the sale of the Vales Point 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 an abridged Sampling, Analysis and Quality Plan (SAQP) 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 in no particular order:

- *Power Block (B Station);*
- *A Station demolition area;*
- *generator transformer areas;*
- *main store – dangerous goods storage area;*
- *contaminated water treatment plant;*
- *waste oil storage area;*
- *fuel oil installation;*
- *vehicle refuelling depot;*
- *water treatment area;*
- *chlorine plant;*
- *coal storage area;*
- *mobile plant maintenance and refuelling;*

- *sewage treatment plant;*
- *Ash Dam (seepage and discharge to groundwater and surface water receptors);*
- *six asbestos landfills*
- *asbestos pipeline carrying ash slurry*
- *Lake Macquarie sediments (sediments may have accumulated contaminants from Vales Point Power Station drainage and discharges over a lifetime of station operation).*
- *Rail coal unloader area, rail infrastructure and coal transfer lines; and*
- *fly ash plant area.*

In addition, the Preliminary ESA identified potential offsite sources of contamination in association with the Mannering Colliery and Chain Valley Colliery, which are *leased from Delta Electricity for the purpose of coal mining operations.*

Based on the results of the Preliminary ESA undertaken by ERM and consideration of Delta Electricity'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, groundwater, surface water and sediments 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

AEC	Area of Environmental Concern
ACM	Asbestos Containing Materials
AFFF	Aqueous Film Forming Foam
AHD	Australian Height Datum
ANZECC	Australia and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASLP	Australian Standard Leaching Procedure
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
EPL	Environment Protection Licence
ERM	Environmental Resources Management
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
MF	Microfiltration
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
RIVM	Netherlands National Institute of Public Health and the Environment
RO	Reverse Osmosis
SEPP	State Environmental Planning Policy
SAQP	Sampling, Analysis and Quality Plan
SOC	State-Owned Corporation
SOP	Standard Operating Procedure

SPR	Source-Pathway-Receptor
SVOC	Semi-Volatile Organic Compound
SWL	Standing Water Level
TCLP	Toxicity Characteristic Leaching Procedure
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 Delta Electricity (a State Owned Corporation - SOC), ERM were 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 Vales Point 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, sediment, surface water and groundwater contamination issues which may be present at the Site and relevant receiving environments; and
- identify what additional works may be required to establish a baseline of soil, sediment, surface water 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 (if required) 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 presented in the ERM proposal dated 21 November 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 site 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) via:
    - identification of past and present potentially contaminating activities at, and adjacent to, the Site;
    - 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;
    - assessment of the sensitivity of surrounding areas and/or property; and
    - compiling a preliminary Conceptual Site Model (CSM).
- Identifying where Stage 2 intrusive investigations are necessary on the site; and
- Developing 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 *Figures 1* and 2 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 a source 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 presented in the following sections.

1.5.1 *Review of Existing Data*

Relevant environmental information on Vales Point Power Station was made available to ERM via an electronic data room.

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 Delta Electricity 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 Delta Electricity 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*).

1.5.2 *Site Visits and Management Interviews*

ERM mobilised to Site and completed interviews with Site management and a site inspection on 9 and 11 December 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. Bryan Beudeker;
- Project Support Officer - Mr. Atul Verma;
- Environmental Officer - Mr. Greg Sellers
- Environmental Officer - Mr. Shannon Bruce
- Chemical Plant Specialist - Mr. Alex Liddel

1.5.3 *Preparation of Stage 1 ESA Report*

This Stage 1 ESA Report was prepared in general accordance with the *Guidelines for Consultants Reporting on Contaminated Sites* (NSW OEH, 2011).

In preparing this report, (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 Council (NEPC) (April 2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999,* NEPC, Canberra, *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 in 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*

2.1 *SITE IDENTIFICATION*

Vales Point Power Station is owned and operated by Delta Electricity, a State Owned Corporation (SOC) that manages two electricity generating assets located on the Central Coast of NSW, Australia.

Vales Point Power Station is situated adjacent to the southern shore of Lake Macquarie, near the township of Mannering Park, approximately 35 km south of Newcastle, NSW. The approximate coordinates of the Power Station are 33°09'58.08"S and 151°32'34.09"E.

The Site encompasses land contained within two local government areas: the Wyong and Lake Macquarie Local Government Areas. The Lot and Deposited Plan (DP) information relevant to the Site, along with the current land zoning for the various parcels of land as per the Wyong Shire Council Local Environmental Plan (1991) and Lake Macquarie Local Environmental Plan (2004), is outlined in *Section 3.3*. The Lot and DP information relevant to the Site is summarised in *Annex C*. A Site Location Map is provided as *Figure 1*, and the Site boundaries are provided as *Figure 2* of *Annex A*.

A number of parcels of land within the Delta Electricity property boundaries are subject to mining leases and have been excluded from the PESA scope of works. These areas have been considered to be potential offsite sources of contamination, for the purposes of this assessment. These areas include;

- The Mandalong coal unloader;
- The Mannering Colliery; and
- The Chain Valley Colliery.

These areas are detailed in *Figure 2 of Annex A*.

The Microfiltration (MF) Plant is located at the Mannering Park Sewage Treatment Plant, immediately to the east of the Vales Point Site. It is understood that the MF Plant site is leased from the Wyong council but that Delta Electricity owns the Plant equipment. This area has also been excluded from the PESA scope of works.

2.2 *SITE DESCRIPTION*

2.2.1 *Overview*

The total Site area of the Vales Point Power Station is approximately 1700 hectares (ha), which includes water canals, but excludes areas for associated mines. The Power Station operational area itself occupies approximately 180 ha.

The majority of the Site is undeveloped and comprises 'buffer' lands which separate the surrounding residential areas from the Power Station. The layout of the Site operational areas is provided as *Figure 3*. Photographs of the Site are presented in *Annex B*.

2.2.2 *Site Layout*

Vales Point Power Station was built in the 1960s as a four-unit station ("A Station"). These generating units were decommissioned in the late 1980s. Vales Point now operates two 660 MW generating units, with a total generating capacity of 1,320 MW of electricity ("B Station").

At the time of ERM's Site inspection in December 2013, Delta Electricity was removing the aboveground A Station structures from the Site. The demolition project commenced in late August 2011 and was scheduled for completion in early 2014. The demolition project involves the removal of the turbine house, four boilers, cladding, concrete and steel from the Site. The existing Vales Point B Station will remain operational.

Further information on electricity generation and distribution processes is presented in *Section 4*.

The Site is composed of the following key features:

- Vales Point Power Station and associated infrastructure;
- Ash Dam and associated pipelines for ash slurry and return water;
- coal storage area, including a truck wash down area, refuelling and maintenance area and settling ponds;
- conveyors transporting coal from nearby mines to the Site;
- waste disposal areas, including six former asbestos dumps;
- several water treatment systems, including a demineralised water plant, a chlorine plant, a reverse osmosis plant and an oil and grit trap;

- buffer lands surrounding the infrastructure described above, this includes State Environmental Planning Policy (SEPP) 14 listed wetlands to north and west of the Site;
- the Rail coal unloader and Rail to Vales Point RV conveyor system, located to the north west of the operational area;
- a fly ash loading plant, operated by Morgan Ash, to the south east of the operational area.

Plant process water is supplied from Chain Valley Bay and discharged into Wyee Bay.

2.3 *TOPOGRAPHY*

The Site is located on the coast of Lake Macquarie, in between Wyee Bay and Chain Valley Bay. The Site and immediate surrounds, including the Ash Dam area, are generally flat, although the local topography slopes to the north east, towards Lake Macquarie.

2.4 *GEOLOGY*

Based on a review of the *Gosford - Lake Macquarie 1:100 000 Provisional Geology Sheet* (Geological Survey of New South Wales, 2003), the Site operational area, including coal storage facility is located on the late Permian to early Triassic Munmorah Conglomerate formation of the Clifton Subgroup, Narrabeen Group. The Munmorah Conglomerate formation is comprised of conglomerate and medium to coarse-grained sandstone with minor siltstone and claystone (Geoscience Australia, 2014). The area comprising the Ash Dam was underlain by man-made fill, identified as comprising dredged estuarine sand and mud, demolition rubble, industrial and house hold waste. Areas immediately surrounding Mannering Bay and Wyee Bay tributaries are located on Quaternary sediments comprised of gravel and sand.

Extensive underground coal mining activities are present in the region with target coal seams occurring in the late Permian Newcastle Coal Measures (a predominantly sandstone and coal sequence with lesser siltstone) that underlie the Clifton Subgroup. The Mannering Colliery, which undermined sections of the Site, targets the Great Northern and Fassifern coal seams. The Great Northern seam, which overlies the Fassifern seam, is located between approximately 140 to 155 metres below ground level (m bgl) in the area (Centennial Coal, 2009).

Based on a review of borehole logs provided in the David Lane Associates (DLA Environmental) groundwater monitoring well installation report (July 2012) site-specific geology was identified as sand fill (0.1 metres thick) overlying orange sandy clay to 4.8 metres (at least). This groundwater monitoring well installation report was specifically relevant to the vehicle refuelling area, located on the south western part of the Site.

2.5 *HYDROGEOLOGY*

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

- Moderately permeable Quaternary sediments. While the geological map indicates that the sediments consist predominantly of sand and gravel, the available information from the limited intrusive works conducted at the Site indicate that there is a relatively high degree of fine grained material within the sediments which would constrain the permeability of the sediments.
- Moderate to relatively highly permeable conglomerate and sandstone, with permeability largely governed by the degree of fracturing in the conglomerate and sandstone.
- Low permeability siltstone and claystone.
- Moderate to relatively highly permeable coal seams within the Newcastle Coal Measures, with permeability governed by the degree of cleat development and fracturing within the coal seams.

Regional groundwater flow is expected to be towards Lake Macquarie, which is generally located to the north and north east of the Site. Temporal and localised variations in the direction of groundwater flow is not considered unlikely given the low lying nature of the area and the presence of tidally influenced lakes, and the effects of increased hydraulic head created by the wet disposal ash dam. The dykes further present potential localised barriers to groundwater flow.

Four groundwater monitoring wells were installed in June 2011 in the area surrounding the vehicle refuelling compounds. These monitoring wells were installed to facilitate Underground Petroleum Storage System (UPSS) monitoring works. Results of the latest round of monitoring (DLA, June 2013) recorded Standing Water Level (SWL) between 1.1 and 1.22 m bgl, with the approximate hydraulic gradient inferred to be towards the north east.

2.6 *GROUNDWATER USE*

The alluvial aquifers and shallow conglomerate and sandstone aquifers are the prime aquifers used in the region for stock and domestic supplies and on which aquatic ecosystems may be dependent. Mining activities have extensively impacted the deep coal seam aquifers with extensive depressurisation of the coal seams having taken place in the region. Use of the coal seams aquifers are further restricted by the general high salinity of groundwater within the coal seems (Centennial Coal, 2009).

The NSW Natural Resource Atlas online bore register (accessed 17 December 2013) identifies six groundwater bores within a 5 km radius of the Vales Point Power Station.

One groundwater bore, located approximately 700 m north of the Site in Mannering Park, is reported used for domestic purposes. The Standing Water Level (SWL) was recorded in this well at 5.5 m bgl. One groundwater bore located approximately 1 km south west of the Power Station operational area and 600 m north of the Ash Dam is reported used for stock (poultry) watering purposes. The remaining groundwater bores were reported to have been installed for testing purposes. SWL was recorded in three of these bores at 6 m bgl.

Annex D provides a detailed summary of the results obtained from the online bore register.

2.7 *HYDROLOGY*

The Site is located in the Lake Macquarie catchment area, with Lake Macquarie identified as the main local hydrological feature. Local waterways can be summarised as follows:

- Chain Valley Bay, located immediately to the north east of the Site;
- Mannering Bay with Wyee Bay immediately beyond, located immediately north of the Site;
- The Vales Point cooling water canal, which enters the Site at Chain Valley Bay and exits the Site at Wyee Bay;
- Chain Valley Retention Pond (also known as Lake Roddham), located approximately 300 m north east of the operational area, forms a part of the Site contaminated water management system;

- Wyee Creek and the Wyee Creek diversion channel is located along the north western site boundary and function as part of the Ash Dam overflow system;
- Mannering Lake, which forms part of the Vales Point Ash Dam;
- Colongra Lake, located approximately 4 km south of the Site operational area;
- Lake Munmorah located 4 km south east of the Site;
- Three settling ponds associated with the sewage treatment works on Site, located 500 m north west of the operational area; and
- Five settling ponds associated with the coal storage area, approximately 700 m south west of the operational area.

Operational use of the dams and ponds listed above are outlined in *Section 4.7.*

2.8 *SURROUNDING ENVIRONMENT*

The Site is surrounded by residential properties, remnant bushland and industrial properties.

Key industrial uses in the area include:

- Chain Valley Colliery, approximately 750 m south east of the operational area of the Site;
- Mannering Colliery, approximately 1.8 km south of the operational area of the Site;
- The Mandalong coal mine located approximately 5 km to the north west;
- A municipal sewerage treatment plant, located approximately 1 km south west of the operation, or immediately west of the Site boundary.

The closest residential areas to the Site include:

- Mannering Park, located north of the Site approximately 600 m from the operational area;
- Doyalson East, located approximately 300 m south of the Ash Dam
- Kingfisher Shores, approximately 2 km south east of the operational area and 1.6 km north east of the Ash Dam; and
- Wyee, located approximately 150 m east of the Ash Dam;

- Wyee Point, located directly to the east of the north western leased mine area.

Rural residential properties are also located immediately to the north of the Ash Dam area and to the south of the Ash Dam area along Wyee Rd.

The Site is surrounded by areas of remnant bushland, with some limited recreational land use. Ecological or recreational areas of note surrounding the Site include:

- SEPP 14 protected wetlands are located along the northern and eastern perimeter of Mannering Lake. The wetlands located on the eastern perimeter of Mannering Lake are also located within approximately 100 m of the Ash Dam toe drain system;

- SEPP 14 protected wetlands are also located on either side of Wyee Creek, approximately 1 km north of the Ash Dam;

- Tom Barney Oval is located immediately to the south west of the operational area. Based on discussions with the Site Environmental Officer, this oval is occasionally booked out for sporting events, and is regularly accessed by the public;

- Chain Valley Bay Reserve is located 1 km south of the operational area. Public use of this area appeared to be limited based on the lack of amenities and cleared areas; and

- Recreational fishing and boating activities are also undertaken in Lake Macquarie, including Mannering Bay, Chain Valley Bay and Wyee Bay.

2.9 *SENSITIVE RECEPTORS*

The sensitive receptors identified in association with the Site include:

- indoor and outdoor human health receptors in the form of onsite and offsite workers;

- intrusive maintenance workers both on and onsite;

- offsite residential receptors, living in the vicinity of the operational area or Ash Dam;

- recreational users of Mannering Bay, Wyee Bay and Chain Valley Bay;

- recreational users of Tom Barney Oval;

- aquifers beneath the Site and nearby potable and stock watering wells; and
- ecological receptors, including those in Mannering Bay, Wyee Creek, Wyee Bay and Chain Valley Bay.

Onsite water bodies that are used for operational purposes, including the Ash Dam, the cooling water canal and the various water retention, treatment and settling ponds are not considered to be ecological receptors.

3 SITE HISTORY AND REGULATORY SETTING

3.1 SUMMARY OF SITE HISTORY

Information provided by Delta Electricity management and a review of aerial photographs (*Section 3.2*) indicates that prior to construction of the Vales Point Power Station, the Site and surrounds were primarily occupied by a mixture of farms and native vegetation.

Construction of the Power Station commenced in the 1963 (A Station) and completion was in the early 1980s (B Station). The layout of the Power Station and surrounding buffer lands has stayed largely consistent since 1975 (at least). Ancillary additions have been made to the Power Station since construction was completed, including the construction of sewage treatment area and additional settlement ponds.

3.2 SUMMARY OF HISTORICAL AERIAL PHOTOGRAPHS

A review of historic aerial photographs was conducted by ERM and is summarised in *Table 3.1* (below). Copies of the photographs reviewed are included in *Annex D*.

Table 3.1 *Summary of Historical Aerial Photographs*

Year	Site	Surrounding Area
1950	The Site appears appear to be undeveloped, vegetated land. This image is of poor resolution and the Site boundaries are not easily discernable.	The Site surrounds appear to be largely undeveloped, vegetated land. Some cleared, rural properties were also observed in the aerials. These properties were likely used for grazing, with minimal crop cultivation observed.
1966	The Vales Point Power Station is present in these images, and construction appears to have been completed on the "A Station" portion of the operational area and on the switch yard located to the north of the Site. The Site surface appears to be exposed or excavated Site soils, which suggested that Site construction, may have still been underway on other parts of the Site. The cooling water canal and Ash Dam are also present on the Site. With deposition of ash material present on the western portion of the Ash Dam. A coal stockpile was located north east of the current coal storage area, immediately south of what is now the administration and amenities building.	The Site was largely surrounded by undeveloped, vegetated land. Two coal mines were present south east of the Site. Residential development was underway in Mannering Park and Kingfisher Shores.

Year	Site	Surrounding Area
	The two ASTs were present in the north western corner of the Site.	
1975	Construction of the A Station portion of the Site appears to be complete, whilst B Station construction appears to be underway. The sewage treatment plant is visible west of the switchyard. The coal storage area appears to be larger than in the 1966 photograph. A stockpile is also visible further south west, in the footprint of the current coal storage area. Ash deposition appears to cover a great extent of the Ash Dam.	The Site surrounds continue to comprise largely of undeveloped, vegetated land with two coal mines present south east of the Site. Residential development continues in Mannering Park and Kingfisher Shores.
1984	Construction of both the A Station and B Station appears complete, and both parts appear operational. The two fuel ASTs are present south of the operational area. Development of the Site has also expanded east of the operational area, with several small buildings observed in this area. These smaller buildings are likely storage sheds or other ancillary facilities associated with main Site operations.	The Site surrounds are largely undeveloped, vacant land with coal mining activities to the east and south east.
1994	The Site layout and infrastructure appears to be the same as previously identified, and generally consistent with the current Site layout. Coal storage activities still extend further northwards, toward the operational area than the current coal storage stockpile Chain Valley Retention Pond (Lake Roddham) is present in the north east site corner. Ash deposition covers most of the Ash Dam facility.	The Site surrounds appear the same as previously identified, however the municipal sewage plant is also present east of the Site.
2001	The Site layout and infrastructure appears to be consistent with the current site layout. The coal storage facility is consistent with the layout observed during the site walkover and described in the current Site layout plans.	The Site surrounds appear to be the same as previously identified and consistent with the extent of the surrounds observed during the Site visit.
2006	The Site layout and infrastructure appears to be consistent as previously identified and consistent with the current Site layout.	The Site surrounds appear to be consistent with that previously identified.

3.3 *ZONING & LAND USE*

The total Site area, including the operational area, Ash Dam, coal storage facility and vegetated buffer zones, is approximately 10 070 ha. Land holdings occur within the Lake Macquarie and Wyong Local Government Authority (LGA).

Under the Wyong Local Environmental Plan (LEP) 2012, most of the Site including the operational area, is zoned SP2 - Electricity Generating Works. Small portions of the Site, immediately south of Wyee Bay, are zoned E2 - Environmental Conservation. Areas designated W2 - Recreational Waterways are also located along the shoreline immediately north east and north west of the Site.

Under the Lake Macquarie LEP 2004, most of the Site is zoned 4(1) – Industrial (core). Areas on the periphery of the Site are zoned 9 – Natural Resources. Areas immediately surrounding Mannering Lake are zoned 7(1 and 2) – Conservation (primary and secondary) and 9 - Natural Resources. Properties zoned 1(1) – Rural were also located south west of Mannering Lake.

Zoning maps, sourced from Lake Macquarie LGA and Wyong LGA are presented in *Annex D.*

3.4 *ENVIRONMENTAL LICENSES AND MANAGEMENT*

Delta Electricity 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 systems provide context for potential contamination sources (e.g. ash disposal) and hence a summary of salient points in relation to these issues has been presented in the following sections.

3.4.1 *Environmental Protection Licences*

The Site holds Environmental Protection Licence (EPL) No. 761 (issued under *Section 55* of the *Protection of the Environment Operations Act 1997)* for the premises described as Vales Point Power Station and Coal Unloader, Vales Point Road, Mannering Park NSW 2259.

The EPL authorises the generation of electrical power from coal (> 4,000 GWh generated), a scheduled activity under the *Protection of the Environment Operations Act 1997.*

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

- petroleum products storage;
- general chemical storage;
- crushing, grinding or separating works;
- coal works; and
- sewage treatment processing by small plants.

The latest version of the EPL is dated 13 November 2013 and is due for review in January 2014.

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 predominantly 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 a requirement to complete a Pollution Reduction Program (PRP) relating to Ash Dam Seepage to groundwater. This groundwater assessment should investigate background groundwater quality particularly concentrations of metals (including arsenic and selenium), pH and conductivity, compare the background groundwater quality with data collected at monitoring bores VPGM/D6, VPGM/D3 and VPGM/D5 from January 2008 to September 2013 and identify any mitigation measures to be carried out to reduce the levels of any elevated concentrations identified. This report is due to the NSW EPA by 31 January, 2014.

A desktop audit was undertaken by the NSW EPA to assess the requirements to publish pollution monitoring data (dated 31 January, 2013). Non-compliances recorded in this audit were limited to do minor data quality issues for air monitoring data and reporting requirements.

Non-compliances reported under EPL 761 identified on the NSW EPA website (accessed 21 December, 2013) which are considered to represent potential contamination of on Site soil and groundwater or the surrounding environment, are outlined in *Table* 3.2 (below).

Table 3.2 *Summary of Environmental Non-Compliance relevant to Potential Contamination Issues*

Licence Condition Number	Details of Non-Compliance	Number of Times Occurred	Date Received
R3.3	Discharge from ash dam to Wyee Creek due to high rainfall in catchment. Internal investigation undertaken & upgrade work to return water pumps in progress, dams to be kept at lower levels. (Incident report 11/2/11 DECCW)	5.	28 February 2011

There was limited data available in the data room with respect to the planning approvals and as such a review of the planning approvals relating to the Site has not been undertaken as a part of this assessment.

3.4.2 *Environmental Management*

Delta Electricity maintains an ISO14001 certified Environmental Management System (EMS) for Vales Point Power Station which is audited on an ongoing basis.

A number of environmental plans for Vales Point 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.

A recent Environmental Compliance Audit undertaken by GHD in November 2010 (GHD, 2010) generally found that Delta Electricity has achieved a high level of compliance with the conditions of the Development Approvals and EPL. The main issues identified in this audit revolve around the system for dealing with public complaints and errors in the number of samples collected and the analytes measured during individual surface water monitoring events.

Challenges associated with the management of licensed discharges from the Vales Point Power Station, which could result in contamination include;

- potential overflows from the Ash Dam to Wyee Creek, which flow into Mannering Bay
- potential seepage from the Ash Dam into Mannering Bay and the nearby SEPP1 4 wetland.

4 *OPERATIONS*

The following sections present an overview of Site operations in order to provide context to the subsequent assessment of potential for contamination. A brief description of key activities is provided including, in particular, chemical and waste storage.

4.1 *INVENTORY OF CHEMICALS*

Various chemical and dangerous goods stores are located throughout the Site, with the largest quantities of dangerous goods stored at the water treatment plants, transformer areas, and fuel depots An inventory of significant storage facilities is provided in *Annex E*, based on the Site's most recent Dangerous Goods Notification (November 2013 - NDG015072).

The Site holds a variety of bulk (>1,000 L) chemical storage:

- Petrol;
- Refrigerated carbon dioxide;
- Diesel;
- Transformer oils;
- Ammonia;
- Turbine oils;
- Waste oils;
- Hydrogen;
- Hypochlorite;
- Sodium hydroxide;
- Sulfuric acid; and
- Sulfur.

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

4.2 COAL SUPPLY AND STORAGE

4.2.1 *Coal Supply*

Chain Valley and Mannering Collieries are located within the footprint of the Vales Point Power Station to the east of the operational area. Coal is delivered to the Power Station via dedicated overland conveyor.

Coal is also delivered to the Power Station via truck from local mines and via the Rail to Vales Point (RV) coal conveyor network.

The Rail unloader is located adjacent to the Ash Dam and the Main Northern Rail Line between Wyee and Morisset, approximately 4.5 km to the north west of the main power block. Coal is delivered by rail to the Rail Unloader where it is then transferred to the Vales Point conveyor system. Coal from the Mandalong Mine, which is located approximately 2 km to the north of the Rail unloader, is also loaded onto the Delta Electricity conveyors at this facility.

ERM was unable to access this facility during the December 2013 Site inspection but understands that it comprises a series of hoppers, feeders and transfer points and a dust suppression system based on the use of water.

The majority of the RV coal conveyor system is at ground level with graduated elevation of conveyors at the entry into the transfer towers. Conveyors are covered to reduce the potential for dust emissions.

4.2.2 *Coal Storage*

The Vales Point Coal Plant area is located on the southern side of the power block. Stockpiled coal can either be fed directly to the Power Station bunkers or deposited in the storage area for later use.

4.2.3 *Truck Wash-down Area*

Truck washing facilities are located within the coal plant area. The truck washing facilities consist of an automatic drive through wheel and under body washer.

The truck washing facility uses reclaimed water supplied from a settling pond within the Coal Storage Area. All dirty water is collected and drained to a settling pit with an overflow weir designed to retain coal and dirt particles. Excess water is directed via an underflow weir designed to retain any oil to the dirty water drain, where after passing through a number of silt traps flows and flows into Settling Pond 3, prior to discharge to the Ash Dam (*Section 4.7*).

4.2.4 *Mobile Plant Maintenance and Refuelling*

A maintenance and refuelling area for the mobile equipment associated with coal stockpiling is located to the north of the coal stockpile area. Within this area, mobile equipment can be refueled from a 35,000 L diesel Above-ground Storage Tank (AST). The diesel AST is filled by road tanker. The Coal Handling Plant workshop also houses a refuse oil AST, a lubricants station and a parts cleaning facility

4.3 ELECTRICITY GENERATION UNITS

4.3.1 *Main Generating Plant Area (B Station)*

The main generating plant area of the Vales Point Power Station operates two 660 MW generating units (B Station) and associated infrastructure;

- coal feed systems;
- two coal-fired boilers;
- turbine house incorporating two steam turbines;
- two 660 MW generator units (units 5 and 6);
- emergency diesel generator; and
- one chimney stack (serving two boilers).

Electricity is produced using pulverised coal-fired boilers. The coal is ground in pulverising mills before being blown into the boiler in a steam of pre-heated air. The coal burned in the boiler furnace chamber produces the heat necessary to convert water circulating in the boiler tubes into high-pressure steam.

The electricity generation process involves high pressure steam passing through cylinders and spinning the shaft of each generator and inducing alternating current. After use, the steam is condensed back to water and is recycled.

4.3.2 *Transformer Area*

There are four transformer vessels present on the Site, containing significant quantities of insulating oil. Spare transformers 1 and 2 and the temporary turbine oil storage ASTs, with a capacity of 115,000 L are also located immediately to the east of the transformer vessels. Refuse oil storage AST No. 2, with a capacity of 35,000 L is also located to the east of the transformer vessels.

Due to the age of the facility, Polychlorinated Biphenyl (PCB) additives would have historically been used in insulating oils in transformers, capacitors and light fittings. Data room documents indicate that low concentrations of PCBs (up to 4.1 µg/g) were detected in transformer oil samples collected from the vessels by Aurecon in 2012 and 2013.

An environmental compliance audit undertaken in 2010 (GHD, 2010) indicated that while there was a PCB register showing all equipment that has been tested for PCBs, there was no defined plan showing where PCB containing equipment is located and how this material is to be managed when oils from this equipment are replaced.

4.3.3 *Turbine Area*

Both Unit 5 and Unit 6 contain a battery room, which stores wet batteries filled with up to 20,000 L of acid. Turbine oil storage tanks with a capacity of up to 50,000 L are also located within both units.

4.3.4 *Transmission*

The Vales Point switchyard is located to the north of the power block and is owned and operated by TransGrid. The output from Vales Point Power Station is stepped up in voltage by generator transformers before passing to the switchyard and being transmitted at 330 kV into TransGrid's high-voltage supply system.

4.3.5 *Emergency Generator*

The emergency diesel generator, located on the north side of the power block, is used to provide emergency electrical supplies to safely shut down plant in the event of a station shutdown and disconnection from the power grid.

The generator runs on diesel, supplied from an AST (5000 L) located within a concrete bunded area on the western side of the building. The AST is filled by road tanker.

4.3.6 *Ammonia Supply*

Aqueous Ammonia is required at the Site to supply the generating units. A generating unit typically requires a transfer of ammonia every 2-3 days to refill the chemical injection tanks.

Historically, aqueous ammonia was stored in ASTs located in the vicinity of the Chain Valley Retention Basin but these facilities have been decommissioned. A new aqueous ammonia storage facility was developed in 2011 and is situated near the demineralised water plant. This facility consists of two ASTs; one main tank of 25,000 L and one back up tank of 1,000 L.

Aqueous ammonia is supplied as a 25% solution from a road tanker. There is a truck filling station for the main tank and ammonia can subsequently be transferred to the small tank. The ammonia is diluted to either 4.5% or 10% as it is transferred to the chemical injection tanks.

4.3.7 *Hydrogen Supply*

Hydrogen is used as a coolant for the generators. The hydrogen system comprises a hydrogen manufacture plant and bulk store located to the north of the power block and the hydrogen cooling system for the generator. The hydrogen generating plant is no longer in service.

Hydrogen is currently stored within banks of cylinders within the hydrogen generating plant area and is transferred to the hydrogen control panels within the generator via pipes.

4.3.8 *Historical Operations at A Station*

Vales Point A Station was built in the 1960s as a four-unit station. These generating units were decommissioned in 1989 and have undergone partial dismantling, with most of the internal plant items removed. At the time of ERM's Site visit in December 2013, the A Station buildings were undergoing demolition and removal offsite.

Prior to the decommissioning and demolition of A Station, this facility was comprised of;

- four coal-fired boilers;
- a turbine house incorporating four steam turbines;
- four 660MW generator units (units 1 to 4);
- an auxiliary bay; and
- two chimney stacks (serving four boilers).

ERM understands that once the demolition is complete, the A Station basement level concrete will remain and in other areas the ground surface will be covered with recycled crushed concrete and left vacant.

4.4 *WORKSHOPS, STORES AND COMPOUNDS*

The Main Store is located on the western side of the operational area and houses flammable gases, corrosive liquids and 200 L drums of flammable liquids, including lubricants and greases.

The Greaser Shed, located to the south of the boiler units is used to store up to 10,000 L of oil in drums.

Small quantities of dangerous goods, including oils and solvents are stored within a number of workshops located throughout the operational area. These smaller volumes of chemicals are generally stored within cabinets.

4.5 *VEHICLE REFUELLING AREA*

The Vehicle Refuelling Area is located adjacent to the Administration Building and consists of two Underground Storage Tanks which are used to store unleaded petrol and diesel, connected to two bowsers.

A single decommissioned underground storage tank is also located approximately 10 m to the north of the operational refuelling facilities and two decommissioned underground storage tanks and bowser plinth are located approximately 30 m north-west of the operational refuelling facilities. Information regarding the type of fuel historically stored within these tanks or the method of decommissioning was not available during the assessment.

4.6 *AUXILIARY FUEL STORAGE*

Vales Point Power Station uses diesel as auxiliary fuel for boiler ignition. The Fuel Oil Installation is located on the southern side of the main operational area and consists of two 1.2 ML tanks in a bunded area.

4.7 *WATER SUPPLY AND TREATMENT*

4.7.1 *Licensed Discharges to Water*

There are four licensed discharge points for water from the Power Station under EPL 761, including;

- LDP 1 - Cooling Water outlet to Wyee Bay;
- LDP 2 - Discharges to the cooling water outlet from the ash water recycle system;
- LDP 4 – Release of seepage from Ash Dam rehabilitated area at the v-notch weir located at the toe of the Dam; and
- LDP 18 – Over boarding of the Ash Dam into the Wyee Creek diversion channel and Wyee Creek.

4.7.2 *Cooling Water*

Water for the Vales Point Power Station is drawn into the inlet canal at Chain Valley Bay. The cooling water system at the Power Station is a 'once through' system, which pumps water from Lake Macquarie, through the condensers in the Power Station and discharges it at an elevated temperature back into the Lake. The outfall canal discharges into Wyee Bay.

Heat liberated during the power generation process is carried away by the cooling water passing through condensers. To ensure that the condensers remain operable, chlorine produced at the onsite plant is added to the system. The Power Station generates free chlorine on site through an electrolytic process using seawater sourced from Lake Macquarie. The chlorine plant is located to the north west of the power block and includes the bulk storage of hydrochloric acid, sodium hypochlorite and hypochlorite in ASTs.

When required, additional cooling water is sourced through the attemperation pumps and mixed with the cooling water within the outlet canal prior to its release. Excess water from the Ash Dam is also discharged into the outfall canal under conditions of the EPL 761 (see *Section 4.8*).

Due to the turbulence created by the mixing of water within the outfall canal, direct dosing with an antifoaming agent is carried out to prevent excessive foaming. Just prior to discharging into Wyee Bay a skimming system operates to reduce foam and remove oil that may be present on the surface. Pumps collect the skimmed water that is piped to a settling pond, which then discharges back into Wyee Bay.

4.7.3 *Process Water*

A number of treatment plants are present on the site to treat water used in Power Station plant processes. These include the Demineralisation Plant, Polishing Regeneration Plant and Water Reclamation Plant.

Process water is treated in the Demineralisation Plant to remove soluble impurities. The Demineralisation Plant is located to the south west of the power block and uses anion and cation exchange resin beds to purify the raw water. The raw water treated in the demineralisation plant is sourced primarily from the Water Reclamation Plant.

Bulk chemical storage associated with the Demineralisation Plant includes storage tanks for acid regeneration (sulphuric acid), storage tanks for caustic regeneration (sodium hydroxide) and storage tanks for flocculation (ferric sulphate).

The Water Reclamation Plant has two components:

- The Microfiltration (MF) Plant located at the Mannering Park Sewage Treatment Plant (STP), immediately to the east of the Vales Point Site. It is understood that the MF Plant site is leased from the Wyong council but that Delta Electricity owns the Plant equipment.

- The Reverse Osmosis (RO) Plant, located adjacent to the Demineralisation Plant.

The bulk storage of hypochlorite and ammonia are associated with both the MF

The condensate polishing plant is located adjacent to the demineralisation plant. This plant removes both particulate and dissolved contaminants to minimise the amount of contaminants entering the boiler water cycle in the feedwater. The resin used in the polishing process is regenerated in separate vessels. The bulk storage of sulfuric acid and sodium hydroxide are associated with the condensate polishing process.

Wastewater generated during the water treatment processes are disposed to the effluent sump ('Wolfy Pit'), located to the south of the power block. The effluent sump is then pumped to the Coal Settling Pond 3 and subsequently discharged to the Ash Dam.

4.7.4 *Domestic Supply and Firewater*

Water for domestic use and firefighting is taken from the Wyong Shire Council reservoir at Doyalson and stored within reservoirs at the Site.

The B Station reservoir is approximately 72,000 kL and is located near the coal stockpile.

There are two reservoirs located at the intersection of Vales Road and the Station Main Entrance Road. Both these reservoirs were previously the main water supply to A Station but with the decommissioning of A Station, the reservoir closest to the Station Main Entrance Road is now used as a head tank for the ash and dust return water system. The reservoir which is the furthest from Station Main Entrance Road is used as the water supply to Tom Barney Oval and fire hydrants along the Station Main Entrance Road.

4.7.5 *Sewage*

The Vales Point Sewage Treatment system is located outdoors to the west of the operational area and consists of an Imhoff tank with sedimentation compartment and sludge compartments and three treatment ponds, with a mechanical aeration system.

The effluent from the third pond in this system is pumped to an initial holding pond (Retention Pond 1) within the Ash Dam area via a tortuous watercourse. The effluent is then gravity fed via piping into a secondary holding pond (Retention Pond 2).

Over boarding from Retention Pond 2 flows into a reed bed and concrete drain. At the base of the drain there us a final holding pond (Retention Pond 3). This runoff is then filtered through the Mannering Creek Retention Basin on the northern side of the Ash Dam. Both Retention Pond 2 and retention Pond 3 also receive runoff from the wider Ash Dam area.

4.7.6 *Stormwater*

Operational Areas

All B Station drains are ultimately directed via the Chain Valley Retention Basin A ('Lake Rodham') prior to discharge to Chain Valley Bay. The drainage system within Station B is separated into water drained from areas where accidental oil spillage could occur (green drains) and general stormwater runoff (red drains).

The green stormwater drains are concentrated in the north eastern portion of the operational area and drain areas including the transformer bays, turbine house, auxiliary generator basement drains and chemical injection pumping area. Drainage captured by green drains is directed to the oil and grit separator ("hairy ropes"), located in the north eastern corner of the site. Waste generated in the facility is trucked from the site and the treated water is directed into the Chain Valley Retention Basin.

The red stormwater drains collect runoff from areas including the Power Station rooves, building floors, workshops and boiler house. This water is directed to the Chain Valley Retention Basin A prior to direct discharge to Chain Valley Bay, via an unlicensed discharge point. The Chain Valley Retention Basin contains an under/over weir at the discharge point and oil slick monitors are fitted to the discharge point to alarm operators if oil is detected.

The boiler house basement area, dust plant and ash plant which may receive spillage of dust, coal pyrites or oil, have their drains directed to trenches that discharge to the ash sluice for disposal to the Ash Pit.

Information regarding the historic or proposed future drainage infrastructure for the A Station area was not available during this assessment

Coal Storage and Handling Areas

The coal stockpile area is surrounded by a system of concrete drains that collect runoff from the stockpiles. These drains discharge to settling ponds (Coal Settling Ponds 1 to 3) to trap sediment and coal particulates and excess water from these ponds is piped to the Ash Dam via Settling Pond 3. Settling Ponds 1-3 are located to the north east of the Coal Plant area. Overflow from these settling ponds is discharged into the outfall canal.

The remaining coal plant area outside of the coal stockpile, drains into separate open concrete lined drains and is discharged into Coal Settling Pond 4 and 5. Coal Settling Ponds 4 and 5 are located to the north east and north west of the Coal Plant Area respectively. The water from these settling ponds is delivered directly into the outfall canal via underground drains.

The refuelling/maintenance facilities within the Coal Handling Area are covered in concrete hardstand equipped with bunding. Runoff collected from within the bunded area is directed via an oil separator and silt settling ponds into Settling Pond 2. Water collected from around the maintenance and workshop area is drained into Settling Pond 5.

4.8 ASH DAM

4.8.1 Ash Placement

The Vales Point Power Station uses coal as the fuel source to generate electricity and as a consequence produces a significant amount of by-product ash including furnace ash and fly ash. A large proportion of the ash which is produced from the Power Station is transported by wet sluicing via a water pipeline to the Ash Dam. The disposal of ash within the Ash Dam is approved under the current Vales Point Power Station EPL (Clause P1.3 of EPL 761).

The Ash Dam was initially established in the 1960s and has been expanded since this time to accommodate the additional capacity requirements of the Power Station.

The central areas of the Ash Dam, known as Pond 4, 5A and 5B, are currently active and receiving wet sluice from the Power Station. Ash settles in these upper reaches of the dam and the water is pumped back to the Power Station via ash return water pumps. The Ash Dam return water system comprises 3 pumps; with two pumps in service and one pump undergoing maintenance at any given time

A selenium demonstration plant was under construction at the time of ERM's Site inspection in December 2013, on a 0.15 ha area at the western end of the Ash Dam. The purpose of this facility is to test the ability of the plant to actively remove selenium and other trace elements from ash dam water. It is understood that the treatment process involves running ash water through steel troughs that have steel plates and steel wool installed to generate iron oxides (rust) for the treatment process. The steel wool will be disposed of within the ash dam and water will be returned to the dam.

4.8.2 *Water Management*

Water collected within the Ash Dam is returned to the Power Station for use in ash and dust transport. Excess ash dam water as a result of rainfall is discharged into the cooling water outfall canal (EPL DP2). The cooling water outfall canal subsequently discharges into Wyee Bay (EPL DP1).

The release of seepage water from the Ash Dam occurs via a v notch weir, which is a licensed discharge point (EPL DP4). A seepage return system is installed to collect seepage water from the Ash Dam embankment and pump it back to the storage.

Seepage from the Ash Dam and runoff from the Ash Dam area is also controlled by a man-made artificial wetland designed to prevent these flows from discharging directly into Lake Macquarie. This area is located on the northern side of the Ash Dam and occupies and area of approximately 5.3 ha. It is separated from Lake Macquarie by a levy that is approximately 2 m high, upon which a conveyor and road are constructed. It is not clear to what extent the water contained within this area is able to percolate through the levy into Lake Macquarie.

There are also discharges associated with discharges from the Ash Dam into Wyee Diversion Channel and subsequently into Wyee Creek, following extended periods of wet weather (EPL DP18). The Wyee Diversion Channel is a man-made channel that enters Wyee Creek approximately 3.6 km upstream of Mannering Bay. The design of Vales Point Ash Dam, allows for flows to Wyee Creek via the Wyee Diversion Channel, either as a result of overflows from the off-take tower or via overflows from the spillway.

The Wyee Creek diversion was originally licenced and operated as the main Ash Dam discharge from around 1982 until 1996. In 1996 it was decided to stop discharging into Wyee Creek following concerns about selenium levels in fish in Wyee Bay. From this time a return water system was installed to discharge water in the Vales Point outfall canal, where it is diluted before entering Lake Macquarie. Currently, discharges from the ash dam to the Wyee Creek Diversion are controlled by minimising water levels as far as practicable using the return water system but discharges still occur during periods of high rainfall.

In recent years, the dam has operated under a higher maximum storage level than was intended in the original design, to keep the exposed ash in the upper reaches of the dam moist and to minimise dust releases. This increased storage level has also however been associated with an increased risk of over boarding. A letter dated 16 August 2013, between Delta Electricity and the EPA indicated that a release from the Ash Dam to Wyee Creek occurred as recently as June 2013.

Licensed discharge point EPL3 relates to the ash dam effluent area on the eastern side of the ash dam. Historically, effluent was used for effluent irrigation to manage dust suppression.

4.8.3 Rehabilitation and Ash Reuse

The northern portion of the Ash Dam has been filled to capacity, capped and rehabilitated. The rehabilitation process involves the draining of the water within the pond and the progressive capping of the area using Virgin Excavated Natural Material (VENM) and Excavated Natural Material (ENM) to a nominal depth of approximately 450 mm. Once this layer has been compacted, a layer of topsoil, approximately 150 mm thick is added to the area and mulch is spread over the top of the capping layer. Vegetation is then established from seed.

A significant Ash reuse operation is undertaken from the Ash Dam by third party contractors. The ash recycling loading area is located in the north eastern corner of the Ash Dam area.

4.8.4 Waste Disposal

The *Central Coast Power Stations Ash Dam Management Plan 2009* (Aurecon, 2009) notes that six dump sites were located within the catchment of the Ash Dam. Information regarding the nature of the material contained within these dumps was not available at the time of the assessment but it is understood that it included asbestos.

These dump sites were closed in approximately 1995, covered and fenced off. Four of the dump areas (Dumps 1-4) have been surveyed and are fenced off. Dump 5 is located entirely within the active area of the Ash Dam. Dump Area 6 is located predominantly within the active area of the Ash Dam, with a small portion located in bushland to the east of the active portion of the Ash Dam. The locations of these areas are shown in *Figure 4*.

All current refuse is now sent offsite, with the exception of material approved for disposal within the Ash Dam by the EPA. The existing conditions for waste disposal at the Site under EPL 761 allow the disposal of a variety of waste materials within the Ash Dam. These materials are currently stockpiled at various locations throughout the Ash Dam Site.

4.9 *FIRE SUPPRESSION SYSTEM*

The fire suppression system uses a combination of water (obtained primarily from the domestic supply) and gas suppression. A water sprinkler and deluge system is located throughout the power block, with hydrants and hose reels present in the administration area and throughout the remainder of the Power Station.

Carbon dioxide (CO_2) gas is supplied to portions of the turbine generators from large CO_2 storage vessels.

A foam and deluge system is present in the fuel oil storage tank area. Information on the type of foam used in this system was not available at the time of the assessment.

5 *SITE CONTAMINATION HISTORY*

5.1 *OVERVIEW*

Information regarding the contamination status of Vales Point Power Station is limited, due to a general absence of previously conducted intrusive environmental assessments at the Site.

The current processes being undertaken at the Site have generally not changed significantly since operation of the Site commenced in 1960s, with the exception of the decommissioning and demolition of the A Station. As such, potential areas of contamination can be assessed based upon current operations, in conjunction with a review of chemical and waste inventories (*Section 4.1*), spill and incident information, a review of the limited soil and groundwater investigations completed to date (*Section 5*) and discussions with Delta Electricity staff.

Potential and actual AECs identified at the Site are presented in *Section 6*.

5.2 *NSW EPA CONTAMINATED SITE RECORDS*

The *Contaminated Land Management Record of Notices* is a public database of information regarding significantly contaminated land in NSW and is managed by the NSW EPA under the *Contaminated Land Management Act 1997*. At the time of this assessment (December 2013), Vales Point Power Station was not listed on the record and no sites within a 5 km radius of the Site were listed on the record.

NSW landowners and occupiers who believe that their sites may be contaminated above the 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, Vales Point Power Station has not been notified to the NSW EPA as being potentially contaminated. However the following nearby properties were identified as being potentially contaminated:

- Mannering Colliery, Rustles Road, Doyalson. Listed as EPA Site Management Class A, which indicated that assessment of the Site by the EPA was still in progress.

- Mannering Park Mini Mart, 70 Vales Road, Mannering Park. This property was identified as a service station. Listed as EPA Site Management Class B, which indicated that initial assessment of the Site by the EPA was still in progress.
- Parkview General Store, 2 Vales Road, Mannering Park. This property was identified as a former service station. Listed as EPA Site Management Class B, which indicated that initial assessment of the Site by the EPA was still in progress.

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*

The history of the Site as a Power Station encompasses over 40 years; as such, a comprehensive listing of spills and inadvertent released was not available as part of this assessment. ERM reviewed available information on spills, leaks and unplanned discharges in the data room and through discussions with Delta Electricity management. Specific information relevant to identifying AECs is presented in *Section 6*.

5.4 *PREVIOUS ENVIRONMENTAL INVESTIGATIONS*

The Site has undergone a limited amount of intrusive soil and groundwater assessments to date as summarised below. Works were generally completed to achieve compliance with EPL requirements and Underground Petroleum Storage System (UPSS) regulations. No comprehensive or systematic intrusive assessment of Site conditions has been undertaken.

The following section summarises the relevant reports reviewed by ERM.

5.4.1 *Groundwater Monitoring Down-gradient of the Ash Dam (Aurecon, 2013)*

At the time of ERM's Site inspection in December 2013, there were three (3) groundwater monitoring wells installed to the north of the Ash Dam.

The existing groundwater monitoring wells have been monitored since 2008 and are generally monitored on a quarterly basis. A qualitative review of this data indicates that the groundwater is saline and slightly acidic and that measured concentrations of copper, lead, nickel and zinc consistently exceed the ANZECC (2000) trigger values for marine water quality.

Site representatives indicated that a small number of additional groundwater monitoring wells were being installed by Aurecon in this area in late December 2013 in response to an EPA request for an additional investigation in form of a Pollution Reduction Programme (PRP) of this issue before the end of January 2014. This PRP relates to the elevated metal concentrations identified in groundwater.

5.4.2 *Compliance Monitoring Associated with Licensed Surface Water Discharges*

As a condition of EPL 761, Delta Electricity is required to undertake monitoring of surface waters, in associated with licensed discharges. The monitoring points are as follows;

- EPA 1 - Cooling water outlet to Wyee Bay – temperature and chlorine;
- EPA 2 - Discharges to the cooling water outlet canal from the ash water recycle system – pH, Total Suspended Solids (TSS), metals, nitrates/nitrites and phosphorus.
- EPA 4 - Seepage from ash dam rehabilitated area – TSS, metals, nitrites and phosphorus.

The surface water quality within Lake Macquarie, including pH, salinity, dissolved oxygen, temperature, water clarity and zooplankton is also monitored on a monthly basis.

A review of the data collected during these monitoring events indicates general compliance with license conditions and the ANZECC (2000) trigger values for marine water quality.

Delta Electricity is also required to monitor the quality of the discharges associated with any over boarding from the Ash Dam into Wyee Creek that exceed 2 hr duration. A review of the data collected in association with discharges from the Ash Dam into Wyee Creek indicates some exceedances of the ANZECC (2000) trigger values for marine water for lead. An ANZECC (2000) marine water quality trigger value is not available for selenium, but selenium concentrations in excess of the fresh water trigger value (11 ug/L for the protection of 95% of species) were frequently identified.

5.4.3 *Investigations Associated with the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008 (UPSS Regulations)*

A groundwater investigation was undertaken by David Lane Associates in July 2010 in relation to the UPSS.

The investigation included the installation and sampling of four (4) groundwater monitoring wells within the UPSS area. Visual and/or olfactory evidence of hydrocarbons were not noted within the wells and concentrations of Total Recoverable Hydrocarbons (TRH) and Benzene, Toluene, Ethylbenzene and Xylene (BTEX) were below the adopted ANZECC (2000) guidelines for freshwater quality in three of the four monitoring wells. A TRH (C_{10} - C_{36}) concentration of 2,540 µg/L was measured in a well installed to the north of the UPSS.

In September 2011, Douglas Partners completed a groundwater investigation in relation to the UPSS. This investigation involved the installation of six additional groundwater monitoring wells and the monitoring of all 10 wells. The results of the investigation indicated that the depth to groundwater ranged from 1.07 - 1.42 m below ground level and groundwater concentrations of BTEX, PAH and lead were all below the adopted ANZECC (2000) guidelines for marine water quality and TRH was not detected in any of the samples analysed.

David Lane and Associates completed groundwater investigations between 2011 and 2013, in relation to UPSS. The investigations involved the installation of four (4) new groundwater monitoring wells (in June 2011) and an assessment of the presence/absence of hydrocarbon sheen in these wells using a visual check and an interface probe (in July 2012 and July 2013). Hydrocarbon sheens were not detected in these investigations.

5.4.4 *Preliminary Baseline Contamination Assessment & Duty To Report Contamination Central Coast Region - Vales Point Power Station, Munmorah Power Station And Colongra Gas Turbine (GHD, January 2012).*

The objectives of the GHD report were to undertake the following:

- Provide an updated risk assessment and report on Delta's obligations to report under the CLM Act, including identification of contamination risks requiring further assessment; and
- Provide a preliminary baseline assessment of site contamination issues at each of the sites, including a preliminary contamination risk ranking and documentation of recommended or current contamination assessment, remediation or site management measures being implemented by Delta to address these.

Results for the Vales Point Power Station state that according to the *'data reviewed as part of this baseline assessment does not indicate that notification is required'*. The report also identifies 14 AECs at Vales Point, namely:

- cooling water outlet;

- aboveground fuel storage;
- refuelling area
- turbine oil tank;
- emergency diesel generator;
- Ash Dam;
- settling ponds;
- coal handling area;
- heavy vehicle wash bay;
- sewage treatment plant;
- transformer operations;
- former asbestos landfills;
- oil water separator; and
- cooling water inlet.

No intrusive investigation was undertaken as part of the GHD assessment.

6 PRELIMINARY CONCEPTUAL SITE MODEL

A Conceptual Site Model (CSM) is a qualitative description of the plausible mechanisms ('pathways') by which humans or sensitive environmental areas ('receptors') may be exposed to site contamination ('sources'). A 'Source-Pathway-Receptor' exposure mechanism is referred to as a 'SPR linkage' throughout this report.

The development of a CSM is an iterative process, staring with 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 the Site is derived from an assessment of the information reviewed to date and presented in the preceding sections of this report. The SPR linkages are specifically addressed in the following sections and a graphical representation of the preliminary CSM is presented in *Annex F*.

The first step in defining the potential the SPR linkages for a Site is to identify the Areas of Environmental Concern (AECs) which may give rise to potential contamination issues. Following a review of Site data and Site visits, a number of AECs were identified where further investigation is required to allow ERM to assess current risk (environmental, financial or regulatory). The following sections describe AECs that are considered to represent data gaps in the CSM that warrant further assessment. The location of the AECs is shown on *Figure 4* of *Annex A*.

6.1 AREAS OF ENVIRONMENTAL CONCERN

6.1.1 Main Generating Plant Area (B Station)

B Station Power Block

The main area of the Power Station contains the two power generating units previously described. The primary source of potential contamination identified in this area is potential leaks of lubricating oil and fuel at various points around the plant. Observations during the Site visit confirmed this oil loss in various areas. In particular, surface staining and/or oily surface water was noted in the area of the emergency generator diesel tank and fuel unloading area for the turbine oil storage tanks.

A major fire event fire also occurred in the 5A Air Heater in November 2011. The potential use of firefighting foam during this fire indicates that perfluorooctane sulfonate (PFOS) and/or perfluorooctanoic acid (PFOA) are Chemicals of Potential Concern (COPC) for this area, as these chemicals are components of Aqueous Film Forming Foam (AFFF), which is a component of firefighting foam.

Within the power block, leaks and spills are generally captured in internal contaminated water drains and transferred to the to the oil and grit separator and Chain Valley Retention Basin, located in the north eastern corner of the site; however larger spills which pool on the ground surface below various infrastructure and from the drainage system have the potential to directly impact underlying soil and groundwater by migration through cracks in concrete or via damaged drains.

No investigation has previously been completed within the immediate area of the power generating units due to access and safety limitations.

Workshops and Minor Dangerous Goods Storage Areas

Various small workshops are present throughout the power block which service specific areas. Many of these workshops hold small quantities of lubricating oils, solvents and similar chemicals. During the Site visit, dangerous goods were generally observed to be appropriately stored within bunded or contained areas. However, staining of the concrete surface in various areas of the workshops was observed, which indicates the potential for pooled spills and leaks to penetrate the concrete through cracks and joints into the subsurface.

No investigations are known to have been undertaken to date which specifically target the small workshops within the power block.

Power Block Drainage Network

The network of drains which runs beneath the power block represent a potential contamination source to soil and groundwater due to the subsurface nature of this network and the various COPCs (including corrosive chemicals) likely to be currently present or having been historically present as a result of the collection and conveyance of spills and leaks in various areas. In addition to the dedicated stormwater and contaminated water drainage systems, a sluiceway which transports ash and coal fines collected in various surface drains in the power block runs through the power block, eventually discharging into the Ash Dam.

No investigations are known to have been undertaken to date which specifically target the drainage network within the power block.

Power Block Investigation Approach

Conducting intrusive investigations within the B Station power block is not considered safe or possible due to the operational nature of this area. The investigations of this AEC will therefore focus on identifying COPC (of a material nature), if any, that may have migrated from this AEC.

It is considered that data collected from around the perimeter of the power block, supplemented with investigation data from other AECs, will be sufficient in terms of spatial coverage to assess the migration of COPCs from this AEC.

6.1.2 A Station

A Station Area

Vales Point A station historically contained four power generating units and associated infrastructure. At the time of ERM's Site visit, the A Station buildings were undergoing demolition and removal and ERM was unable to access the area during their December 2013 Site inspection, due to safety concerns. Site personnel indicated that this demolition process would be completed in early 2014.

The primary sources of potential contamination within the A Station area are associated with historic lubricating oil and fuel leaks at various points around the plant.

Intrusive investigations have not previously been completed within the A Station due to access and safety limitations.

Power Block Investigation Approach

The completion of intrusive investigations within the B Station power block is not considered safe or possible due to the demolition activities being undertaken. Intrusive investigations are also not considered to be possible following the completion of the demolition activities, due to the high probability of encountering unmarked subsurface utilities historically associated with the operation of the facility. The investigations of this AEC will therefore focus on identifying COPC (of a material nature), if any, that may have migrated from this AEC.

It is considered that data collected from around the perimeter of the A Station area, supplemented with investigation data from other AECs, will be sufficient in terms of spatial coverage to assess the migration of COPCs from this AEC.

6.1.3 *Transformer Area*

The Transformer Area houses the main transformers for the Site and is located immediately west of the B Station power block. In addition to the potentially contaminating activity of transformer operation, also located within this area are two temporary turbine oil storage ASTs and refuse oil storage AST No. 2.

The transformers are contained within bund systems that drain to the oil and grit separator. Waste generated in the oil and water separator is trucked from the site and the treated water is directed into the Chain Valley Retention Basin prior to discharge into Chain Valley Bay.

Based on verbal information supplied by Delta Electricity personnel during the site visit, ERM understands that a PCB removal program has been undertaken at the Site. Low concentrations of PCBs have been detected in transformer oil samples collected in 2012/2013.

In November 2006 the Vales Point Unit 6A 330/22kV Generator Transformer failed, resulting in an explosion and fire. A large volume of water and fire retardants were reported to have been used in the emergency operations associated with this event. This event is likely to have released transformer oil to the surrounding area. The potential use of firefighting foam during this fire also indicates that PFOS and/or PFOA are also COPC.

No investigations are known to have been completed within this AEC to date.

Transformer Area Investigation Approach

Conducting intrusive investigations within the Transformer Area is not considered safe or possible due to the operational nature of this area. The investigations of this AEC will therefore focus on identifying COPC (of a material nature), if any, that may have migrated from this AEC.

It is considered that data collected from around the perimeter of the power block, supplemented with investigation data from other AECs, will be sufficient in terms of spatial coverage to assess the migration of COPCs from this AEC.

6.1.4 *Main Store - Dangerous Goods Storage Area*

The Main Store compound is located on the south western edge of the operational area of the Power Station and comprises a covered section and an open lay-down area covered in concrete hardstand. This area is used for storage of various materials used throughout the Power Station, including dangerous goods.

The Main V1 Store Building houses minor quantities (< 200 L) of flammable liquids and oils in cabinets. An outdoor compound area is located to the south of the Main Store and has a roofed enclosure used to house drums of lubricants and greases. A storage area located within a brick structure to the south east of the Main Store is used to house gases and corrosive liquids.

No investigations are known to have been completed within this AEC to date.

Main Store Area Investigation Approach

Given the lack of investigation data in this AEC and the potential sources of contamination, further investigation is considered to be required to provide a baseline for this area and to assess potential material issues associated with soil and groundwater contamination.

6.1.1 *Contaminated Water Treatment System*

The oil-water separation facility treats the water captured by the contaminated water drain system at the Power Station. Water entering the facility could contain a range of potential contaminants including fuels, chemicals, coal and ash.

All the elements of the oil-water separation facility are located to the north east of the operational area. The facility comprises a sediment basin with an oil skimmer ('hairy ropes') and a separate secondary oil water separation section. Waste generated in the facility is trucked from the site for offsite disposal.

After passing through the oil-water separator, water discharges into the Chain Valley Retention Basin, located immediately to the north east. The Chain Valley Bay Retention basin contains a series of booms to further isolate oil that may enter the pond. Water from the pond enters a pit before discharge into Chain Valley Bay. The pit contains isolation valves and the outlet pipe is covered with a membrane filter as a final screen for oil and other detritus.

Visual inspection of the oil-water separation facility during ERM's site visit in December 2013 identified an oily layer of Light Non-Aqueous Phase Liquid (LNAPL) on the water within the sediment basin. While oily residue was not observed in the holding pond, dissolved phase impact may still be present in water held within the pond.

Groundwater and surface water are not monitored in the immediate vicinity of the oil-water separation system.

Contaminated Water Treatment Area Investigation Approach

Given the lack of groundwater characterization data collected in the vicinity of this AEC, coupled with the potential for impact from the oily residues and contaminated water, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions.

6.1.1 *Waste Oil Storage Area*

Waste oil in drums and containers and oily rags are stored in the waste oil collection area to the south of the oil and grit trap. This area also temporarily stores new oil drums for use in the Power Station. The area is bunded and collected stormwater from this area is pumped into the oil-water separation facility.

During ERM's site visit in December 2013, the grate in the corner of the bunded area was covered in oil at the time of the inspection. It was not clear whether this grate was attached to a sump or discharged directly to the oil-water separator.

Groundwater and surface water are not monitored in the immediate vicinity of the waste oil storage area.

Waste Oil Storage Area Investigation Approach

Given the lack of groundwater characterization data collected in the vicinity of this AEC coupled with the potential for impact from the waste oils and contaminated runoff, further investigation would be required to assess potentially material environmental issues associated with soil and groundwater conditions.

6.1.2 *Fuel Oil Installation*

The Fuel Oil Installation comprises two 1.2 ML steel ASTs, which are used for the storage of diesel. This installation is located outside the station inner security fencing and the bulk fuel oil supplies are delivered by road tanker. The volume of fuel being stored and transferred from this facility to the Site represents a significant source of potential contamination.

The ASTs are bunded with drainage from the bund discharging to the No. 1 Settling Basin for disposal to Ash Dam. Delta Electricity personnel indicated that the integrity of the bunds is regularly assessed.

No information was available at the time of assessment regarding procedures for reconciling delivery and usage volumes. Regardless of this data gap, given the limitations of wet stock reconciliation when dealing with such large volumes, there is a potential for leaks or spills to have caused the migration of contaminants to the underlying soil and groundwater.

There have been no soil and groundwater investigations completed in the area of the Fuel Oil Installation or adjacent to any of the associated pipework.

Fuel Oil Installation Investigation Approach

Given the absence of previous environmental investigations undertaken in association with this AEC, the age of infrastructure, volume of stored and transferred fuel, and the potential for historic release events to impact soil and groundwater receptors, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions.

6.1.3 *Vehicle Refuelling Depot*

The Vehicle Refuelling Area is located adjacent to the Administration Building and consists of two Underground Storage Tanks (USTs) which are used to store unleaded petrol and diesel, connected to two bowsers. Data room documents indicated that a single decommissioned underground storage tank is also located approximately 10 m to the north of the operational refuelling facilities and two decommissioned USTs and bowser plinth are located approximately 30 m north west of the operational refuelling facilities.

Tank integrity test results were not available for review during this assessment.

Soil and groundwater investigations have been completed in the areas of underground tank infrastructure to ensure compliance with relevant UPSS legislation. Four groundwater monitoring wells were installed in the UPSS area in 2010 and an additional six (6) wells were installed in 2011. In 2010, TRH(C_{10} - C_{36}) was identified at a concentration of 2,540 µg/L, in a well installed to the north of the UPSS but TPH was not detected in any of the ten (10) wells sampled in 2011. In 2011, four (4) new groundwater monitoring wells were installed and these have been subsequently assessed for the presence/absence of hydrocarbon sheen using a visual check and an interface probe. Hydrocarbon sheens were not detected in these investigations.

Vehicle Refuelling Depot Investigation Approach

Based on the previous investigation results, it is considered that material contamination related to the presence of the USTs and aboveground fuel dispensing infrastructure does not appear to be present. However, it is recommended that the existing groundwater wells are sampled to provide up-to-date baseline data in this area.

During ERM's Site visit in December 2011, Delta Electricity personnel indicated that only three (3) groundwater monitoring wells were currently present in the vicinity of the vehicle refuelling depot. It is unclear whether any of the additional wells installed between 2010 and 2011 are still present at the Site. Additional wells may therefore also need to be installed within this area.

6.1.4 *Water Treatment Plant Areas*

The Demineralisation Plant, Reverse Osmosis Plant and Polisher Regeneration Plant are located to the south west of the B Station power block. Significant quantities of sulphuric acid, sodium hydroxide, hypochlorite, ammonia and ferric sulphate are stored in ASTs in this area.

The water treatment plant area is bunded but potential damage to the bunds or bund linings surrounding some of the ASTs or corrosion of the associated pipework may have led to uncontrolled releases of chemicals to stormwater or directly to the subsurface via cracks or other preferential pathways.

Overall, the likelihood of receptors being exposed to contaminants originating from the water treatment plant area is considered to be low but no investigations are known to have been completed within this AEC to date.

Water Treatment Area Investigation Approach

Soil and groundwater investigations within the Water Treatment Area are not considered safe or possible due to the operational nature of this area. The investigations of this AEC will therefore focus on identifying COPC (of a material nature), if any, that may have migrated from this AEC.

It is considered that data collected from around the perimeter of the Water Treatment Area, supplemented with investigation data from other AECs, will be sufficient in terms of spatial coverage to assess the migration of COPCs from this AEC.

6.1.5 *Coal Storage Area*

The coal storage area is located to the south west of the power block and is used for stockpiling of coal prior to being transferred via conveyor to the coal mill and boilers. Truck washing facilities are located within this area and large area was formerly used to store biomass (primarily wood chips).

Potential contamination sources include dirty water from the truck washing facility and contaminated stormwater runoff from this area, which are captured by a system of concrete drains that discharge into the settling ponds located in the northern portion of the stockpile area. Water from the retention ponds is discharged to the Ash Dam and overflow from these settling ponds is discharged into the outfall canal. Leaching of contaminants from the coal stockpiled on open ground may also affect groundwater.

No soil or groundwater investigations are known to have been completed within this AEC to date.

Coal Storage Area Investigation Approach

Given the absence of previous environmental investigations, the volume of stored and transferred coal, and the runoff and leaching to impact soil, groundwater and surface water receptors, further investigation would be required to assess potential material environmental issues associated with this AEC.

6.1.6 *Mobile Plant Maintenance and Refuelling*

Mobile plant associated primarily with the coal storage area are serviced and refuelled in this area, located directly to the north of the coal storage area. This area also houses a diesel AST, refuse oil AST, a lubricants station and a parts cleaning facility. The refuelling/maintenance facilities are contained within a bunded area and runoff from this area is directed via an oil separator into a settling pond.

Potential contamination sources in this area include contaminated stormwater runoff from this area and leaks or spills of oils and solvents.

No soil or groundwater investigations are known to have been completed in the vicinity of the mobile plant facilities.

Mobile Plant Area Investigation Approach

Given the absence of previous environmental investigations conducted within this AEC, the storage of fuel, oils and solvents in this area and the potential for historic release events to have impacted soil and groundwater, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions within this AEC.

6.1.7 *Sewage Treatment Plant*

The Vales Point Sewage Treatment system is located outdoors to the west of the operational area and consists of an Imhoff tank with sedimentation compartment and sludge compartments and three treatment ponds, with a mechanical aeration system. The effluent from the third pond in this system ultimately discharges to the Retention Basin on the northern side of the Ash Dam.

Sewage can contain a variety of contaminants, including nitrates, metals, trace concentrations of toxic chemicals and salts. Potential contamination sources in association with the sewage treatment plant include leakage from the sewage treatment systems, associated pipework or retention basin into the underlying soil or groundwater

No soil or groundwater investigations are known to have been completed in the vicinity of the sewage treatment plant facilities.

Sewage Treatment Plant Area Investigation Approach

Given the absence of previous environmental investigations in the vicinity of the sewage treatment plant facilities and the potential for leakage to have impacted soil and groundwater, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions within this AEC.

6.1.8 **Chlorine Plant**

The Power Station generates free chlorine on site through an electrolytic process using seawater sourced from Lake Macquarie. The chlorine plant is located to the north west of the power block and includes the bulk storage of hydrochloric acid and sodium hypochlorite in ASTs.

The water treatment plant area is bunded but potential damage to the bunds or bund linings surrounding some of the ASTs or corrosion of the associated pipework may have led to uncontrolled releases of chemicals to stormwater or directly to the subsurface via cracks or other preferential pathways.

It is also noted that the transformer oil storage filtration building, associated with the TransGrid Switchyard is located immediately adjacent to the Chlorine Plant.

Overall, the likelihood of receptors being exposed to contaminants originating from the chlorine treatment plant area is considered to be low but no investigations are known to have been completed within this AEC to date.

Chlorine Plant Investigation Approach

Given the absence of previous environmental investigations in the vicinity of the chlorine plant and the potential for leakage to have impacted soil and groundwater, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions within this AEC.

The data collected within this AEC could also be used to evaluate COPCs associated with the operation of the adjacent transformer oil storage filtration building.

6.1.9 **Rail and Mandalong Coal Unloader Area**

The Rail unloader is located adjacent to the Ash Dam and the Main Northern Rail Line between Wyee and Morrisset, approximately 4.5 km to the north west of the main power block. A network of coal conveyors links this facility to the coal storage area, adjacent to the operational area of the Site.

ERM was unable to gain access to this area during the December 2013 site inspection and there is limited information available in the data room about the nature of operations in this area.

ERM understands that the facility comprises a series of hoppers, feeders and transfer points and a dust suppression system based on the use of water. Two retention ponds are located to the west of the unloader area. The *Land Management Manual Central Coast* (GHD, 2012) indicates that coal wastes are present within a bunded area in the vicinity of the conveyor loop.

A review of recent aerial imagery relating to this area indicates the presence of 9 ASTs. No information was available at the time of the assessment on the contents of these vessels. A cleared area and retention pond are present in the eastern portion of this area, approximately 600 m to the south east of the conveyor loop.

The majority of the RV coal conveyor system is at ground level with graduated elevation of conveyors at the entry into the transfer towers. Conveyors are covered to reduce the potential for dust emissions.

No soil or groundwater investigations are known to have been completed in the vicinity of the rail unloader or conveyor network.

Rail Unloader Area and Conveyor Network Investigation Approach

Given the absence of previous environmental investigations in the vicinity of the rail unloader and the potential for leakages or contaminated runoff to have impacted soil and groundwater, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions within this AEC.

The conveyor network is considered unlikely to be a source of material soil or groundwater contamination. On this basis, an intrusive investigation along the length of this infrastructure is not recommended at this stage of the assessment. A more detail inspection along the length of this network, with the aim of identifying any visual signs of contamination, would be required to determine the requirement for any intrusive investigations.

6.1.10 Ash Dam

The Ash Dam is located to the south-west of the Vales Point Power Station and covers an area of approximately 150 ha. The northern portion of the Ash Dam (Ponds 1, 2 and 3) have been filled to capacity and rehabilitated.

The Ash Dam receives ash from Vales Point via slurry pipelines and dirty water from the coal handling area and effluent pit in the Power Station. Prior to Munmorah Power Station ceasing operations, the Vales Point Ash Dam was also used for the storage of fly ash produced at Munmorah Power Station Various other solid wastes are also directed to the Ash Dam. The waste material approved for disposal in the Ash Dam under the EPL include ash, coal fines, mill pyrites, residual detergents and oil sheens, sand, concrete products, boiler blowdown, minor chemical spill residues, chemicals for environmental control, ash dam water treatment plant residues, dust returned from the ash recovery plant, marine growth, debris, seaweed, chemical cleaning solutions, oil and chemically impacted soil, desilting of settling basins, dredge spoil, waste wood, wood chips, dirty water drains, treatment plant discharges, coal handling plant stormwater, neutralised demineralisation effluent, polisher plant effluent, spent ion exchange resins, chlorine plant storage vessel precipitates, cable tunnel drainage, fabric filter bags, coal chitter and soil capping materials, coal mine dewatering discharges. Asbestos Containing Material (ACM) was also historically disposed within the dam.

Three existing groundwater monitoring wells installed to the north of the Ash Dam have been monitored since 2008 to assess seepage from the Ash Dam. Data collected from these wells indicates that seepage from the ash dam has the potential to be saline and contain elevated concentrations of heavy metals (specifically copper, lead, nickel and zinc). As a result, the EPA has requested additional groundwater investigations in this area, in form of a PRP.

Ash Dam Investigation Approach

While some environmental assessment has been undertaken in this area, it is not considered that suitable characterisation of environmental conditions has been established, and further investigation would be required to confirm soil and groundwater conditions within this AEC.

Intrusive soil and groundwater investigations within the active or rehabilitated areas of the Ash Dam are not considered necessary, as it is already acknowledged that these areas are impacted with waste materials. The investigations of this AEC will therefore focus on identifying COPC (of a material nature), if any, that may have migrated from this AEC towards sensitive receptors. Data collection within this AEC will therefore focus on the boundary areas, with a particular focus on the downgradient areas.

6.1.11 Asbestos Landfills

Six dump sites are located within the catchment of the Ash Dam. These dump sites were closed in approximately 1995. Four of the dump areas (Dumps 1-4) have been closed and covered, revegetated, surveyed and fenced. Dump 5 is located entirely within the active area of the Ash Dam. Dump Area 6 is located predominantly within the active area of the Ash Dam, with a small portion located in bushland to the east of the active portion of the Ash Dam.

Detailed information about the waste materials disposed within the landfills was not available for review as a part of this assessment but it is understood that the material disposed within these areas included asbestos. The waste materials contained within the landfill areas have the potential to impact the conditions of underlying soil and groundwater.

No soil or groundwater investigations are known to have been completed in the vicinity of the asbestos landfill areas.

Asbestos Landfill Investigation Approach

Given the absence of previous environmental investigations and the potential disposal of a variety of materials within the landfill areas, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions surrounding this AEC.

Intrusive soil and groundwater investigations within the asbestos landfills is not considered safe or necessary, as it is already acknowledged that these areas are impacted with waste materials. The investigations of this AEC will therefore focus on defining the extent of the waste areas and identifying COPC (of a material nature), if any, that may have migrated from this AEC towards sensitive receptors. Data collection within this AEC will therefore focus on the boundary areas.

6.1.12 Asbestos-containing Pipeline

Site personnel indicated that an aboveground dust pipeline transferring dust from the operational area of the Site and the Ash Dam contains asbestos. The asbestos register for the Site indicates that approximately 7 km of dust pipes at the Site contain asbestos.

Site personnel indicated that the pipe had been treated with paint to minimise the release of ACM to the environment but very limited information was available regarding the condition or maintenance of the pipeline and surface paint layer, at the time of the assessment. The potential exists for soil in the vicinity of the pipeline to have been impacted by asbestos fibres, from the degradation of this equipment.

The asbestos register for the Site identified ACM in buildings, plant, electrical equipment and fire services equipment across the operational areas of the Site.

Asbestos Investigation Approach

Given the absence of previous environmental investigations in the area of the asbestos containing pipeline, the significant length of this pipeline and the limited available information pertaining to its condition, further investigation would be required to assess potential material environmental issues associated with soil conditions surrounding this AEC.

An assessment of the potential for widespread asbestos contamination to be present across the Site would also be required to assess potential material environmental issues associated with the ACM in buildings, plant, electrical equipment and fire services equipment across the operational areas of the Site. This assessment can be undertaken in association with the investigations undertaken within AECs located across the Site.

6.1.13 Wyee Creek and Lake Macquarie Sediments

Lake Macquarie sediments and surface water have been identified as a potential AEC due to the discharges that the Lake receives from the Power Station, which include:

- cooling water that has passed through the plant and therefore:
    - has been treated with biocides and anti-scale chemicals;
    - is heated;
    - may contain traces of oil;
    - has potentially elevated salts and metals due to concentration created by evaporation.
- treated effluent from the oil-water separator associated with the operational site drainage network;
- overflow and potential seepage from the Ash Dam and associated tributary streams;
- stormwater runoff from across the Site; and
- groundwater from across the Site.

Surface water samples are collected from Lake Macquarie on a regular basis, as a part of the EPL conditions associated with the operation of the Site but the parameters analysed generally have not include metals.

Discharges to Wyee Creek are also monitored when they exceed 2 hr duration. These monitoring events have identified exceedences of the ANZECC (2000) trigger values for marine water for metals and elevated concentrations of selenium.

Wyee Creek and Lake Macquarie Investigation Approach

While some environmental assessment has been undertaken in this area, it is not considered that suitable characterisation of environmental conditions has been established.

Given the absence of available previous detailed environmental characterisation work at the Site, the numerous discharge points and sources of potential contaminants, and the presence of recreational users of the Lake, further investigation of selected depositional areas would be required to provide a baseline for this area and to assess potential material issues associated with impacts to sediment and surface water at the Site.

6.1.14 TransGrid Switchyard

The TransGrid Switchyard, although not operated by Delta Electricity, is a potential AEC due to the storage/use of transformer oil which may have historically contained PCBs. The Switchyard is located on the western side of the cooling water canal from the power block, adjacent to the chlorine plant, hydrogen plant and Site canteen.

It is also noted that the Vales Point Fire Training Area is located adjacent to the TransGrid Switchyard to the south east.

No investigations are known to have been completed within this AEC to date.

Transformer Area Investigation Approach

Conducting intrusive investigations within the Switchyard Area is not considered safe or possible due to the operational nature of this area. The investigations of this AEC will therefore focus on identifying COPC (of a material nature), if any, that may have migrated from this AEC.

It is considered that data collected from around the perimeter of the Switchyard, supplemented with investigation data from other AECs, will be sufficient in terms of spatial coverage to assess the migration of COPCs from this AEC. This perimeter data will also be used to evaluate COPCs in soils and groundwater that is associated with the vales Point Fire Training Area.

6.1.15 Fly Ash Plant Area

The Vales Point Fly Ash Plant is located next to the Power Station for the purpose of reusing the fly ash that is produced as a by-product of generating power.

ERM was unable to gain access to this area during the December 2013 site inspection and there is limited information available in the data room about the nature of operations in this area

It is understood that the fly ash is pumped directly into overhead silos located above a weighbridge and trucks are then filled from overhead while stationed on the weighbridge. The fly ash is then trucked from the Site.

No investigations are known to have been completed within this AEC to date.

Fly Ash Plant Area Investigation Approach

Given the absence of previous environmental investigations within this AEC and the limited information available at the time of this assessment regarding the nature of the operations in this area, further investigation would be required to assess potential material environmental issues associated with soil and groundwater conditions within this AEC.

6.1.16 Acid Sulfate Soil Areas

Potential Acid Sulfate Soil (PASS) conditions have been identified in a number of areas of the Site. In particular, PASS conditions are located to the north of the Ash Dam and north east of the Power Block. In the event that areas of PASS are disturbed by excavation activities or similar, Acid Sulfate Soil (ASS) conditions can occur. Acid sulfate soil conditions have the potential to adversely affect environmental receptors through the mobilisation of heavy metals.

A detailed delineation of PASS and ASS conditions within the Site is outside the scope of this assessment. During detailed environmental characterisation works undertaken across the Site however, field and laboratory indicators of ASS and PASS in soil, surface water and groundwater can be recorded.

6.2 SENSITIVE RECEPTORS

Approximately 400 ha of the Site are actively used for Site operations. Lands surrounding these active areas are maintained as buffer zones of native vegetation to segregate the Site from surrounding residential communities.

The Vales Point Land Management Plan (GHD, 2012) identified a number of threatened floral communities within the buffer zone. State Environmental Planning Policy No. 14 (SEPP 14) wetlands are located in the vicinity of the Site; immediately to the north of the Ash Dam toe drain around the fringes of Mannering Bay, on the northern edge of Mannering Bay and along the waterways within the northern buffer zones.

The sensitive receptors identified in association with the Site include;

- indoor and outdoor human health receptors in the form of onsite and offsite workers;
- intrusive maintenance workers both on and onsite;
- offsite residential receptors, living in the vicinity of the operational area or Ash Dam;
- recreational users of Mannering Bay, Wyee Bay and Chain Valley Bay;
- recreational users of Tom Barney Oval;
- aquifers beneath the Site and nearby potable and stock watering wells; and
- ecological receptors, including those in Mannering Bay, Wyee Creek, Wyee Bay and Chain Valley Bay.

Onsite water bodies that are used for operational purposes, including the Ash Dam, the cooling water canal and the various water retention, treatment and settling ponds are not considered to be ecological receptors

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 and incidental ingestion of contaminated soils/sediments;
- inhalation of vapours related to impacted soils/groundwater (e.g. in presence of high concentrations of volatile contaminants or LNAPL);
- seepage from the Ash Dam, into local creeks;
- inhalation of asbestos fibres; and
- groundwater flow into surface water bodies (e.g. Lake Macquarie).

7 *RECOMMENDATIONS FOR STAGE 2 ASSESSMENT*

Based on the results of the Preliminary ESA undertaken by ERM and consideration of Delta Electricity'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, groundwater, sediment and surface water contamination issues is proposed to assess current conditions at the Site and relevant offsite 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. It is noted that the proposed sampling locations are only indicative and will be confirmed through a Site inspection and ground-truthing process. A level of redundancy is inherent in the proposed sampling design, to account for the fact that not all of the sampling points are likely to be able to be installed on the Site due to access and safety considerations at individual locations.

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 (including water, land and sediments), 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 I 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 AECs, the most appropriate sampling design to achieve the stated project objectives is considered to be primarily based on a judgemental (targeted) sampling program, with additional sampling undertaken to provide spatial coverage for low risk areas of the Site (e.g. buffer lands) or to fill material data gaps within the CSM.

It is noted that intrusive investigations 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 are proposed 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 hectares. 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 5-1* to *5-7* of *Annex A*, with information on rationale, constituents of potential concern 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**
B Station Power Block	VA	Contamination of soil and groundwater from spills and leaks of various chemicals	Standard Suite* plus VOCs, PCBs & PFOS/PFOA	• 4 soil bores • 8 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs
A Station	VB	Contamination of soil and groundwater from spills and leaks of various chemicals	Standard Suite* plus VOCs, PCBs & PFOS/PFOA	• 3 soil bores • 7 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs
Transformer Area	VC	Contamination of soil and groundwater from spills and leaks of various chemicals	Standard Suite* plus VOCs, PCBs & PFOS/PFOA	• 2 soil bores • 5 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs
Main Dangerous Goods Store	VD	Contamination of soil and groundwater from spills and leaks of various chemicals	Standard Suite* plus VOCs	• 2 soil bores • 5 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs
Contaminated Water Treatment Plant	VE	Contamination of soil and groundwater from contaminated water from operational areas	Standard Suite* plus VOCs and PCBs	• 1 soil bores • 3 monitoring wells
Waste Oil Storage Area	VF	Contamination of soil and groundwater from leaks and spills of various waste oils and chemicals	Standard Suite* plus VOCs and PCBs	• 3 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs
Fuel Oil Installation	VG	Contamination of soil and groundwater from loss of fuel and oil	Standard Suite*	• 4 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs

Area of Environmental Concern	AEC ID	Issue	Analytes	Proposed Boreholes & Monitoring Wells
Vehicle Refuelling Depot	VH	Contamination of soil and groundwater from loss of fuel (UPSS)	Standard Suite*	• 10 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs
Water Treatment Plant Area	VI	Contamination of soil and groundwater from spills and leaks of chemicals used in water treatment processes	Standard Suite* plus pH, major cations/anions	• 2 soil bores • 3 monitoring wells
Coal Storage Area	VJ	Potential leaching of contaminants from stockpiled coal, retention ponds and truck wash facilities	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium	• 4 soil bores • 10 monitoring wells
Mobile Plant Maintenance and Refuelling Area	VK	Contamination of soil and groundwater from fuel storage/dispensing, waste oil tank and cleaning/lubricating facilities	Standard Suite*plus VOCs	• 2 soil bores • 7 monitoring wells
Sewage Treatment Plant	VL	Potential leaching of contaminants from sewage treatment facilities or retention ponds	Standard Suite*	• 1 soil bore • 3 monitoring wells
Chlorine Plant	VM	Contamination of soil and groundwater from spills and leaks of chemicals used in water treatment processes and the adjacent transformer oil storage and filling station	Standard Suite* plus pH, major cations/anions, and PCBs	• 1 soil bore • 5 monitoring wells
Rail Coal Unloader Area and Coal Conveyors	VN	Contamination of soil and groundwater from transfer line gearbox oil leaks, fugitive coal fines, current and historic fuel and coal storage, locomotive maintenance, and rail infrastructure activity.	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium	• 5 soil bores • 12 monitoring wells • Visual inspection of coal transfer lines to assess the need for further investigation
Ash Dam	VO	Contamination of soil and groundwater from ash dam leachate, waste disposal and ash slurry/return water lines with ACM.	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium, pH, major cations/anions	• 3 soil bores • 21 monitoring wells
Asbestos Landfills	VP	Contamination of soil and groundwater from current and historical waste burial	Standard Suite* plus VOCs. Asbestos in surface soil samples only	• 10 soil bores • 2 monitoring wells

Area of Environmental Concern	AEC ID	Issue	Analytes	Proposed Boreholes & Monitoring Wells
Asbestos Pipeline	VQ	Contamination of soil with ACM from ash slurry pipeline	Asbestos	• 11 soil bores for asbestos only
Sediments in Surrounding Waterways and Lake Macquarie	VR	Contamination of sediments in Wyee Creek from discharges related to the operation of the Ash Dam. Contamination of sediments in SEPP14 wetlands from Ash Dam seepage. Contamination of sediments in Lake Macquarie from discharges (drainage lines and groundwater seepage) related to Power Station operations.	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium plus PCBs and PSD and TOC for ecological risk.	• 7 sediment and surface water locations from Wyee Creek • 6 sediment and surface water locations from Mannering Bay • 4 sediment and surface water locations from Wyee Bay • 3 sediment and surface water locations from Chain Valley Bay • 3 sediment and surface water locations from the wider Lake Macquarie
TransGrid Switchyard	VS	Contamination of soil and groundwater from surface water and groundwater migrating from the TransGrid switchyard onto land operated by Delta Electricity. The Vales Point Fire Training Area is also located immediately to the SE of the TransGrid boundary and these proposed samples cover this area.	Standard Suite*plus VOCs, PCBs and PFOS/PFOA	• 1 soil bore • 5 monitoring wells
Fly Ash Plant	VT	Contamination of soil and groundwater from oil leaks and fugitive coal fines	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium	• 3 monitoring wells
Site Boundary and Buffer Areas	VU	Assessing migration of potential contamination across the Site boundaries and background conditions where there are no investigations locations as part of other AECs	Standard Suite* plus 13 metals and boron, molybdenum, thallium and selenium, pH, major cations/anions	• 3 soil bores • 20 monitoring wells • Supplemented with additional investigation locations from other surrounding AECs

Notes:

* - Standard Suite includes TRH (C_6 – C_{40}), BTEX, suite of 8 metals, PAHs, phenols. Asbestos will be analysed in one shallow fill sample at each borehole in operational areas. Field personnel to record any indicators of ASS and/or PASS identified across the investigation area

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.

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

7.2.1 *Waterways*

Sediment sampling is proposed to target potential contamination from cooling water discharges, treated water discharges and other potential instances of off-site migration of contaminants from the Site and includes sampling in four areas:

- within Wyee Bay, which receives cooling water discharges;
- within Chain Valley Bay, which receives discharges of treated water from the Chain Valley Bay Retention Basin;
- within Wyee Creek and the Wyee Creek diversion channel, which has been reported to have received unplanned overflow from the Ash Dam; and
- within Mannering Bay, which receives discharges from Wyee Creek.

The proposed sediment sampling design for these areas is targeted at the source and limited downgradient areas. A transect approach to sampling is not considered to be required initially, but may be considered upon receipt of laboratory results from the initial sediment samples. Paired sampling was not considered necessary as the primary objective of this sediment sampling program is to determine baseline conditions in the waterways surrounding the Site, not to assess variability in contaminant concentrations at each sampling location.

A grab sampler is proposed to collect sediment samples at the majority of sampling locations. However, it is also proposed that the core samples are collected at all locations in Mannering Bay, two locations in Wyee Creek and Wyee Bay, one location in Chain Valley Bay, and one background location. The core samples will allow for analysis of trends in metal concentrations in sediment concentrations over time (i.e. the depth profile of metal impacts).

7.2.2 *Existing Groundwater Wells*

Existing monitoring wells have been identified in the vicinity of the Ash Dam toe drain and within the operational Site area in the area of the UPSS. The locations of these wells are presented on *Figure 5-2 and Figure 5-5* of *Annex A.*

It is proposed that existing groundwater monitoring wells will be sampled during Stage 2 investigation works. Sampling will only occur where the groundwater monitoring wells 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;
- where bore logs are not available, wells will be assessed for suitability on a case-by-case basis; 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, sediment, surface water and groundwater investigation works will generally involve the following key steps:

- underground service location and mark-out (this may influence currently proposed investigation design);
- proposed borehole location mark-out;
- coring of hard standing surfaces where present;
- drilling and soil sampling of subsurface material using a combination of hand auger, push tube and / or auger drilling;
- sampling of sediment using either a stainless steel push tube or a grab sampler, depending on the conditions at individual locations;
- sampling of surface water using a swing sampler placed below the surface of the water;
- 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;
- test pitting/trenching using excavator or backhoe in selected locations outside of the operational area where access permits;

- reinstatement of hardstanding surfaces;
- surveying the location of boreholes and monitoring wells and marking sediment and surface water sampling points using a GPS; and
- development, measurement of standing 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 and Sediment

Soils will be logged by an appropriately trained and experienced scientist/engineer to record the following information: soil/sediment 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 Volatile Organic Compounds (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 LNAPLs/DNAPLs. 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 contaminants of potential concern listed below along with additional contaminants of potential concern 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)
- asbestos (presence/absence).

Additional contaminants of potential concern 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:

- Power Block (B Station);
- A Station demolition area;
- generator transformer areas;
- main store – dangerous goods storage area;
- contaminated water treatment plant;
- waste oil storage area;
- fuel oil installation;
- vehicle refuelling depot;
- water treatment area;
- chlorine plant;
- coal storage area;
- mobile plant maintenance and refuelling;
- sewage treatment plant;
- Ash Dam;
- asbestos landfills;
- asbestos pipeline;
- Lake Macquarie sediments;
- Rail coal unloader area, rail infrastructure and coal transfer lines; and
- fly ash plant.

In addition, the Preliminary ESA identified potential offsite sources of contamination in association with the Mannering Colliery and Chain Valley Colliery, which are leased from Delta Electricity for the purpose of coal mining operations.

Based on the results of the Preliminary ESA undertaken by ERM and consideration of Delta Electricity'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, groundwater and sediments at the established AECs for the Site, which is also considered to provide suitable spatial coverage to act as a baseline assessment.

Based on the results of the Preliminary ESA and consideration of the 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, groundwater, surface water and sediments at the established AECs 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 Delta Electricity ("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 9 December 2013 and 10 January 2014 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 (2000). *Australia and New Zealand Guidelines for Fresh and Marine Water Quality.*

Brown, R. E. and Vickery, N. M. (2007). *Gosford - Lake Macquarie, 1:100 000 Geology Sheet 9131, 9231.* Provisional. NSW Department of Primary Industries.

Centennial Coal, (2009). Environmental Assessment for the Mannering Colliery Extension of Mine Project.

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

David Lane and Associates (DLA Environmental) (2010). *Groundwater Monitoring Well Report, Vales Point Power Station, Vales Road, Mannering Park.*

National Environment Protection Council (NEPC) (April 2013). *National Environment Protection (Assessment of Site Contamination) Measure 1999*, NEPC, Canberra

Geoscience Australia (2014). Australian Stratigraphic Units Database. http://www.ga.gov.au/products-services/data-applications/reference-databases/stratigraphic-units.html. Website Accessed 8 January 2014.

Geological Survey of New South Wales (2003). Gosford-Lake Macquarie 1:100 000 Geological Sheets 9131 & 9231, provisional edition, Sydney.

National Health and Medical Research Council and National Resource Management Ministerial Council (2011). *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy.*

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

New South Wales Environmental Protection Authority (NSW EPA) (2013) *Desktop Audit of Requirements to Publish Pollution Monitoring Data. Final Audit Findings - Vales Point Power Station and Coal Unloader (Licence No. 761).* Dated 31 January 2013.

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

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

DOCUMENT 6b

Vales Point Power Station

Stage 2 Environmental Site Assessment – Part 1

Environmental Resources Management

July 2014

Delta
electricity

COMMERCIAL IN CONFIDENCE

Delta Electricity

Project Symphony – Vales Point Power Station

Stage 2 Environmental Site Assessment

Final

Ref: 0237747

July 2014

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Project Symphony -
Vales Point Power Station
Stage 2 Environmental Site Assessment

Approved by:	Peter Lavelle
Position:	*Technical Director*
Signed:	
Date:	July, 2014

Environmental Resources Management Australia Pty Ltd Quality System

Delta Electricity - Project Symphony

July 2014

Final

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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Delta Electricity to undertake a Stage 2 Environmental Site Assessment (Stage 2 ESA) at Vales Point Power Station (herein referred to as the "Site") in accordance with the work scope presented in the Preliminary Environmental Site Assessment (PESA; ERM Reference 0227637RP01) prepared by ERM.

The primary objective for the Stage 2 ESA was to develop a baseline of environmental conditions at the Site, as at or near the time of the sale of the Site. Data obtained during completion of this Stage 2 ESA may also be used to inform future management of contamination at the Site.

Investigation Methodology

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

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

Investigation Outcomes

- *The key impacts identified included benzene in groundwater in the Vehicle Refuelling Area and downgradient of the Asbestos Landfills, PFOS (a chemical associated with firefighting foams) in groundwater around the boundary of the former A Station Demolition Area and the Chlorine Plant and Total Recoverable Hydrocarbons (TRH), benzo(a)pyrene, asbestos and metals in individual soil samples across the Site.*

- *Selenium concentrations above adopted screening values were also identified in sediment samples collected from within Wyee Creek and Mannering Lake. It is considered likely that discharges from the Ash Dam, potentially including licensed discharges, runoff and groundwater flow have partially contributed to these impacts. Other potential sources within the catchment include mines, other power stations and other industries. The selenium concentrations identified in the current assessment were of the same order of magnitude as those identified in historic investigations suggesting that, as a result of changes to the management of discharges from the Ash Dam, the selenium load in Wyee Creek and Mannering Bay sediments has not increased significantly in recent years.*

- *TRH and chlorinated hydrocarbons were reported in groundwater samples collected around the boundary of former A Station Demolition Area. The former A Station area could not be investigated directly due to ongoing demolition work and thus a potential data gap exists in this area.*

- *Various metals were identified at concentrations in excess of the adopted screening values across the Site. Where metals were identified above background concentrations, impact generally appears to be localised in distinct areas of the Site. The Ash Dam and Coal Storage Area, where the creation of Acid Sulfate Soil (ASS) conditions through the disturbance of alluvial sediments, historical and current underground coal mining works and/or the long term storage of waste ash materials and coal may have contributed to the observed metal impacts in groundwater. Acidic groundwater conditions in the vicinity of the Vehicle Refuelling Area also appear to have contributed to the presence of elevated metal concentrations in groundwater in that part of the Site.*

- *Fly-tipped waste was identified on the soil surface on the eastern boundary of the Wyee Rail Coal Unloader Area in the vicinity of the publicly accessible roadway.*

Human Health and Environmental Risks

- *With the exception of the selenium impacts identified in sediment (see below), the impacts identified in soil and groundwater at the sites are generally unlikely to represent a significant risk to human health and/or the environment given appropriate ongoing management based on the current and continued use of the Site as a Power Station.*

- *The selenium concentrations measured in Wyee Creek and Mannering Bay have the potential to adversely affect marine organisms in these areas. ERM understands that elevated selenium concentrations have previously been measured in fish collected from Mannering Bay and that the NSW EPA has previously been made aware of these impacts. Signage has been posted along Rutleys Road warning the public about the potential health risks associated with the long-term consumption of fish from this area.*

- *Licensed groundwater bores are not present in the immediate vicinity of the Ash Dam, but rural residential and residential communities are located immediately to the north, west and south. If the extraction of groundwater for potable, domestic, stock watering or commercial purposes was to occur in these areas in the future, the elevated metal concentrations in groundwater may be associated with risks to human health or livestock. It is recommended that this issue is raised with the NSW EPA when discussing the next scheduled deliverable associated with Pollution Reduction Program (PRP) being implemented in the Ash Dam area. It is suggested that the NSW EPA should manage ongoing communications on this issue, given the range of potential sources of metals in groundwater in this area and potential for the wider distribution of metals in groundwater.*

- *Asbestos was detected in individual shallow soil samples collected from bare ground within the Transformer Area, Chlorine Plant and around the boundaries of the Asbestos Landfill at concentrations in excess of the adopted human health screening values. All of these areas of asbestos impact may represent a health risk if Site employees were to come into contact with them. ERM understands that Delta has recorded these sites in its Asbestos Register and that these impacts shall be managed in accordance with Delta's existing asbestos management procedures.*

Site Management and Remediation Requirements

Contamination issues that may require material management,r remediation or further investigation, based on the current and continued use of the Site as a Power Station include the metals impacts in groundwater in the vicinity of the Ash Dam. These metal impacts in the vicinity of the Ash Dam are currently managed by Delta but this is an ongoing issue which could, in a worst case scenario, be material. Estimates for ongoing costs have not been made, as these costs will be dependent on outcome of the Pollution Reduction Program (PRP) currently in place within the Ash Dam area and ongoing discussions with NSW EPA. It is also noted that elevated background metal concentrations are present in the area and that the potential exists for inputs from current and historic mining activities and other potential sources to be material.

It is noted that conducting intrusive investigations within the B Station, Transformer Area and Former A Station demolition Area was not possible, due to the health and safety issues associated with demolition works and the presence of underground services in these areas. Further assessment may be required to identify unidentified soil and groundwater impacts within these areas if the land use of the Site was to change in the future.

Requirements under the Contaminated Land Management (CLM) Act 1997

ERM considers that NSW EPA would most likely continue to manage the metals in groundwater in the vicinity of the Ash Dam under the POEO Act (1997) via the Site Environmental Protection License (EPL). The Vales Point EPL includes the requirement for monthly groundwater monitoring in the vicinity of the Ash Dam throughout 2014. It is recommended that Delta include groundwater results from within the Ash Dam Area in the next scheduled report to the NSW EPA.

It is recommended that the NSW EPA is notified regarding the benzene concentrations measured in excess of the adopted human health (drinking water) screening levels in the Vehicle Refuelling Area and Asbestos Landfills. On the basis that the identified benzene impacts do not appear to be migrating offsite, it is considered unlikely in ERM's opinion that these impacts would be considered significant enough to warrant regulation by the NSW EPA.

1 *INTRODUCTION*

On 24 November 2011, the New South Wales (NSW) Government announced that it would divest certain State-owned electricity generation assets. In order to support the sale of electricity generation assets owned and operated by Delta Electricity (a State Owned Corporation), Environmental Resources Management Australia Pty Ltd (ERM) were commissioned to undertake a Stage 2 Environmental Site Assessment (Stage 2 ESA) at Vales Point Power Station.

Vales Point Power Station, herein referred to as "the Site", is situated adjacent to the southern shore of Lake Macquarie, near the township of Mannering Park, approximately 35 km south of Newcastle, NSW. A Site location plan is presented as *Figure 1* of *Annex A*. The general Site layout is presented in *Figure 2* and *Figure 3* of *Annex A*.

The works detailed herein were completed in accordance with the work scope presented in the *Preliminary Environmental Site Assessment (PESA)* (ERM, 2014).

1.1 *OBJECTIVES*

The primary objective for the Stage 2 ESA was to gather soil, sediment, surface water and groundwater data in order to develop a baseline assessment of environmental conditions at the Site and within surrounding receiving environments (including sediment and surface water samples from Wyee Creek and Lake Macquarie), as at or near the time of the proposed transaction. Data obtained during completion of the Stage 2 ESA may also be used to inform future management of contamination issues both at the Site and in relation to the relevant receiving environments.

1.2 *APPROACH AND SCOPE OF WORK*

The adopted approach and scope of works for the Stage 2 ESA works comprised the following general tasks, in accordance with the requirements set out in the Sampling Analysis and Quality Plan (*SAQP)* defined in *Annex G* of the *PESA* (ERM, 2014):

Preliminaries

- preparation of a site-specific Health and Safety Plan (HASP) and Environmental Management Plan (EMP);
- assessment of whether suitable monitoring wells exist at the Site, and whether they can be sampled as part of this investigation;

- identification of areas and constituents of potential concern additional to those identified during the *PESA* (ERM, 2014) ;
- revision and amendment of the *SAQP* (ERM, 2014), as necessary;
- engagement of subcontractors including underground utility locators, drillers, laboratories and surveyors;
- scheduling of Site works with Delta Electricity; and
- completion of site-specific inductions and permitting.

Site Works

- ground-truthing of proposed sampling locations including clearance of underground services as noted below;
- identification of above and below ground services in the vicinity of drilling locations by reviewing publically available Dial Before You Dig (DBYD) plans and site engineering drawings, and engaging suitably qualified underground service locators;
- intrusive drilling works and environmental sampling, including soil, groundwater, sediment and surface water sampling, in accordance with the requirements of the *SAQP* (ERM, 2014);
- laboratory analysis of selected soil, groundwater, sediment and surface water samples for particular constituents of potential concern (COPC) in accordance with the requirements of the *PESA* (ERM, 2014) and *SAQP* (ERM, 2014) and as outlined in *Section 4.8;* and
- the survey of newly installed and existing monitoring wells by a registered surveyor to Australian Height Datum (AHD) and Map Grid of Australia (MGA) coordinates.

An additional round of groundwater sampling to aid in delineation of any impact identified in the original round of groundwater sampling.

Reporting

- preparation and submission of weekly progress reports to Delta Electricity; and;
- preparation and submission of this Stage 2 ESA report at the completion of works.

1.3 *MATERIALITY THRESHOLD*

For the purposes of this report, a consistent approach regarding the materiality of a contamination issue has been adopted to that utilised in the *PESA* (ERM, 2014) which was as follows:

- ERM adopted a materiality threshold of AUD 0.5 M (+ GST if applicable) per contamination source;
- material costs are those costs for that item to meet relevant requirements of NSW Environment Protection Authority (EPA) under its current land use to remediate or manage the contamination issue. Remediation or management includes additional assessment, environmental monitoring, management, containment or other remediation measures; and
- 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 has been considered material.

1.4 *REPORT STRUCTURE*

This Stage 2 ESA report has been prepared in general accordance with the NSW EPA *Guidelines for Consultants Reporting on Contaminated Sites* (EPA, 1997), as follows:

- *Section 1* - Introduction, background, objectives and scope of works;
- *Section 2* - Site setting including a summary of the Site history and Site conditions;
- *Section 3* - Data Quality Objectives (DQOs) for the works conducted;
- *Section 4* - Sampling and works methodologies for completing the investigation;
- *Section 5* - Results of the Stage 2 ESA works and Site-specific discussions and recommendations; and
- *Section 6* – Overall Discussion
- *Section 7* - Conclusions.

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

1.5 *LIMITATIONS*

The findings of this report are based on the client-approved *SAQP* within the PESA (ERM, 2014) and the scope of work summarised in *Section 1.2* of this report. ERM performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment profession. No warranties express or implied, are made.

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

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

All conclusions and recommendations made in the report are the professional opinions of the ERM personnel involved with the project and, while normal checking of the accuracy of data has been conducted, ERM assumes no responsibility or liability for errors in data obtained from regulatory agencies or any other external sources, nor from occurrences outside the scope of this project.

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

2 BACKGROUND

2.1 SITE SETTING

2.1.1 Site Identification

The Site location and the Site boundaries are presented in *Figures 1* and *2* of *Annex A*. A summary of site identification information is presented in *Table 2.1*.

Table 2.1 ***Site Identification Details***

Site Detail	Description
Site Name	Vales Point Power Station
Site Location	Vales Road, Mannering Park, NSW
Coordinates	33°09'58"S and 151°32'34"E.
Area	Total area approximately 1700 hectares (Ha)[1] Operational area approximately 180 Ha
Owner	Delta Electricity (State Owned Corporation)
Local Government	Wyong Shire Council and Lake Macquarie City Council
Title Information[2]	The Site is sub-divided into 133 Lots within 51 separate Deposited Plans.
Zoning[3]	Under the Wyong Local Environmental Plan (LEP) 2012, most of the Site including the operational area, is zoned SP2 - Electricity Generating Works. Small portions of the Site, immediately south of Wyee Bay, are zoned E2 – Environmental Conservation. Areas designated W2 – Recreational Waterways are also located along the shoreline immediately north east and north west of the Site. Under the Lake Macquarie LEP (2004), most of the Site is zoned 4(1) – Industrial (core). Areas on the periphery of the Site are zoned 9 – Natural Resources. Areas immediately surrounding Mannering Lake are zoned 7(1 and 2) – Conservation (primary and secondary) and 9 – Natural Resources. Properties zoned 1(1) – Rural were also located south west of Mannering Lake

1. Includes water canals, but excludes areas for associated mines.
2. A full list of relevant title information is presented in *Annex C* of the *PESA* (ERM, 2014).
3. Detailed zoning plans are presented in *Annex D* of the *PESA* (ERM, 2014).

A number of parcels of land within the Delta Electricity property boundaries are subject to mining leases and have been excluded from the Stage 2 scope of works. These areas have been considered to be potential offsite sources of contamination for the purposes of this assessment. These areas include;

- the Mandalong Mine delivery infrastructure adjacent to the Wyee rail coal unloader;
- the Mannering Colliery; and
- the Chain Valley Colliery.

These areas are detailed in *Figure 2 of Annex A*.

A Microfiltration (MF) Plant is located at the Mannering Park Sewage Treatment Plant, immediately to the east of the Vales Point Site. It is understood that the MF Plant site is leased from Wyong Shire Council but that Delta Electricity owns the plant and equipment. This area has also been excluded from the Stage 2 scope of works.

2.1.2 *Site Features*

The Site is composed of the following key features:

- Vales Point Power Station and associated infrastructure. Vales Point Power Station was built in the 1960s as a four-unit station (the former A Station). These generating units were decommissioned in the late 1980s and the aboveground structures were being demolished at the time of this investigation. Vales Point now operates two 660 MW generating units, with a total generating capacity of 1320 MW of electricity (B Station);
- ash dam and associated pipelines for ash slurry and return water;
- coal storage area, including a truck wash down area, refuelling and maintenance area and settling ponds;
- conveyors transporting coal from nearby mines to the Site;
- waste disposal areas, including six former asbestos dumps;
- several water treatment systems, including a demineralised water plant, a chlorine plant, a reverse osmosis plant and an oil and grit trap;
- buffer lands surrounding the infrastructure described above, this includes State Environmental Planning Policy (SEPP) 14 listed wetlands to the north and west of the Site;
- the Wyee Rail coal unloader and Rail to Vales Point conveyor system (referred to as RV conveyor system, located to the north west of the operational area;
- a fly ash loading plant, owned and operated by Adelaide Brighton Cement (trading as Morgan Ash), to the south east of the operational area.

For the purpose of this assessment, the Site has been divided into 21 individual Areas of Environmental Concern (AECs), according to usage and the presence of potential sources of contamination, as follows;

- VA - B Station Operational Area;
- VB - former A Station Demolition Area;
- VC - Transformer Area;

- VD – Main Dangerous Good Store;
- VE – Contaminated Water Treatment Plant;
- VF – Waste Oil Storage Area;
- VG - Fuel Oil Installation;
- VH- Vehicle Refuelling Area;
- VI – Water Treatment Area;
- VJ – Coal Storage Area;
- VK – Mobile Plant Area;
- VL – Sewage Treatment Plant;
- VM – Chlorine Plant;
- VN – Wyee Rail Coal Unloader;
- VO – Ash Dam;
- VP – Asbestos Landfills;
- VQ – Dust Line;
- VR – Wyee Creek and Lake Macquarie Sediments and Surface Waters;
- VS – TransGrid Switchyard;
- VT – Fly Ash Plant
- VU – Site Buffers and Boundaries

The locations of the AECs are illustrated in *Figures 6.1* to *6.6* of *Annex A*.

2.1.3 *Surrounding Environment*

The Site is surrounded by residential properties, remnant bushland and industrial properties, as well as waterways and areas of protected wetlands.

Key industrial uses in the area include:

- Chain Valley Colliery, approximately 750 m south east of the operational area;

- Mannering Colliery, approximately 1.8 km south of the operational area;
- the Mandalong coal mine delivery infrastructure located approximately 5 km to the north west; and
- a municipal sewage treatment plant, located approximately 1 km south west of the operational area, or immediately west of the Site boundary.

The closest residential areas to the Site include:

- Mannering Park, located north of the Site approximately 600 m from the operational area;
- Doyalson East, located approximately 300 m south of the Ash Dam
- Kingfisher Shores, approximately 2 km south east of the operational area and 1.6 km north east of the Ash Dam; and
- Wyee, located approximately 150 m east of the Ash Dam; and
- Wyee Point, located directly to the east of the north western leased mine area.

Rural residential properties are also located immediately to the north of the Ash Dam area and to the south of the Ash Dam area along Wyee Rd.

The Site is surrounded by areas of remnant bushland. Ecologically significant areas or recreational areas of note surrounding the Site include:

- State Environmental Planning Policy (SEPP) No. 14 protected wetlands located along the northern and eastern perimeter of Mannering Lake. The wetlands located on the eastern perimeter of Mannering Lake are also located within approximately 100 m of the Ash Dam toe drain system;
- SEPP 14 protected wetlands are also located on either side of Wyee Creek, approximately 1 km north of the Ash Dam;
- Tom Barney Oval is located immediately to the south west of the operational area. Based on discussions with the Site Environmental Officer, this oval is occasionally booked out for sporting events, and is regularly accessed by the public;
- Chain Valley Bay Reserve is located 1 km south of the operational area. Public use of this area appeared to be limited based on the lack of amenities and cleared areas; and
- Recreational fishing and boating activities are also undertaken in Lake Macquarie, including Mannering Bay, Chain Valley Bay and Wyee Bay.

2.2 ENVIRONMENTAL SETTING

2.2.1 *Topography*

The Site is located on the coast of Lake Macquarie, in between Wyee Bay and Chain Valley Bay. The operational area of the Site is generally flat and lies at an average elevation of approximately 3 m Australian Height Datum (AHD).

A ridge lies along the eastern boundary of the operational area and the Fuel Oil Installation, Fly Ash Plant, Coal Storage Area and Mobile Plant Area are located at between approximately 8 and 20 m AHD to the east and south of this ridge. To the west of the operational area the Site slopes upwards towards the Sewage Treatment Plant, at an elevation of approximately 10 m AHD.

The Ash Dam has been constructed within a natural valley, from the ridge to the south orientated to the north east, towards Mannering Bay, with a slight incline towards the north west, where it discharges into Wyee Creek.

The Wyee Rail Coal Unloader area lies at between approximately 18 and 50 m AHD, with a slope towards Lake Macquarie in the east.

2.2.2 *Hydrology*

The Site is located in the Lake Macquarie catchment area, with Lake Macquarie identified as the main local hydrological feature. Local waterways can be summarised as follows:

- Chain Valley Bay, located immediately to the north east of the Site;
- Mannering Bay with Wyee Bay immediately beyond, located immediately north of the Site;
- the Vales Point cooling water canal, which enters the Site at Chain Valley Bay and exits the Site at Wyee Bay;
- Chain Valley Retention Pond (also known as Lake Rodham), located approximately 300 m north east of the operational area, forms a part of the Site contaminated water management system;
- Wyee Creek and the Wyee Creek diversion channel is located along the north western site boundary and function as part of the Ash Dam overflow system;
- Mannering Lake, which forms part of the Vales Point Ash Dam;
- three settling ponds associated with the sewage treatment works on Site, located 500 m north west of the operational area; and

These dykes have a regional spacing of approximately 0.2 km to 2 km with strike lengths in excess of 2km in the study area. The geology map further indicates the presence of a north-west to south-east striking fault with a south-westerly dip in the southern section of the ash dam.

Extensive underground coal mining activities are present in the region with target coal seams occurring in the late Permian Newcastle Coal Measures (a predominantly sandstone and coal sequence with lesser siltstone) that underlie the Clifton Subgroup. The Mannering Colliery, which undermined sections of the Site, targets the Great Northern and Fassifern coal seams. The Great Northern seam, which overlies the Fassifern seam, is located between approximately 140 to 155 metres below ground level (m bgl) in the area (Centennial Coal, 2009).

The local geology, as encountered during the drilling program undertaken as part of Stage 2 ESA, is discussed further in *Section 5.1* of this report.

The GHD (2012) *Delta Coast Land Management Manual* identified that there is a high risk of Potential Acid Sulfate Soil (PASS) conditions being present in a number of areas of the Site, including areas to the north of the Ash Dam and north east of the Power Block. A detailed delineation of PASS conditions within the Site is outside the scope of this assessment as they are a naturally occurring geological condition and unrelated to the operations on the Site. The presence of actual acidic ground conditions (which may have been created via the disturbance and oxidation of soils or modification of hydrogeological conditions) has been assessed via field observations (e.g. presence of jarosite) and the measurement of field parameters including pH and ORP during groundwater monitoring (refer to *Section 4.4*).

2.2.4 *Hydrogeology*

Regional Hydrogeology

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

- Moderately permeable Quaternary sediments. While the geological map indicates that the sediments consist predominantly of sand and gravel, the available information from the intrusive works conducted at the Site indicate that there is a relatively high degree of fine grained material within the sediments (which have generally been described as sandy clay) which would constrain the permeability of the sediments.

- Moderate to relatively highly permeable conglomerate and sandstone, with permeability largely governed by the degree of fracturing in the conglomerate and sandstone.

- Low permeability siltstone and claystone.

- Moderate to relatively highly permeable coal seams within the Newcastle Coal Measures, with permeability governed by the degree of cleat development and fracturing within the coal seams.

Regional groundwater flow is expected to be towards Lake Macquarie, which is generally located to the north and north east of the Site. Temporal and localised variations in the direction of groundwater flow is considered likely given the low lying nature of the area and the presence of tidally influenced lakes, and the effects of increased hydraulic head created by the wet disposal ash dam.

The presence of dykes that have intruded into the Munmorah Conglomerate further present potential localised barriers to groundwater flow.

Details of hydrogeological conditions encountered during this Stage 2 ESA are summarised in *Section 5.2*.

2.2.5 *Groundwater Use*

The alluvial aquifers and shallow conglomerate and sandstone aquifers are the prime aquifers used in the region for stock and domestic supplies. Mining activities have extensively impacted the deep coal seam aquifers in the region, with extensive depressurisation of the coal seams having taken place in the region. Use of the coal seams aquifers for stock and domestic purposes are further restricted by the general high salinity of groundwater within the coal seams (Centennial Coal, 2009).

The NSW Natural Resource Atlas online bore register (accessed 17 December 2013) (NSW Government) identifies six groundwater bores within a 5 km radius of the Vales Point Power Station.

One groundwater bore, located approximately 700 m north of the Site in Mannering Park, is reportedly used for domestic purposes. The Standing Water Level (SWL) was recorded in this well at 5.5 m bgl. One groundwater bore, located approximately 1 km south west of the Power Station operational area and 600 m north of the Ash Dam is reportedly used for stock (poultry) watering purposes. The remaining four groundwater bores were reported to have been installed for test or monitoring purposes, with SWL recorded in three of these bores at 6 m bgl.

2.3 *SITE OPERATIONAL HISTORY*

Construction of the Power Station commenced in 1963 with construction of A Station, and B Station was completed in the early 1980s. Ancillary additions have been made to the Power Station since construction was completed in the early 1980s, including the construction of the sewage treatment area and additional settlement ponds. At the time of completion of the Stage 2 ESA, the A Station buildings were undergoing demolition and removal offsite.

Further detailed information regarding the history and operation of the Site, including historical aerial photographs, zoning and environmental approvals, licenses and management is presented in the *PESA* (ERM, 2014).

2.4 *NSW EPA CONTAMINATED SITE RECORDS*

The *Contaminated Land Management Record of Notices* is a public database of information regarding significantly contaminated land in NSW and is managed by the NSW EPA under the *Contaminated Land Management Act 1997 (CLM Act 1997)*.

At the time of this assessment, the Site had not been notified to the NSW EPA as being potentially contaminated. As part of the *Preliminary Baseline Contamination Assessment & Duty to Report Contamination Central Coast Region - Vales Point Power Station, Munmorah Power Station And Colongra Gas Turbine* (GHD, 2012) concluded that '*data reviewed as part of this baseline assessment does not indicate that notification is required*'. The following nearby properties were identified on the *NSW EPA List of Contaminated Lands Notified to the EPA* as properties where it has yet to be determined whether contamination is significant enough to warrant regulation under the *CLM Act 1997*:

- Mannering Colliery, Rutleys Road, Doyalson. Listed as EPA Site Management Class A, which indicated that assessment of the Site by the EPA was still in progress.

- Mannering Park Mini Mart, 70 Vales Road, Mannering Park. This property was identified as a service station. Listed as EPA Site Management Class B, which indicated that initial assessment of the Site by the EPA was still in progress.

- Parkview General Store, 2 Vales Road, Mannering Park. This property was identified as a former service station. Listed as EPA Site Management Class B, which indicated that initial assessment of the Site by the EPA was still in progress.

2.5 *PREVIOUS ENVIRONMENTAL INVESTIGATIONS*

The Site has undergone a limited number of historical intrusive soil and groundwater assessments which are described in the *PESA* (ERM, 2014). Works were generally completed to achieve compliance with EPL requirements and Underground Petroleum Storage System (UPSS) regulations.

Previous environmental investigations reviewed included:

- groundwater monitoring undertaken down-gradient of the ash dam by Aurecon in 2013. It is understood that additional groundwater monitoring wells were being installed by Aurecon in this area in late December 2013. The installation of these groundwater wells is part of an additional investigation of elevated metals concentrations in groundwater undertaken by Delta to comply with the Pollution Reduction Programme (PRP) notice on the POEO licence.

- surface water monitoring associated with licensed discharges as a condition of EPL 761;

- investigations associated with the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008 (UPSS Regulations) including routine groundwater monitoring by David Lane Associates and Douglas Partners between 2010 and 2013; and

- a preliminary (non-intrusive) baseline assessment of contamination issues (GHD, 2012). This included a preliminary contamination risk ranking, recommendations for contamination assessment, remediation or site management measures and a summary of Delta Electricity's obligations to report under the CLM Act 1997 based on the available information for the Site. The GHD (2012) report also identifies 14 areas of environmental concern (AECs) at the Site.

2.6 *POTENTIAL AND KNOWN SOURCES OF CONTAMINATION*

Potential AECs were identified in the *PESA* (ERM, 2014) based upon current operations, in conjunction with a review of chemical and waste inventories, spill and incident information, a review of the limited soil and groundwater investigations completed to date and discussions with Delta Electricity staff.

Potential and actual AECs identified at the Site are presented in *Table 2.2*.

Table 2.2 ***Summary of Areas of Environmental Concern***

I.D.	Name	Description
VA	B Station Power Block	The primary source of potential contamination identified is potential leaks or spills of lubricating oil and fuel at various points which may migrate through cracks in concrete or via damaged drains. A major fire event fire occurred in the 5A Air Heater in 2011 and Aqueous Film Forming Foam (AFFF) constituents (used in firefighting foams) are therefore potential COPCs. The network of drains which runs beneath the power block may also be a source of impact.
VB	Former A Station	The primary sources of potential contamination within the former A Station area are associated with historic lubricating oil and fuel leaks at various points.
VC	Transformer Area	Potential for PCBs associated with transformer operation and oil storage in ASTs. In 2006 the Vales Point Unit 6A 330/22kV Generator Transformer failed, resulting in an explosion and fire. Aqueous Film Forming Foam (AFFF) constituents are therefore potential COPCs.
VD	Main Dangerous Goods Store	Storage of flammable liquids, oils, lubricants, greases and corrosive liquids.
VE	Contaminated Water Treatment Plant	Treatment of the water captured by the contaminated water drain system at the Power Station. Water entering the facility could contain a range of potential contaminants including fuels, chemicals, coal and ash.
VF	Waste Oil Storage Area	Storage of waste oil in drums and containers and oily rags.
VG	Fuel Oil Installation	Storage of diesel in 2 ASTs.
VH	Vehicle Refuelling Depot	Underground Storage Tanks (USTs) (current and decommissioned) used to store unleaded petrol and diesel.
VI	Water Treatment Plant Area	Significant quantities of sulfuric acid, sodium hydroxide, hypochlorite, ammonia and ferric sulfate are stored in ASTs in this area.
VJ	Coal Storage Area	Leaching of contaminants from the coal stockpiled on open ground may affect groundwater. Dirty water from the truck washing facility and contaminated stormwater runoff.
VK	Mobile Plant Maintenance and Refuelling	Potential contamination sources include contaminated stormwater runoff from this area and leaks or spills of oils and solvents.
VL	Sewage Treatment Plant	Potential contamination sources associated with the sewage treatment plant include leakage from the sewage treatment systems, associated pipework or retention basin into the underlying soil or groundwater. Sewage can contain a variety of contaminants, including nitrates, metals, trace concentrations of toxic chemicals and salts.
VM	Chlorine Plant	The water treatment plant area is bunded but potential damage to the bunds or bund linings surrounding some of the ASTs or corrosion of the associated pipework may have led to uncontrolled releases of chemicals to stormwater or directly to the subsurface via cracks or other preferential pathways. It is also noted that the transformer oil storage filtration building, associated with the TransGrid Switchyard is located immediately adjacent to the Chlorine Plant.

I.D.	Name	Description
VN	Rail Coal Unloader Area and Coal Conveyors	Storage and transport of coal and coal wastes.
VO	Ash Dam	The Ash Dam receives ash from Vales Point via slurry pipelines and dirty water from the coal handling area and effluent pit in the Power Station. Prior to Munmorah Power Station ceasing operations, the Vales Point Ash Dam was also used for the storage of fly ash produced at Munmorah Power Station. Various other solid wastes are also directed to the Ash Dam in accordance with EPL 761.
VP	Asbestos Landfills	Six known dump sites are located within the catchment of the Ash Dam.
VQ	Dust Line	Aboveground dust pipeline transferring dust from the operational area of the Site and the Ash Dam contains asbestos.
VR	Sediments in Surrounding Waterways	Lake Macquarie sediments and surface water have been identified as a potential AEC due to the discharges that the Lake receives from the Power Station including cooling water, treated effluent, overflow and potential seepage from the Ash Dam, stormwater and groundwater
VS	TransGrid Switchyard	TransGrid Switchyard, although not operated by Delta Electricity, is a potential AEC due to the storage/use of transformer oil which may have historically contained PCBs. The Vales Point Fire Training Area is located adjacent to the TransGrid Switchyard
VT	Fly Ash Plant Area	Operations associated with the management of fly-ash by-products.
VU	Buffer Lands and Boundaries	General baseline conditions and offsite migration.

2.7 *SENSITIVE RECEPTORS*

The sensitive receptors identified in association with the Site include:

- indoor and outdoor human health receptors in the form of onsite and offsite workers;
- intrusive maintenance workers both on and offsite;
- offsite residential receptors, living in the vicinity of the operational area or Ash Dam;
- recreational users of Mannering Bay, Wyee Bay and Chain Valley Bay;
- recreational users of Tom Barney Oval;
- aquifers beneath the Site and nearby potable and stock watering wells; and
- ecological receptors, including those in the vegetated buffer lands and aquatic environments of Mannering Bay, Wyee Creek, Wyee Bay and Chain Valley Bay, including SEPP 14 protected wetlands along the northern and eastern perimeter of Mannering Lake, and either side of Wyee Creek.

Onsite water bodies that are used for operational purposes, including the Ash Dam, the cooling water canal and the various water retention, treatment and settling ponds, are not considered to be ecological receptors.

The *Delta Coast Land Management Manual* (GHD, 2012) provides information on the uses of the various areas of the Site, including operational areas (including those allocated for power generation activities, ash storage areas, coal conveyors, canals, pipelines and coal storage areas) and buffer lands. Within the buffer lands are areas of vegetation and decommissioned and operational coal mines. GHD (2012) indicates that threatened flora and fauna has been identified in the buffer lands surrounding the Ash Dam and the Wyee Rail Coal Unloader.

3 *DATA QUALITY OBJECTIVES*

Data quality objectives (DQOs) were developed to define the type and quality of data required to achieve the project objectives outlined in *Section 1.1* of this report. The DQOs have been prepared in line with the seven-step approach outlined in National Environment Protection (Assessment of Site Contamination) Measure 1999 (ASC NEPC, 2013), and with reference to relevant guidelines published by the NSW EPA, ANZECC/ARMCANZ, and NEPC.

The DQO process is validated, in part, by the Quality Assurance and Quality Control (QA/QC) procedures and assessment, summarised in *Section 5.5* and presented as *Annex F* of this report.

The seven steps of the DQO process, and how they were applied to this assessment, are presented in the following sections.

3.1 STEP ONE: STATE THE PROBLEM

A statement of the problem is provided by the particular objectives of the assessment as stated in *Section 1.1.* Background information is provided by *Sections 1* and 2 of this report, and by the conceptual site model (CSM) which was initially developed as part of the *PESA* (ERM, 2014).

3.2 STEP TWO: IDENTIFY THE DECISION

Decision Statements

The principal decision to be made is:

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

Additional decisions to be made include:

- Is there sufficient data to provide an environmental baseline at the time of the transaction?

- What is the nature and extent of soil, surface water and groundwater impact on or beneath the Site?

- What is the nature and extent of sediment and surface water and impact to surrounding water bodies?

- Does the impact at the Site represent a risk to human health, based on the current and continued use of the site?

- Is the impact at the Site likely to warrant notification and / or regulation under the *NSW Contaminated Land Management Act, 1997*?
- Is material remediation likely to be required?

Adopted screening values which informed these decisions are identified below in *Section 4.10*.

3.3 *STEP THREE: IDENTIFY INPUTS TO DECISION*

The inputs required to make the above decisions are:

- existing relevant environmental data, taking into consideration the number and location of existing soil and groundwater sampling locations, the construction of existing groundwater monitoring wells and the date of the most recent sampling events;
- direct measurement of environmental variables including soil/sediment type, soil gas concentrations, odours, staining or other visual evidence of potential contamination, water strike, groundwater level and water quality parameters;
- collection and laboratory analysis of soil, groundwater, sediment and surface water samples for identified COPCs;
- field and laboratory QA/QC data; and
- comparison of data against adopted screening values (outlined in *Section 4.10*).

3.4 *STEP FOUR: DEFINE THE STUDY BOUNDARIES*

Spatial Boundaries

The Site location and description is provided in *Section 2*. Figures identifying the Site boundary and investigation areas are presented in *Annex A*. The investigation included the surface and subsurface soils as well as groundwater beneath the site but the vertical boundaries of the investigation were limited to the depth of borehole advancement.

Temporal Boundaries

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

Constraints within the Study Boundaries

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

- location of underground or overhead services or infrastructure;
- the condition of existing monitoring wells; and
- access restrictions, such as flooded areas.

3.5 STEP FIVE: DEVELOP A DECISION RULE

The DQOs were designed to facilitate the collection of adequate soil, sediment, surface water and groundwater data to address the decisions in Step 2 of the DQO process. Decision Rules were therefore developed both in relation to evaluating the nature and extent of soil, surface water and groundwater impact on or beneath the Site and the adequacy of the data set, as outlined herein.

3.5.1 *Sample Locations*

Where these constraints were identified, boreholes and monitoring wells were moved (where possible to nearby locations) and where drilling was not feasible, surface soil samples were collected to assess direct contact pathways. Additionally monitoring wells that could not be successfully drilled to depth were converted to soil bores.

In areas which could not be accessed for drilling or where the abovementioned constraints prevented the installation of groundwater monitoring wells, monitoring wells were located around the perimeter of the inaccessible area where possible. The distribution of monitoring wells around the perimeter of AECs was then evaluated to assess whether it provided an understanding of groundwater conditions up-gradient and down-gradient to assess the potential extent of contamination and identify potential for migration of contaminants.

Deviations from the Stage 2 program were tracked during the course of the investigation via the weekly progress spreadsheet and were communicated to the relevant project stakeholders.

A summary of the investigation locations proposed and installed and evaluation of the adequacy of spatial coverage of the Site is presented in *Section 4.1* of this report.

3.5.2 *Field and Laboratory QA/QC*

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

In the event that acceptable QC limits were not met, the field observations of the samples were reviewed for obvious sources for the non-conformance (such as an error in sampling, preservation of sample(s) or heterogeneity of sample(s), etc.) If obvious sources of the non-conformance were not identified, liaison with the laboratories was undertaken to identify the issue that had given rise to the non-conformance.

In the event that acceptable QC limits were not met, the impact of these non-conformances was also evaluated in relation to adequacy of the data set facilitate the collection of adequate soil, sediment, surface water and groundwater data to address the decisions in Step 2 of the DQO process.

The acceptable limits on decision errors applied during the review of the results are discussed in *Section 3.6* and a summary of the QA/QC procedures is presented in *Section 4.9* and *Annex F* of this report.

3.5.3 *Screening Values*

Groundwater, sediment and surface water data, along with the maximum, minimum, mean, standard deviation and 95% upper confidence limit (UCL) of the mean concentration (if required) were compared to screening values to provide a screening value assessment of potential risks that may be associated with the SPR linkages that have been identified for this Site.

The adopted screening values have generally been sourced from guidelines made or approved under the *CLM Act 1997*, which includes the *ASC NEPM* (ASC NEPC, 2013). Where alternative sources have been utilised, appropriate justification has been provided. The specific assessment levels adopted are presented alongside the analytical data in the summary tables presented in *Tables 4a-u and 5a-u* of *Annex B*. The screening values are discussed in detail in *Section 4.10*.

Individual soil, groundwater, sediment and surface water data, along with the maximum, minimum, mean, standard deviation and 95% upper confidence limit (UCL) of the mean concentration (if required) were compared to adopted screening values.

Exceedance of adopted screening values does not necessarily indicate the requirement for remediation and/or a risk to human health or the environment. The approach to the screening of the data gathered in this assessment has generally been to initially adopt conservative assessment values. Any exceedances of these values have then been evaluated on a case by case basis, in light of the specific characteristics of the individual sample and the area of the Site from which the sample was collected. The extent of the impact, the potential for receptors to be exposed to the impact, and regulatory compliance was also considered.

If individual or 95% UCL concentrations exceeded the adopted screening values and these exceedances were evaluated to be associated with a potentially complete SPR linkage, these results were considered to be indicative of actual or potential material contamination issues relevant to the sale of the Site, as per DQO Step 2 (*Section 3.2*).

3.5.4 *Appropriateness of Laboratory Limit of Reporting*

Comparison of the laboratory Limit of Reporting (LOR) to the screening values has been undertaken to confirm that the screening values are less than the laboratory LOR. In the event that the screening value is greater than the laboratory LOR, consideration has been given to the significance of this result, with specific reference to addressing the Decisions in Step 2 of the DQO process.

An evaluation of the screening values with reference to the laboratory LORs is provided in *Section 5.5*.

3.6 *STEP SIX: SPECIFY LIMITS ON DECISION ERRORS*

The primary output from Step 6 of the DQO Process is a set of acceptance criteria that the collected data should achieve in order to minimise the possibility of either making a decision error or failing to keep uncertainty limits with acceptable levels (US EPA , 2006).

The acceptable limits on decision errors applied during the review of the results has been based on the Data Quality Indicators (DQIs) of Precision, Accuracy, Representativeness, Comparability and Completeness (PARCC) in accordance with (NHMRC and NRMMC, 2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013*, Schedule B3 - Guideline on Laboratory Analysis of Potentially Contaminated Soils.

The potential for significant decision errors was also minimised by:

- completing a robust QA/QC assessment of the validation data and application of the probability that 95% of data will satisfy the DQIs, therefore a limit on the decision error would be 5% that a conclusive statement may be incorrect (see *Section 4.9*);
- assessing whether appropriate sampling and analytical density has been achieved for the purposes of providing a baseline of soil, sediment and groundwater conditions at the point of transaction (see *Section 4.1*); and
- ensuring that the screening values adopted were appropriate for the ongoing use of the site as a power generation facility (see *Section 4.10*).

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

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

4 INVESTIGATION METHODOLOGY

4.1 SAMPLING LOCATIONS

Based on a review of the available data, the most appropriate sampling design to achieve the stated project objectives was considered to be primarily based on a judgemental (targeted) sampling program, which provides good coverage of operational areas and minimal additional sampling undertaken to provide spatial coverage for low risk areas of the site (e.g. buffer lands) or to fill material data gaps within the CSM.

Given the scale of the site, different sampling densities were adopted based on estimated contamination risk and logistical constraints of different areas of the site. The sampling approach was generally in accordance with the NSW EPA *Sampling Design Guidelines* (NSW EPA, 1995) which does not recommend a minimum number of sampling points for sites larger than 5 ha. As recommended in these guidelines, the Site has been divided into smaller areas of concern based on a review of historical activities and identified potentially contaminating activities. Judgemental sampling was adopted to target potential sources for all AECs.

It is noted that intrusive investigations were limited to areas where access and site activities enabled investigations to occur without unacceptable health and safety risks to personnel and/or unacceptable disruption to site operations. The sampling plan was discussed with site management prior to the commencement of works to assess this risk and was subject to alteration.

The main constraints on the implementation of the Stage 2 program were the presence of subsurface and overhead utilities and access restrictions within the buffer zone. Where these constraints were identified, the Decision Rules outlined in Step 5 of the DQO process (*Section 3.5.1*) were implemented

The proposed Stage 2 program included soil samples from 188 locations and groundwater samples from 133 locations. The completed Stage 2 program included soil samples from 173 locations and groundwater samples from 89 locations. An evaluation of the proposed and completed investigation locations for each AEC is provided in *Table 8 of Annex B* and on this basis it is considered that the number and distribution of completed boreholes and monitoring wells is sufficient for characterising soil and groundwater conditions for the purpose of this baseline assessment.

Deviations from the Stage 2 program were tracked during the course of the investigation via the weekly progress spreadsheet and were communicated to the relevant project stakeholders. An extract of the weekly progress spreadsheet is provided below as *Table 4.1* which highlights locations proposed but abandoned and the monitoring wells proposed but changed to soil bores during the course of the investigation.

Table 4.1 *Vales Point Power Station – Locations Abandoned or Changed to Soil Bores*

AEC	Location ID	Location Type	Change Details	Comments
VA	VA_MW07	Monitoring Well	Abandoned	Abandoned due to proximity of overhead and underground services. Surface is concrete hardstand.
VA	VA_MW08	Monitoring Well	Abandoned	
VA	VA_SB04	Soil Bore	Abandoned	
VB	VB_MW04	Monitoring Well	Abandoned	Abandoned due to proximity to critical services (stormwater and sewer which could not be identified using CAT GPR). Surface is concrete hardstand.
VB	VB_MW06	Monitoring Well	Abandoned	Locations are in an area containing deep stormwater drains and thick concrete rails used to move transformers. Not possible to drill in this location. Not possible to move location as area is confined by canal and former A station
VB	VB_MW07	Monitoring Well	Abandoned	Abandoned due to proximity to critical services (High Voltage Kiosk) that are not shown on plans. No safe location to move to.
VB	VB_SB02	Soil Bore	Abandoned	Abandoned due to the presence of multiple services in the area. No safe area to move location to.
VB	VB_SB04	Soil Bore	Abandoned	Locations are in an area containing deep stormwater drains and thick concrete rails used to move transformers in the area. Not possible to drill in this location. Not possible to move location as area is confined by canal and former A station
VC	VC_MW03	Monitoring Well	Changed to shallow soil bore	Shallow soil sample collected only due to the presence of multiple services in the area. No safe area to move location to.
VC	VC_SB02	Soil Bore	Abandoned	Abandoned due to proximity to stormwater pipes and anchor points for transformer rails. Concrete in this area likely to be 600 mm thick to support the weight of transformers
VE	VE_MW01	Monitoring Well	Changed to shallow soil bore	Shallow soil sample collected only, due to the presence of multiple services in the area. No safe area to move location to due to the presence of a slope on one side and services on 3 other sides.
VI	VI_MW03	Monitoring Well	Abandoned	Abandoned due to proximity of services, overhead cable trays and underground services.

AEC	Location ID	Location Type	Change Details	Comments
VI	VI_SB01	Soil Bore	Changed to shallow soil bore	Changed to a shallow soil bore due to the presence of multiple services in a small area.
VI	VI_SB02	Soil Bore	Abandoned	Abandoned due to proximity of services, overhead cable trays and underground services.
VL	VL_SB01	Soil Bore	Changed to shallow soil bore	Changed to a shallow soil bore due to the proximity of main electrical services
VM	VM_MW02	Monitoring Well	Changed to shallow soil bore	Changed to a shallow soil bore as there is no safe location to advance a monitoring well. The location is in a 2m wide area between a canal and a building and contains multiple services.
VM	VM_MW05	Monitoring Well	Changed to shallow soil bore	Changed to a shallow soil bore due to the proximity of services, overhead cable trays and underground services.
VM	VM_SB01	Soil Bore	Changed to shallow soil bore	Changed to a shallow soil bore as there is no safe location to advance a monitoring well. The location contains multiple services.
VN	VN_MW04	Monitoring Well	Abandoned	Abandoned due to flooding in the area and therefore lack of access
VN	VN_MW11	Monitoring Well	Abandoned	
VO	VO_MW16	Monitoring Well	Changed to soil bore	Changed to soil bore due to the proximity to the Jemena gas pipeline
VT	VT_MW02	Monitoring Well	Abandoned	Abandoned as there is no safe location to drill due to topography and large truck turning circle.
VT	VT_MW03a	Monitoring Well	Changed to soil bore	Changed to a soil bore due to the location being within the turning circle of trucks.
VU	VU_MW11	Monitoring Well	Changed to shallow soil bore	Changed to a shallow soil bore due to bushy terrain and lack of access for drilling equipment.
VU	VU_MW18	Monitoring Well	Changed to soil bore	Changed to soil bore due to the proximity to the Jemena gas pipeline.
VU	VU_MW19	Monitoring Well	Abandoned	

Notes: extract from Weekly Progress Report

Final investigation locations are presented in *Figures 6.1 to 6.6 of Annex A.*

4.2 *SITE INSPECTION*

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

4.3 *SOIL INVESTIGATION*

4.3.1 *Soil Sampling Procedure*

Soil investigation and sampling works were undertaken in general accordance with ERM's Standard Operating Procedures (SOPs). The location and number of sampling locations are presented within *Figures 6.1 to 6.6* of *Annex A* and listed by AEC (Area VA - Area VU) in *Table 1* of *Annex B*.

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

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

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

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

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

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

Soil samples were generally labelled using the nomenclature presented in *Table 4.2* (below).

Table 4.2 ***Sample Naming Protocol***

Sample	Identification
Sample taken from shallow hand auger soil bore or deeper soil bore, SB01 at depth of 0.5 m bgl, within work area VA	VA_SB01_0.5
Sample taken from depth of 5 m bgl from a soil bore to be installed as Monitoring Well MW07, within work area VA	VA_MW07_5.0
Sediment samples taken from SS01 within work area VM at a depth of 0.25 m below the surface of the sediment.	VM_SS01_0.25
Surface water samples taken from SW01 within work area VG	VG_SW01

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

No potential asbestos containing material (ACM) was identified at the surface or during the investigation works, and there were no ACM fragments submitted for analysis. Discrete 500 mL samples of soil were collected in snap lock bags during NDD for laboratory analysis for asbestos fibres. These samples were submitted to the laboratory for asbestos identification and (where identified) quantification (%w/w analysis) in accordance with the WA DOH guidelines (WA DOH, 2009).

4.3.2 *Decontamination Procedure*

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

4.3.3 *Soil Bore Reinstatement*

Upon completion, soil bores were backfilled and the surface covering reinstated to match existing.

4.3.4 *Management of Waste Materials Generated During Drilling*

Non-liquid waste materials generated during drilling works were stored on-site in stockpiles inside a temporary bund in a designated area near the Vales Point Power Station Ash Dam, prior to disposal within the Ash Dam in accordance with environmental licence conditions.

4.4 *GROUNDWATER INVESTIGATION*

4.4.1 *Monitoring Well Construction*

Selected boreholes were converted to groundwater monitoring wells in accordance with ERMs SOPs. The groundwater monitoring well locations are presented in *Figures 6.1 to 6.6* of *Annex A*. The following methodology was implemented to install new monitoring wells:

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

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

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

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

Following monitoring well installation, each well was developed using a submersible 12V electric 'Typhoon' pump to remove any fine or granular materials or contaminants potentially introduced during drilling and to optimise hydraulic connectivity with the surrounding aquifer. Wells were considered developed when either a minimum of 10 well volumes had been removed, when water quality parameters had stabilised or if the well was developed dry prior to this.

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

4.4.2 *Groundwater Purging and Sampling Protocol*

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

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

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

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

Table 4.3 *Water quality parameter stabilisation criteria*

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

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

Low-flow sampling techniques were used to obtain samples that were representative of the local groundwater environment at the Site. The inlet of the low-flow purge pump was placed approximately 50 cm from the base of the well in order to obtain a representative sample. Water samples were collected using equipment dedicated to each monitoring well to reduce the potential for cross-contamination between sampling locations.

The following order of sampling was adopted:

- samples to be analysed for volatile compounds placed into 40 mL amber vials;
- samples to be analysed for semi-volatile compounds placed into one 100 mL solvent washed amber bottles and one, 1 litre solvent washed amber bottle (for inter-laboratory duplicate samples);
- samples to be analysed for dissolved metals filtered through disposable 0.45 µm filters and placed in 60 mL plastic bottles preserved with nitric acid, or 60 mL unpreserved plastic bottles for ultra-trace metals;
- samples to be analysed for ferrous iron filtered through disposable 0.45 µm filters and placed in 60 mL plastic bottles preserved with hydrochloric acid; and
- samples to be analysed for major cations and anions placed in an unpreserved 250 mL plastic bottle.

Light Non-Aqueous Phase Liquid (LNAPL) was not observed at any of the sampling locations or detected with an interface probe.

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

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

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

4.4.3 *Waste Material Generated During Groundwater Development/Purging*

With approval from Delta Electricity, waste water from development and purging of groundwater monitoring wells was disposed of into the Ash Dam.

4.5 *SURVEYING*

All soil bore investigation locations were digitally located by field staff with a handheld Global Positioning System (GPS) unit. Additionally, all groundwater monitoring wells were surveyed by a registered surveyor (Monteith and Powys) to AHD for elevation and MGA coordinates for location. Survey data is presented in *Annex J*. The elevation of the highest point of the top of the uPVC well casing was surveyed to facilitate appropriate groundwater elevation calculations and groundwater flow direction interpretations.

4.6 *SEDIMENT INVESTIGATION*

Sediment samples were collected from within Wyee Bay, Chain Valley Bay, Wyee Creek and the Wyee Creek diversion channel, and Mannering Bay.

Sediment samples were collected in general accordance with the methodologies outlined in CSIRO *Handbook for Sediment Quality Assessment* (2005). Sediment was collected from each sampling location with either a stainless steel van Veen grab sampler or a polycarbonate push tube.

The grab sample was inspected and if it was deemed to be of acceptable quality i.e. van Veen fully closed, the sediment-water interface undisturbed with no evidence of loss of fines, and sufficient sample volume, the sediment was transferred to a container and homogenised.

The samples collected using polycarbonate push tubes were laid out within a one metre core catcher and split into multiple depths for sampling.

If there was insufficient sample volume in a single grab or core sample, but the sample was otherwise of acceptable quality, sediment from multiple grabs/cores was included in the sample.

Sample handling and labelling procedures were consistent with those adopted for soil sampling and those outlined in *Handbook for Sediment Quality Assessment* (CSIRO, 2005). The sediment volume, colour, grain size, odour, and presence of debris, organic matter, or biota were noted. Sediment samples were transferred to laboratory supplied glass jars for chemical analysis and 500 mL 'snaplock' bags for grain size analysis. Care was taken to minimise head space in the sample jars to reduce the potential for loss of volatile COPCs. The samples were stored on ice and transported under chain of custody to the analytical laboratory.

The van Veen, core and all other equipment used in the process of collecting the sediment samples were decontaminated (using the same procedures as those previously outlined for soil sampling equipment) between sampling locations.

4.7 *SURFACE WATER INVESTIGATION*

Surface water samples were collected from Lake Macquarie and Wyee Creek. Surface water samples were collected approximately 1 m from the bottom using a van Dorn sampler. If there were any locations where water depth was not sufficient for van Dorn deployment, samples were collected by hand, holding the sampling container beneath the surface of the water with the container facing upstream, while avoiding disturbing substrate.

Sample containers were sealed and immediately placed in a cooler on ice to reduce the potential for degradation of organic compounds. The samples were transported under chain of custody documentation to a NATA accredited laboratory at the end of each day.

A calibrated water quality meter was used to measure field parameters including pH, conductivity, oxidation reduction potential, temperature, total dissolved solids (TDS), and dissolved oxygen. Observations of the general condition of the surface water and its surrounds were recorded during sampling.

4.8 *LABORATORY ANALYSIS*

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

Soil, sediment, groundwater and surface water samples were analysed for the following COPCs:

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

Additional contaminants of concern were analysed within individual AECs to target specific sources of contamination or if required based on observations made in the field.

These contaminants include:

- Polychlorinated Biphenyls (PCBs) – related to use of PCB-containing transformer oil on site;
- Volatile Organic Compounds (including benzene, toluene, ethylbenzene and xylenes - BTEX); and
- Perfluorooctane sulfonate (PFOS) and Perfluorooctanoic acid (PFOA) – to target areas where fire retardants may have been used or stored;
- Asbestos (soil only).

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

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

4.9 QUALITY ASSURANCE/QUALITY CONTROL

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

In summary, the QA/QC data reported by ALS for soil and groundwater samples and field duplicate results were generally free of systematic and method biases and were assessed to be of sufficient quality for the purposes of this investigation.

There were some instances where the adopted screening values were less than the laboratory LOR. These potential non-conformances are discussed in *Section 5.5* of this report.

4.10 DATA SCREENING

Individual soil, groundwater, sediment and surface water data, along with the maximum, minimum, mean, standard deviation and 95% upper confidence limit (UCL) of the mean concentration (if required) were compared to adopted screening values.

The screening values adopted for the Site are designed to provide a screening value assessment of potential risks that may be associated with the SPR linkages that have been identified for this Site. The specific assessment levels adopted are presented alongside the analytical data in the summary tables presented in *Annex B*. The approach to the screening of the data gathered in this assessment has generally been to initially adopt conservative assessment values. Any exceedances of these values have then been evaluated on a case by case basis, in light of the specific characteristics of the individual sample and the area of the Site from which the sample was collected.

The adopted screening values have generally been sourced from guidelines made or approved under the *CLM Act 1997*, which includes the *ASC NEPM* (ASC NEPC, 2013). Where alternative sources have been utilised, appropriate justification has been provided.

4.10.1 Soil Screening Values

Soil data was assessed against investigation criteria published in the NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999*, Schedule B1 - Guideline on Investigation Levels for Soil and Groundwater (ASC NEPC, 2013), including;

- Health Investigation Level (HIL) – 'D' Commercial/Industrial
- Health Screening values (HSLs) for Vapour Intrusion and Direct Soil - 'D' Commercial/Industrial
- Ecological Investigation / Screening values (EILs/ESLs) – for areas of ecological significance and commercial industrial areas (as applicable).
- The Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE, 2011) *Technical Report No. 10* HSLs for Vapour Intrusion and Direct Contact - Intrusive Maintenance Workers (labouring within shallow trenches).

The EILs/ESLs for commercial/industrial areas have been adopted across the Site and the EILS/ESLs have been adopted only in areas where threatened and/or endangered species have been identified (i.e. AECs including the Ash Dam, Wyee Rail Coal Unloader area and Site Buffers and Boundaries).

Laboratory analysis for pH and CEC is required to establish site specific EILs/ESLs, and an assessment of background conditions is necessary. The establishment of EILs/ESLs was undertaken, and sample locations in buffer/boundary locations were utilised in establishing background conditions. The details of the calculations used to establish Site specific EILs/ESLs are provided in *Annex I*.

The ASC NEPM (2013) also provides EILs for aged and fresh contamination for the metal constituents Ni, Cr III, Cu, Zn and Pb. For the purposes of EIL derivation, a constituent incorporated in soil for at least two years was considered to be aged. Given that the Site has been operational since the 1960s and no significant individual release events of these metals have been recorded, any identified impacts are likely to primarily represent aged contamination. The EILs for aged contamination have been adopted.

The ASC NEPM (2013) and CRC CARE (2011) *Health screening values for petroleum hydrocarbons in soil and groundwater* provide Health Screening values (HSLs) for soil and groundwater impacts located at depths from 0 to 4+ m bgl in soil types ranging from sand to clay and Health Investigation Levels (HILs) for shallow soil impacts. The screening values for sandy soils have been adopted across the Site, as a conservative approach. The significance of any exceedances of the HILs/HSLs have been evaluated on a case by case basis, with reference to the use of the area of identified potential concern.

4.10.2 Groundwater and Surface Water Screening Values

Water data has been assessed against investigation criteria published in NEPC (NEPC, 2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)*, Schedule B1 - Guideline on Investigation Levels for Soil and Groundwater including;

- Australia and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ, 2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* - Trigger values for marine water, level of protection 95% species;

- National Health and Medical Research Council and National Resource Management Ministerial Council (NHMRC and NRMMC, 2013) *Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy;*

- National Health and Medical Research Council (NHMRC , 2008) *Guidelines for Managing Risks in Recreational Waters* - note that these will be applied with reference to (ANZECC/ARMCANZ, 2000) and (NHMRC and NRMMC, 2013) referenced above; and

- Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE, 2011)*Technical Report No. 10, Health Screening values for Petroleum Hydrocarbons in Soil and Groundwater.* HSLs for Vapour Intrusion - 'D' Commercial and Intrusive Maintenance Worker (Shallow Trench).

The groundwater beneath the Site is not considered to be an ecological receptor of concern in itself, but the trigger values for the protection of 95% of marine species have been adopted across the Site to evaluate potential risks associated with the discharge of groundwater into the marine environment of Lake Macquarie.

Groundwater is not extracted for potable use across the Site. The National Health and Medical Research Council (NHMRC) (2011) *Australian Drinking Water Guidelines,* however been adopted across the Site to evaluate the requirement to report groundwater contamination across the Site, in accordance with the DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997.* The potable use of groundwater has been considered for areas in proximity to residential areas – namely AEC VO (Ash Dam) and VU (Site Buffers and Boundaries).

4.10.3 *Sediment Screening Values*

Sediment quality data have been assessed against screening values published in:

- (ANZECC and ARMCANZ, 2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* - Interim Sediment Quality Guidelines (ISQGs), or the equivalent Commonwealth of Australia (DEWHA, 2009) *National Assessment Guidelines for Dredging.* (ANZECC/ARMCANZ, 2000).

Where no Australian endorsed assessment levels are available reference has been made to the following National Institute of Public Health and the Environment (RIVM) document:

- (RIVM, 2001) *Ecotoxicological serious risk concentrations for soil, sediment and (ground)water - updated proposals for first series of compounds.*

It is noted that these guideline values have no regulatory standing in NSW and hence these values have been adopted to provide a high level evaluation of potential ecological risk and have not been used to assess the duty to report requirements under the Contaminated Land Management (CLM) Act 1997.

4.10.4 *Screening values for Perfluorooctane Sulfonate (PFOS) And Perfluorooctanoic Acid (PFOA)*

Soil

No authoritative screening criteria have been published within Australia for assessing chronic risks to human health from either perfluorooctane sulfonate (PFOS) or Perfluorooctanoic acid (PFOA) in soils. As such, a literature review and web-based research were conducted to identify conservative screening values for these COPCs.

Values of 6 mg/kg and 16 mg/kg were adopted for PFOS and PFOA in soil respectively, based on recently published US EPA Region 4 guidance *Emerging Contaminants Fact Sheet -PFOS and PFOA, May 2012* (US EPA, 2009c) for residential land-use settings. Whilst these criteria are acknowledged to be designed for application to a more sensitive land-use, they are considered appropriate to inform requirements for more detailed, or site-specific, risk characterisation.

It is noted that these guideline values have no regulatory standing in NSW and hence these values have been adopted to provide a high level evaluation of potential ecological risk and have not been used to assess the duty to report requirements under the CLM Act (1997).

Groundwater

No authoritative guidelines have been published in Australia for PFOS or PFOA in groundwater, protective of human health or the environment.

Whilst groundwater is not used on-site for potable supply, in the absence of a more appropriate guideline, a health screening values of 0.2 and 0.4 µg/L for PFOS and PFOA respectively in groundwater have been adopted. These values are proposed by the US EPA (2009).

Whilst groundwater beneath the Site is not considered to be an ecological receptor in itself, ecological impacts may be associated with the discharge of groundwater into the adjacent marine environment of Wyee Creek and Lake Macquarie. In the absence of a local guideline, an ecological screening value of 7.2 µg/L has been adopted for PFOS. This value was recommended by (RIVM, 2010) as the Maximum Acceptable Concentration (MAC) for marine ecosystems.

It is noted that these guideline values have no regulatory standing in NSW and hence these values have been adopted to provide a high level evaluation of potential ecological risk and have not been used to assess the duty to report requirements under the CLM Act (1997).

4.10.5 Screening Values For Selenium

ANZECC and ARMCANZ (2000) provides a low reliability marine trigger value for selenium, which has been adopted as the ecological screening value for surface water and groundwater in this assessment.

In the absence of ANZECC and ARMCANZ (2000) screening values for selenium in sediment, the British Columbia Ministry of Environment (2001) *Ambient Water Quality Guideline* marine sediment screening value for selenium of 2 mg/kg has been adopted in this assessment. This value is designed to be protective of selenium bioaccumulation through the food chain and direct selenium toxicity.

It is noted that these guideline values are not regulatory criteria in British Columbia and have no regulatory standing in NSW and hence these values have been adopted to provide a high level evaluation of potential ecological risk and have not been used to assess the duty to report requirements under the CLM Act (1997).

5 RESULTS AND DISCUSSION

5.1 SITE GEOLOGY OBSERVATIONS

A generalised description of the lithology and geology encountered at the Site is presented *in Table 5.1.*

Alluvial sediments, ranging from clayey sand to clay in texture with sandy clay predominating in the majority of bore locations, were encountered at relatively shallow depths in some sections of the Site, generally in close proximity to Mannering Creek, Mannering Bay and Lake Macquarie. Highly weathered conglomerate with minor sandstone and siltstone of the Munmorah Conglomerate formation was encountered across the majority of the Site. The highly weathered nature of the Munmorah Conglomerate is attested by the fact that the majority of monitoring well bores were able to be drilled with solid flight augers or hollow stem augers following refusal with push-tube methods.

Moderately weathered to unweathered rock was encountered in ten locations (including VA_MW03, VA_MW06, VL_MW02, VN_MW03, VN_MW10, VO_MW08, VU_MW08, VU_MW09, VU_MW13 and VU_MW14) within the Munmorah Conglomerate. These bores were generally completed using the rotary air percussion method. Depths to the unweathered conglomerate in these locations generally varied from 5 to 6 m bgl, and the unweathered sedimentary rock extended to 15 m bgl (the maximum depth of the investigation). Dykes identified on the geology map for the area (see *Section 2.2.3*) were not encountered during the drilling program.

Table 5.1 ***Generalised Field Lithology Descriptions***

Lithological Unit	Description	Depth[1] (m bgl)
Hardstanding	Concrete and asphalt generally in good condition (present in some locations within the operational area).	0 – up to 0.35
Fill	Fill material of variable composition, varying from sandy gravel to gravelly sandy clay (present in some locations within the operational area).	0 – up to 2.8
Alluvial Sediments	Generally poorly sorted sediments, ranging from clayey sand to clay with sandy clay predominating in the majority of bore locations.	0 – up to 6
Munmorah Conglomerate	Highly weathered conglomerate with minor sandstone, siltstone and mudstone. The conglomerate contained a heterogeneous gravel lithology, with matrix (>15%) generally consisting of silty sand. The Munmorah Conglomerate underlies the majority of the site. Relatively unweathered rock was encountered at depths varying from 7.5 to 15 m bgl.	Highly weathered: 0 – up to 13. Moderately weathered to unweathered: 3.4 - ≥15

1. Given the variation in topography across the Site, depths and lithologies may vary across the site.

Detailed descriptions of the Site lithology and geology as observed at each location during the investigation are presented in the borehole logs in *Annex D*.

5.2 *GROUNDWATER FIELD OBSERVATIONS*

Newly installed monitoring wells were generally gauged and sampled at least 72 hours after well installation and development to allow subsurface conditions to stabilise. Groundwater gauging and sampling was completed for newly installed and existing monitoring wells between 20 March and 1 April 2014.

Groundwater gauging data is presented in *Table 2 of Annex B*. Groundwater was encountered at depths ranging from the near surface (001 m bgl in VO_MW12) to 9.80 m bgl, or -0.13 m AHD to 38.67 m AHD in the alluvial sediments and the highly weathered Munmorah Conglomerate. Potentiometric water levels in the moderately weather to unweathered sedimentary rock, where groundwater storage and flow is expected to be governed mainly by fractures within the rock matrix, varied from 1.24 bgl to 9.73 m bgl, or 0.57 m AHD to 27.02 m AHD. For monitoring wells drilled into fractured rock, stabilised water levels were well above water strikes where observed as well as above the interface between the highly weathered and less weathered conglomerate, and the groundwater levels in these monitoring wells are considered to present potentiometric water levels.

The interpolated groundwater contouring indicates that groundwater flow in the alluvial sediments and highly weathered Munmorah Conglomerate is generally in a northerly direction towards Lake Macquarie for the majority of the site (see *Figure 7*) and to the east north-east from the Wyee rail coal unloader area. Localised variations in groundwater flow direction occur at the ash dam as governed by local variations in topography, with the groundwater gauging indicating a westerly groundwater flow component downgradient of the south-western most section of the ash dam, towards the east downgradient of the south-easterly section of the ash dam and toward the north and Mannering Bay downgradient of the north-western section of the ash dam. Groundwater contours for the monitoring wells intersecting the deeper lying fractured conglomerate have not been interpolated as the number and spread of monitoring wells in the deeper lying fractured rock do not facilitate the interpolation of groundwater contours. Groundwater flow in this unit is however expected to be towards Lake Macquarie, located to the north for the majority of the Site and to the east north-east for the Wyee rail coal unloader area.

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

An additional round of groundwater sampling was undertaken on 27 May, 2014. Specific wells were sampled in order to delineate previously identified impacts, and to provide further data, specifically:

- Additional sampling of VP_MW01 where Benzene was detected a concentration greater than the adopted drinking water screening levels, to assess temporal variation.
- Sampling of VB_MW03. Due to a communication error, samples from this well had not previously been analysed.
- Sampling of surface water near the 'toe drain' area of the Ash Dam to provide further data on metals concentrations in this area.

5.3 *AREAS OF ENVIRONMENTAL CONCERN (AEC) SUMMARY*

This section discusses the analytical results of the soil, sediment, surface water and groundwater samples collected in each of the Areas of Environmental Concern (AEC's). It is noted that metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs and that background conditions contribute to these impacts in some areas of the site. As such, groundwater metal data has not been discussed in the context of each individual AEC; a consolidated discussion of this issue is presented in *Section 5.4.*

5.3.1 *VA – B Station Power Block*

Background

The main generating plant area of the Vales Point Power Station operates two 660 MW generating units (B Station) and associated infrastructure including;

- coal feed systems;
- two coal-fired boilers;
- turbine house incorporating two steam turbines;
- two 660 MW generator units (units 5 and 6);
- emergency diesel generator; and
- one chimney stack (serving two boilers).

Electricity is produced using pulverised coal-fired boilers. The coal is ground in pulverising mills before being blown into the boiler in a stream of pre-heated air. The coal burned in the boiler furnace chamber produces the heat necessary to convert water circulating in the boiler tubes into high-pressure steam.

The electricity generation process involves high pressure steam passing through cylinders and spinning the shaft of each generator and inducing alternating current. After use, the steam is condensed back to water and is recycled.

The primary source of potential contamination identified in this area is potential leaks of lubricating oil and diesel fuel at various points around the plant. Observations during the Site visit confirmed this oil loss in various areas. In particular during the Phase 1 investigation, surface staining and/or oily surface water was noted in the area of the emergency generator diesel tank and oil unloading area for the turbine oil storage tanks.

A major fire event also occurred in the 5A Air Heater in November 2011. Although there is no information to suggest that Aqueous Film Forming Foam (AFFF) was used for firefighting, in conjunction with this event, PFOS and/or PFOA have been included as COPC for this area.

Within the power block, leaks and spills are generally captured in internal contaminated water drains and transferred to the oil and grit separator and Chain Valley Retention Basin, located in the north eastern corner of the site. However, there remains potential for seepage of leaks and spills through cracks in the concrete around infrastructure.

Various small workshops are present throughout the power block which service specific areas. Many of these workshops hold small quantities of lubricating oils, solvents and similar chemicals. During the Site works dangerous goods were generally observed to be appropriately stored within bunded or contained areas. However, staining of the concrete surface in various areas of the workshops was observed, and there remains potential for spills and leaks to penetrate the concrete through cracks and joints into the subsurface.

The network of drains which runs beneath the power block also represent a potential contamination source to soil and groundwater due to the subsurface nature of this network and the various COPCs (including corrosive chemicals) likely to be currently present or having been historically present as a result of the collection and conveyance of spills and leaks in various areas. In addition to the dedicated stormwater and contaminated water drainage systems, a sluiceway which transports ash and coal fines collected in various surface drains in the power block runs through the power block, eventually discharging into the Ash Dam.

No soil or groundwater investigations are known to have been undertaken to date which specifically target the B Station Power Block. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of nine soil investigation bores, six of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. Due to the potential health and safety risks from the operational nature of this area investigation locations were distributed around the perimeter of the AEC to identify COPC that may have migrated from within this AEC.

Sampling locations were distributed around the AEC as presented in *Figure 6.3* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

Monitoring wells VA_MW07 and VA_MW08, located in the north west corner of the investigation area, were abandoned due to the proximity to both overhead and underground utilities. Soil bore VA_SB40 was also abandoned due to the proximity of overhead and underground utilities. However, the position of monitoring well VC_MW01 in the adjacent transformer area (AEC VC) provides sufficient interception of potential off-site migration of COPCs from the north west corner of the B Station Power Block AEC.

Black staining and an unknown odour were observed at VA_SB01 at a depth of 0.2 to 0.3 m bgl. There were no other field indicators of contamination, such as staining or odours detected at any depth during the sampling process within this AEC. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 8 parts per million by volume (ppm v) (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.2*.

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

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
VA_MW01	3	None	0-0
VA_MW02	14	None	0-8.0
VA_MW03	12	None	0-3.4
VA_MW05	7.5	None	0-0.2
VA_MW06	11.5	None	0-1.6
VA_SB01	0.95	Black staining and odour at 0.2- 0.3 m bgl	0-1.0
VA_SB02	1.05	None	0
VA_SB03	3.0	None	0-1.6

Groundwater samples were collected from six groundwater monitoring wells within the B Station Power Block AEC. Groundwater parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Electrical conductivity measurements were generally indicative of freshwater conditions, with a range between 583-714 µS/cm, with the exception of two monitoring wells, VA_MW01 (2168 µS/cm) and VA_MW05 (1417 µS/cm) which were indicative of brackish groundwater conditions. pH measurements were typically neutral to slightly acidic (pH 5.98 to 6.78) with the exception of acidic conditions indicated in VA_MW05 (pH 4.44) located on the northern boundary.

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

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4a of Annex B*

Measured concentrations of COPCs were below the adopted human health screening values in all soil samples collected from within this AEC with the exception of carcinogenic PAHs at VA_SB01 at a depth of 0.25 m bgl. Concentrations of TRH were also reported above the laboratory LOR in this sample however did not exceed the adopted human health screening values. Measured concentrations of PFOS were detected above the laboratory LOR in two soil samples at VA_MW05 at a depth of 0.1 m bgl and VA_MW02 at a depth of 0.1 m bgl, however the measured concentrations of PFOS did not exceed the adopted screening value.

Measured concentrations of COPCs were below the adopted ecological screening values in all soil samples collected from within this AEC with the exception of zinc at VA_MW02 at a depth of 0.1 m bgl, nickel at VA_MW02 at a depth of 2 m bgl and benzo(a)pyrene at VA_SB01 at a depth of 0.25 m bgl.

The majority of the remaining measured concentrations were below the corresponding laboratory LOR with the exception of various heavy metals, however all of these concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5a of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

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

It is noted that PFOS/PFOA were not detected in groundwater beneath this AEC. These chemicals would have been expected if the extensive use of AFFF had occurred in this area.

Discussion

One exceedance of the adopted human health screening values was identified in a soil sample collected from VA_SB01, with no further exceedances identified in soil samples collected from within this AEC.

The shallow fill material at VA_SB01 at a depth of approximately 0.2 to 0.3 m bgl was observed to be heterogeneous gravelly sandy clay with black staining and an unknown odour.

The corresponding laboratory results for VA_SB01 at a depth of 0.25 m bgl exceeded the human health screening value for carcinogenic PAHs, and exceed the ecological screening value for benzo(a)pyrene. Based on the laboratory results, it is likely that the odour observed was related to the presence of hydrocarbons in soil at this depth. The PAH impacts in soil at this location appear to be localised and limited to the shallow soil, as vertically delineated by laboratory results from VA_SB01_0.8. It is noted that the soil bore VA_SB01 was abandoned at a depth of 0.9 m bgl at refusal on conglomerate, and that water was observed to be infiltrating at the base of the bore.

As discussed in Schedule B7 of the ASC NEPM (2013), benzo(a)pyrene (and other carcinogenic PAHS) are not considered sufficiently volatile to be of significance and inhalation exposures associated with particulates outdoors and indoors are expected to be of less significance than ingestion of soil. The majority of this AEC is covered in hardstanding, including the area in the proximity of the soil boreVA_SB01, and therefore the exposure to this chemical could only occur through direct contact with the soil or exposure to dust. The measured concentration of PAH constituents in groundwater in all monitoring wells within this AEC were below the laboratory LOR and the adopted screening values. Therefore, it is considered that the detected concentrations of PAH constituents in soil at VA_SB01 are not contributing to impacts in groundwater. On this basis, the PAH impacts identified in this location are considered unlikely to represent a significant risk to human health or the environment under the ongoing operational use of the Site.

Zinc and nickel concentrations marginally exceeded the adopted ecological screening values in shallow soil sampled from VA_MW02 at a depth of 0.1 m bgl and 2 m bgl, respectively. These exceedances are likely attributed to the composition of fill materials placed in this area. It is noted that the B Station Power Block AEC is an operational area and is primarily covered in hardstanding. These impacts are therefore considered unlikely to represent a significant risk to the terrestrial environment assuming ongoing commercial industrial use in the current or similar configuration.

5.3.2 *VB – Former A Station*

Background

Vales Point A Station was built in the 1960s as a four-unit station. These generating units were decommissioned in 1989 and since then have undergone partial dismantling, with most of the internal plant items removed. During ERMs Site works the A Station buildings were undergoing demolition and removal offsite.

Prior to the decommissioning and demolition of A Station, this facility was comprised of;

- four coal-fired boilers;
- a turbine house incorporating four steam turbines;
- four generator units (units 1 to 4), with a total capacity of 875 MW;
- an auxiliary bay; and
- two chimney stacks (serving four boilers).

ERM understands that once the demolition is complete, the A Station basement level concrete will remain and in other areas the ground surface will be covered with recycled crushed concrete and left vacant.

The primary sources of potential contamination within the former A Station area are associated with historic lubricating oil and fuel leaks at various points around the plant and leaks from the oily water drainage network.

Intrusive investigations have not previously been completed within the former A Station. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area. Due to the high probability of encountering unmarked subsurface utilities historically associated with the operation of the facility, the investigation locations targeting this AEC have therefore been focused around the perimeter of the AEC to identify COPC that may have migrated from this AEC.

AEC Methodology and Investigation Field Observations

A total of five soil investigation bores, four of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater.

The sampling locations advanced within this AEC are presented on *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

During the sampling process, no field indicators of contamination, such as staining or odours were detected within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis of 13.3 and 23.5 ppm v (isobutylene equivalent) at VB_MW03 at a depth of 3.8 to 4.0 m bgl were not associated with visual or olfactory evidence of contamination. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 23.5 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.3*.

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

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
VB_MW01	4	None	0
VB_MW02	4	None	0-1.5
VB_MW03	5.1	None	0-23.5
VB_MW05	6	None	0-1.0
VB_SB01	0.95	None	0-1.0

Groundwater samples were collected from four groundwater monitoring wells within the former A Station AEC. Groundwater parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Electrical conductivity (EC) measurements ranged from 570-2006 µS/cm, which indicates fresh to slightly brackish groundwater conditions. pH measurements were slightly acidic at VB_MW02 and VB_MW05 (pH of 5.77 and 5.5, respectively) and acidic at VB_MW01 and VB_MW03 (pH of 3.92 and 4.28 respectively). The acidic pH at VB_MW01 and VB_MW03 may indicate the presence of acid sulfate soil conditions within the western part of this AEC.

No indications of contamination such as sheens or odours were observed during groundwater sampling within this AEC, however a slight sulfurous odour was detected during the gauging in VB_MW03. A summary of field observations from the groundwater sampling works are presented within *Table 3 of Annex B*.

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.b of Annex B*.

Concentrations of TRH and PAHs were reported above the laboratory LOR in soil samples at VB_MW01 at a depth of 0.5 m bgl and VB_MW02 at a depth of 0.5 m bgl; however all concentrations were below the adopted human health screening values. Concentrations of PFOS were reported above the laboratory LOR in the soil sample collected from VB_SB01 at 0.5 m bgl however the detected concentration was below the adopted screening value.

Measured concentrations of COPCs were below the adopted ecological screening values in the soil samples collected from within this AEC with the exception of TRH C_{10}-C_{16} (excluding naphthalene) in the soil sample collected from VB_MW01 at a depth of 0.5 m bgl.

The majority of remaining measured concentrations of COPCs in soil samples analysed were below the corresponding laboratory LOR with the exception of various heavy metals, however all of these concentrations were below the adopted screening values.

Asbestos was not detected in soils sampled within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.b of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9* of *Annex A*.

Chlorinated hydrocarbons including cis-1,2-dichloroethene, trichloroethene and tetrachloroethene were detected above the laboratory LOR in VB_MW02, however all concentrations were below the adopted screening values.

Phenol was detected in VB_MW03 above the laboratory LOR however the concentration detected was below the adopted screening values.

Measured concentrations of PFOS and PFOA were detected groundwater samples collected from VB_MW01 and VB_MW02. The concentrations of PFOA were below the adopted screening value. The concentrations of PFOS in groundwater at VB_NW02 exceeded the adopted human health screening value.

Discussion

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

The adopted ecological screening value for TRH C_{10}-C_{16} (excluding naphthalene) was exceeded in one soil sample collected from within this AEC at VB_MW01. The ground surface at VB_MW01 is covered in concrete hardstanding and this area is used for miscellaneous operational activities, including the storage of skip bins and spare parts. On this basis, TRH impact in this area is not considered to represent a significant risk to the terrestrial environment.

Measured concentrations of TRH, chlorinated hydrocarbons, phenol and PFOS were reported above the laboratory LOR in groundwater samples from the AEC. The concentrations did not exceed the adopted screening values, with the exception of PFOS at VB_MW02 which exceeded the adopted human health (drinking water) screening value. On the basis that groundwater is not extracted for potable use within the vicinity of the operational area of the Site, this identified PFOS impact is not considered to represent a significant risk to human health .

It is noted that the source of the TRH, chlorinated hydrocarbon and PFOS impact was not identified during this assessment and that the presence of underground and overhead services prevented the installation of sampling locations within this AEC and limited the installation of sampling locations around the boundaries of this AEC. It is therefore considered possible that further TRH, chlorinated hydrocarbon and PFOS impacts may be present within the former A Station area.

5.3.3 *VC - Transformer Area*

The Transformer Area is located to the north west of the B Station Power Block, adjacent to the inlet canal for the Power Station. There are four transformer vessels present on the Site, containing significant quantities of insulating oil. Spare transformers 1 and 2 and the temporary turbine oil storage ASTs, with a capacity of 115 000 L are also located immediately to the east of the transformer vessels. Refuse oil storage AST No. 2, with a capacity of 35 000 L is also located to the east of the transformer vessels. The AEC is entirely covered by a concrete hardstand, with a thickness of approximately 600 mm to withstand the weight of the transformers.

Due to the age of the facility, PCB additives would have historically been used in insulating oils in transformers, capacitors and light fittings within the main operational areas. Data room documents indicate that low concentrations of PCBs (up to 4.1 µg/g) were detected in transformer oil samples collected from the vessels by Aurecon in 2012 and 2013.

In November 2006 the Vales Point Unit 6A 330/22kV Generator Transformer failed, resulting in an explosion and fire. A large volume of water and fire retardants were reported to have been used in the emergency operations associated with this event. This event is likely to have released transformer oil to the surrounding area. The potential use of firefighting foam during this fire also indicates that PFOS and/or PFOA are also COPCs.

No soil or groundwater investigations are known to have been undertaken to date which specifically target the Transformer Area. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Investigation Methodology and Field Observations

A total of four soil investigation bores, all of which were completed as groundwater monitoring wells, were advanced within this AEC, and two surface soil samples were collected, to assess potential impacts to soil and groundwater.

Three groundwater monitoring wells were located at the eastern end of the transformer AEC, targeting COPCs of the historical transformer fire and the off-site migration of materials and one groundwater monitoring well was located to the western end of the transformer AEC. The distribution of sampling locations is presented in *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining or odours, were noted within this AEC. No staining or unusual odours were detected through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 2.5 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

Field observations during the drilling works are summarised in *Table 5.4*.

Table 5.4 ***Field Observations Summary - AEC VC***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
VC_MW01	6.3	None	0-0.4
VC_MW02	4	H2S odour at 4.2 m bgl	0-2.5
VC_MW04	4	None	0-1.3
VC_MW05	4	None	0-1.9
VC_SB03	0.1	None	0

Groundwater field parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Electrical conductivity measurements indicated fresh water conditions at monitoring wells VC_MW01, VC_MW04 and VC_MW05 and saline conditions were encountered within the north eastern location VC_MW02. Moderately acidic to neutral groundwater conditions were recorded in this AEC (pH of 4.81 - 5.86).

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

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.c, Annex B*.

Measured concentrations of COPCs were below the adopted human health and ecological screening values in all soil samples collected from within this AEC. Measured concentrations of various heavy metals exceeded the corresponding laboratory LOR in a number of soil samples collected from within this AEC however all concentrations were below the adopted screening values. TRH was also reported at a concentration above the laboratory LOR in VC_MW03 at a depth of 0.1 m bgl, however the concentration was below the adopted ecological and human health screening values.

Concentrations of PFOS were detected above the laboratory LOR in three soil samples at VC_MW02 at a depth of 0.5 m bgl, VC_MW05 at a depth of 1 m bgl and VC_SB03 at a depth of 0.1 m bgl, however all concentrations were below the adopted ecological and human health screening values. The measured concentrations of asbestos fines and fibrous asbestos (0.005 %w/w) in the soil sample from VC_MW03 at a depth of 0.1 m bgl exceeded the adopted human health screening value of 0.001 %w/w).

Chrysotile asbestos detected in one soil samples from this AEC at VC_MW03 at a depth of 0.1 m bgl and the laboratory report identified "one piece of friable asbestos cement sheeting approximately 8 x 7 x 2mm".

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.c* of *Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9* of *Annex A*.

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

PFOS was not detected in groundwater within this AEC.

Discussion

No exceedances of the adopted ecological or human health screening values were identified in soil samples collected from within this AEC with the exception of asbestos fines and fibrous asbestos in one shallow soil sample at VC_MW03 at a depth of 0.1 m bgl. These asbestos impacts are located in an area of open ground and may represent a risk to the health of employees if potential exposure pathways are not managed appropriately.

Exceedances of the adopted screening levels identified within this AEC were limited to metals, as discussed in *Section 5.4*.

5.3.4 *VD - Main Dangerous Goods Store*

Background

The Main Store compound is located on the south western edge of the operational area of the Power Station and comprises of a covered section and an open lay-down area covered in concrete hardstand. This area is used for storage of various materials used throughout the Power Station, including dangerous goods.

The Main V1 Store Building houses minor quantities (< 200 L) of flammable liquids and oils in cabinets. An outdoor compound area is located to the south of the Main Store and has a roofed enclosure used to house drums of lubricants and greases. A storage area located within a brick structure to the south east of the Main Store is used to house gases and corrosive liquids.

No soil or groundwater investigations are known to have been completed within this AEC to date. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Investigation Methodology and Field Observations

A total of seven soil investigation bores, five of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. The sampling locations within this AEC are presented on *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

During the sampling process, no field indicators of contamination, such as staining or odours were detected within this AEC however a slight sulfurous odour was detected in VD_MW05. No staining or unusual odours were detected at any depth through the sampled soil profile.

Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 6.3 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.5*.

Table 5.5 *Field Observations Summary – AEC VD*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
VD_MW01	3.5	None	0-1.2
VD_MW02	3.5	None	0-6.3
VD_MW03	3.5	None	0-1.1
VD_MW04	4	None	0-0.9
VD_MW05	6.3	Sulfur odour	0-5.9
VD_SB02	3.0	None	0-1.3

Groundwater samples were collected from five groundwater monitoring wells within the Main Dangerous Goods Store Area AEC. Groundwater parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B.*

Electrical conductivity (EC) ranged from 37100 µS/cm in VD_MW01, to 3806 µS/cm in VD_MW03 indicating saline groundwater conditions. pH levels were indicative of acidic conditions within all wells with a pH ranging between 4.32 and 5.32. No evidence of hydrocarbon impact was detected in groundwater however a slight sulfurous odour was detected during the gauging in VD_MW05.

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

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.d of Annex B.*

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

Asbestos was not detected in soils sampled from within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented *in Table 5.d of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed. The exceptions to this were some detection of metals (discussed in *Section 5.4*) and phenol. Concentrations of total phenols were detected at VD_MW03 above the laboratory LOR, however the detected concentration was below the adopted ecological screening value.

Discussion

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

Exceedances of the adopted screening levels identified within this AEC were limited to metals, as discussed in *Section 5.4*

5.3.5 *VE – Contaminated Water Treatment Plant*

Background

The Contaminated Water Treatment Plant treats the water captured by the contaminated water drainage system at the Power Station. Water entering the facility could potentially contain a range of contaminants including fuels, lubricants, chemicals, coal and ash.

All the elements of the Contaminated Water Treatment Plant are located to the north east of the operational area near the inlet canal within a grassed area. The facility comprises a sedimentation basin with an oil skimmer ('hairy ropes') and a separate secondary oil water separation section. Waste generated in the facility is understood to be trucked from the Site by an appropriately licensed contractor for offsite disposal at a licensed facility.

After passing through the oil-water separator, water discharges into a retention basin (the Chain Valley Retention Basin), located immediately to the north east. The Chain Valley Bay Retention Basin contains a series of booms to further isolate oil that may enter the pond. Water from the pond enters a pit before discharge into Chain Valley Bay. The pit contains isolation valves and the outlet pipe is covered with a membrane filter as a final screen for oil and other detritus.

Visual inspection of the Contaminated Water Treatment Plant during ERM's Phase 1 site visit in December 2013 identified an oily layer of Light Non-Aqueous Phase Liquid (LNAPL) on the water within the sediment basin. While oily residue was not observed in the holding pond, dissolved phase impact may still be present in water held within the pond.

No soil or groundwater investigations are known to have been undertaken to date which specifically target the Contaminated Water Treatment Plant. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Investigation Methodology and Field Observations

A total of three soil investigation bores, two of which were completed as groundwater monitoring wells, and one surface soil were advanced within this AEC to assess potential impacts to soil and groundwater.

The sampling locations within this AEC are presented on *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

During the sampling process, no field indicators of contamination, such as staining or odours were detected within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1.3 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.6*.

Table 5.6 ***Field Observations Summary – AEC VE***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
VE_MW01	0.2	None	0
VE_MW02	4.0	None	0
VE_MW03	4.0	None	0-1.0
VD_SB02	3.0	None	0-1.3

Groundwater samples were collected from two groundwater monitoring wells within the Contaminated Water Treatment Plant AEC. Groundwater parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*.

Electrical conductivity (EC) ranged from 1113 µS/cm in VE_MW03, to 3152 µS/cm in VE_MW02 indicating slightly saline groundwater conditions. ORP measurements (mV) were within the expected range and pH levels were indicative of acidic conditions within both wells (pH of 4.26 at VE_MW02 and 4.33 at VE_MW03).

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

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.e* of *Annex B*.

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

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

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.e* of *Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9* of *Annex A*.

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed.

The exceptions to this were some detections of metals (discussed in *Section 5.4*) and phenol. The concentrations of phenol detected above the LOR at VE_MW02 were below the adopted ecological screening value.

Discussion

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

Exceedances of the adopted screening levels identified within this AEC were limited to metals, as discussed in *Section 5.4*

5.3.6 *VF – Waste Oil Storage*

Background

Waste oil in drums and containers and oily rags are stored in the waste oil collection area to the south of the oil and grit trap and AEC VE. This area also temporarily stores new oil drums for use in the Power Station. The area is bunded and collected stormwater from this area is pumped into the Contaminated Water Treatment Plant.

During the Stage 2 ESA field works the grate in the corner of the bunded area was observed to be covered in oil. Delta indicated that this waste oil collection/storage sump is fitted with a level sensor. When the sump is 50% full the water is decanted from the bottom and sent to the oil and grit trap and the oil disposed by Delta's waste collection contractor as required. The sump level is also monitored during routine inspections.

The area immediately surround the waste oil storage area is a combination of open ground and hardstanding. The inlet canal is approximately 30 m to the west and Chain Valley Bay is approximately 150 m to the north.

No soil or groundwater investigations are known to have been undertaken to date which specifically target the Waste Oil Storage area. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Investigation Methodology and Field Observations

A total of three soil investigation bores, all of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. The sampling locations within this AEC are presented on *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

During the sampling process, no field indicators of contamination, such as staining or odours were detected within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.9 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.7*.

Table 5.7 *Field Observations Summary – AEC VF*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
VF_MW01	6.0	None	0-0.8
VF_MW02	3.7	None	0
VF_MW03	6.5	None	0-0.9

Groundwater samples were collected from three groundwater monitoring wells within the Waste Oil Storage AEC. Groundwater parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*.

Electrical conductivity (EC) ranged from 540-1126 µS/cm indicating fresh to brackish groundwater conditions. pH measurements ranged from pH 5.12 to 5.85, and were indicative of slightly acidic groundwater conditions.

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

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.f* of *Annex B*.

Measured concentrations of COPCs were below the adopted human health screening values in all soil samples collected from within this AEC.

Measured concentrations of COPCs were below the adopted ecological screening values in all soil samples collected from within this AEC with the exception of soil collected from VF_MW02 at a depth of 0.1 m bgl which exceeded the ecological screening value for zinc.

Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC however, with the exception of zinc, all concentrations were below the adopted screening values. Concentrations of PAHs were also reported above the laboratory LOR at VF_MW02 at a depth of 0.1 m bgl (duplicate sample) however the concentration was below the adopted screening value.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.f* of *Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9* of *Annex A*.

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed. The exceptions to this were some detections of metals.

Discussion

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

Zinc concentrations marginally exceeded adopted ecological screening values in shallow soil sampled from 0.1 m bgl at VF_MW02. It is noted that the concentration of zinc in the deeper soil sample collected from 2.0 m bgl at this location was below the adopted ecological screening values, and the exceedance at 0.1 m bgl may be attributed to shallow fill material at this location. This AEC is within the fenced operational area and therefore use of the area by wildlife is limited. The groundcover within this AEC is a mix of hardstanding and areas of grass cover. On this basis, these marginal exceedances are therefore considered unlikely to represent a significant risk to the terrestrial environment assuming ongoing commercial industrial use in the current or similar configuration.

5.3.7 *VG – Fuel Oil Installation*

Background

The Fuel Oil Installation comprises two 1.2 ML steel ASTs, which are used for the storage of diesel. This installation is located outside the station inner security fencing and the bulk fuel oil supplies are delivered by road tanker. The volume of fuel being stored and transferred from this facility to the Site represents a significant source of potential contamination.

The ASTs are bunded with drainage from the bund discharging to the No. 1 Settling Basin for disposal to the Ash Dam.

Delta personnel indicated that the fuel within this system is reconciled on a monthly basis and a formal stocktake conducted every 6 months as part of the fuel accounting procedure. Given the limitations of wet stock reconciliation when dealing with such large volumes, there is a potential for leaks or spills to have caused the migration of contaminants to the underlying soil and groundwater.

No soil or groundwater investigations are known to have been undertaken to date which specifically target the Fuel Oil Installation. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Investigation Methodology and Field Observations

A total of four soil investigation bores, all of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. The sampling locations within this AEC are presented on *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

During the sampling process, no field indicators of contamination, such as staining or odours were detected within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 34.0 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.8*.

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

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
VG_MW01	14.8	None	0-1.2
VG_MW02	9.0	None	0
VG_MW03	10	Hydrocarbon staining, slight hydrocarbon odour	0-34.0
VG_MW04	14	None	0-3.5

Groundwater samples were collected from four monitoring wells within the Fuel Oil Installation AEC. Groundwater parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*.

Electrical conductivity (EC) ranged from 213.8 - 4419 µS/cm indicating fresh to saline groundwater conditions. pH levels were indicative of acidic conditions within the four wells and VG_MW02 demonstrated a pH of 3.89 which is quite acidic and may be indicative of acid sulfate soil conditions in this area.

No indications of contamination such as sheens or odours were observed during groundwater sampling within this AEC, however sheen was observed during the initial purging of VG_MW02 and VG_MW04. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B*.

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.g of Annex B*.

Measured concentrations of COPCs were below the adopted human health screening values in all soil samples collected from within this AEC.

Measured concentrations of COPCs were below the adopted ecological screening values with the exception of TRH C_{10}-C_{16} (excluding naphthalene) in the soil sample collected from VG_MW03 at a depth of 0.5 m bgl and benzo(a)pyrene in the soil sample collected from VG_MW01 at a depth of 0.1 m bgl. Measured concentrations of various heavy metals were above the corresponding laboratory LOR in a number of soil samples collected from within this AEC, however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.g* of *Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

Measured concentrations of all COPCs were below the laboratory LOR in all groundwater samples analysed, with the exception of metals (discussed in *Section 5.4)*.

Discussion

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

The measured concentration of TRH C_{10}-C_{16} exceeded the adopted ESL in the soil sample collected from VG_MW03 at a depth of 0.5 m bgl and the measured concentration of benzo(a)pyrene exceeded the adopted ESL in the soil sample collected from VG_MW01 at a depth of 0.1 m bgl. These sampling locations are located on the eastern and northern side of the AST bund beneath concrete hardstand, and the vegetation in this area is limited to patchy grass and some isolated trees on adjacent areas of open ground. No obvious signs of stressed vegetation were noted in the adjacent vegetated areas. These impacts are therefore considered unlikely to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a power station.

5.3.8 *VH - Vehicle Refuelling Depot*

Background

The Vehicle Refuelling Depot is located adjacent to the Administration Building and consists of two Underground Storage Tanks (USTs) which are used to store unleaded petrol and diesel and are connected to two bowsers.

Anecdotal evidence from Delta personnel indicated that a single decommissioned underground storage tank is also located approximately 10 m to the north of the operational refuelling facilities and two decommissioned underground storage tanks and bowser plinth are located approximately 30 m north-west of the operational refuelling facilities. Tank integrity test data was not available for review.

The area is sealed to allow vehicles and heavy machinery such as cranes to refuel. The area is also a thoroughfare to the main operational areas of the Site.

Soil and groundwater investigations have been completed in the areas of underground tank infrastructure to facilitate compliance with relevant UPSS legislation. Four groundwater monitoring wells were installed in the UPSS area in 2010 and an additional six wells were installed in 2011.

In 2010, TRH(C_{10} - C_{36}) was identified at a concentration of 2540 µg/L, in a well installed to the north of the UPSS but TRH was not detected in any of the 10 wells sampled in 2011 (DLA Environmental, 2012). In 2011, four new groundwater monitoring wells were installed by David Lane and Associates and these have been subsequently assessed for the presence/absence of hydrocarbon sheen using an interface probe. Hydrocarbon sheens were not detected in these investigations (David Lane and Associates, 2013).

AEC Methodology and Investigation Field Observations

Ten existing groundwater monitoring wells were gauged and sampled during the Phase 2 ESA. Due to the presence and coverage of the existing wells around the active and decommissioned UST's, ERM did not undertake additional well installation within the area. The sampling locations within this AEC are presented on *Figure 6.5* of *Annex A*.

A summary of the field observations from the drilling works are presented within *Table 5.9*.

Table 5.9 ***Groundwater Field Observations Summary - AEC VH***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence
VH_X_MW01	5.18	None
VH_X_MW02	5.42	None
VH_X_MW03	5.21	None
VH_X_MW04	5.21	None
VH_X_MW05	3.51	None

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence
VH_X_MW06	3.30	None
VH_X_MW07	4.34	None
VH_X_MW08	3.28	None
VH_X_MW09	3.38	None
VH_X_MW10	3.51	None

Groundwater samples were collected from the 10 existing groundwater monitoring wells present within the AEC. Groundwater parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters indicated typically brackish groundwater conditions with electrical conductivity ranging from 1337 to 7064 μS/cm.

pH measurements in groundwater within this AEC ranged between 3.32 and 4.35 indicating acidic conditions, which may be indicative of the presence of acid sulfate soil conditions in this area.

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

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.h of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

Measured concentrations of the majority of COPCs were below the laboratory LOR, with the exception of metals in most groundwater monitoring wells (discussed below), benzene at VH_X_MW06 and TRH, BTEX and phenols at VH_X_MW08. The concentration of benzene in groundwater at VH_X_MW06 exceeded the adopted human health (drinking water) screening values. The concentrations of TRH C_6-C_{10} (less BTEX), phenols, toluene, ethylbenzene and xylene in groundwater at VH_X_MW08 were above the laboratory LOR; however all concentrations were below the adopted human health and ecological screening values. The concentration of benzene at VH_X_MW08 exceeded both the human health (drinking water) and human health (recreational) screening values.

Discussion

Benzene was reported at concentrations exceeded the adopted human health (drinking water) screening values in two groundwater monitoring wells (VH_X_MW06 and VH_X_MW08) within this AEC. The adopted human health (recreational) screening value for benzene was also exceeded at VH_X_MW08). It is considered likely that the benzene impacts in AEC VH are associated with the presence of USTs in this area.

Groundwater monitoring has been ongoing within AEC VH since 2010, when TRH(C_{10} - C_{36}) was identified at a concentration of 2540 µg/L, in a well installed to the north of the USTs. Hydrocarbon detections in the current assessment were limited to BTEX constituents and do not suggest the presence of a significant ongoing release in this area of the Site.

The inferred groundwater flow direction in the area of the Vehicle Refuelling Depot is north east below the former A Station Power Block towards the inlet/outlet canal. In the absence of potable groundwater use in this area of the Site, these impacts are not considered to represent a significant potential risk to human health under the ongoing use of the Site as a Power Station. Benzene impacts were also not identified in sediment or surface water samples collected from the mouth of the inlet/outlet canal, indicating that these impacts are unlikely to be impacting upon recreational users of Lake Macquarie.

5.3.9 *VI - Water Treatment Plant Area*

Background

The Demineralisation Plant, Reverse Osmosis Plant and Polisher Regeneration Plant are located to the south west of the B Station Power Block. Significant quantities of sulfuric acid, sodium hydroxide, hypochlorite, ammonia and ferric sulfate are stored in ASTs in this area.

The water treatment plant area is bunded with the surrounding area consisting of concrete hardstand. The water treatment plant is confined by the former A Station to the north, and the Power Station access road utilised by vehicles and heavy plant to the south followed by a steep embankment up towards the Fly Ash Plant (AEC VT).

No soil or groundwater investigations are known to have been undertaken to date which specifically target the Water Treatment Plant Area. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of three soil investigation bores, two of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. The sampling locations within this AEC are presented on *Figure 6.5*. Relevant borehole logs are presented within *Annex D*. For the purpose of discussion of groundwater results, monitoring wells from VA, VB and VH have been considered where they are located around the perimeter of this AEC, to identify COPC that may have migrated from this AEC.

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

A summary of the field observations from the drilling works are presented within *Table 5.10.*

Table 5.10 ***Field Observations Summary***

AEC VIBorehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
VI_MW01	3.9	None	0-0.6
VI_MW02	4	None	0
VI_SB01	0.1	None	0

Groundwater field parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Electrical conductivity measurements indicated fresh water conditions at VI_MW02 and brackish groundwater conditions at VI_MW01. pH measurements indicated acidic conditions at VI_MW01 (pH 4.2) and slightly acidic conditions at VI_MW02 (pH 5.39) and moderately acidic pH values.

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

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.i of Annex B.*

Measured concentrations of all COPCs with the exception of zinc (discussed below) were below the adopted human health and ecological screening values in all soil samples collected from within this AEC. The majority of measured concentrations were below or close to the corresponding laboratory LOR.

Concentrations of some TRH fractions were above the corresponding laboratory LOR in soil collected from VI_SB01 at a depth of 0.1 m bgl; however all concentrations were below the adopted screening values.

Concentrations of various heavy metals were identified above the corresponding laboratory LOR in a number of soil samples collected from within this AEC. All concentrations of COPC in soil were below the adopted human health and ecological screening values, with the exception of zinc at VI_SB01 at a depth of 0.1 m bgl which exceeded the adopted ecological screening value.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.i of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed with the exception of metals, TRH and PFOS. Measured concentrations of TRH C_{16}-C_{34} and PFOS were detected above the laboratory LOR at VI_MW01, however all detected concentrations were below the adopted screening values.

Cobalt, copper and zinc were detected at concentrations exceeded the adopted ecological screening values in groundwater samples collected from monitoring wells within this AEC. Manganese was detected at concentrations exceeded the adopted human health (drinking water) in groundwater samples collected from several monitoring wells within this AEC.

Discussion

No exceedances of the adopted human health screening values were identified in soil samples collected from within this AEC. The ecological screening value for zinc was exceeded by a factor of approximately 300% in one soil sample collected from VI_SB01 at a depth of 0.1 m bgl.

This sampling point is located in a strip of open ground within the operational area that is approximately 20 m in width. The vegetation in this area is limited to a covering of grass and isolated trees. Given the highly disturbed and operational nature of the Site, this isolated area of zinc impact is not considered to represent a significant risk to the terrestrial environment under the ongoing commercial industrial use of the Site.

5.3.10 *VJ – Coal Storage Area*

Background

The coal storage area is located to the south west of the power block and is used for stockpiling of coal prior to transfer via conveyor to the coal mill and boilers. Truck washing facilities are located within this area and it is understood that biomass (primarily wood chips) for electricity generation were historically stored within this AEC.

Potential contamination sources include dirty water from the truck washing facility and contaminated stormwater runoff from this area, which are captured by a system of concrete drains that discharge into the settling ponds located in the northern portion of the stockpile area. Water from the retention ponds is discharged to the Ash Dam and overflow from these settling ponds is discharged into the outfall canal. Leaching of contaminants from the coal stockpiled on open ground may also impact groundwater.

No soil or groundwater investigations are known to have been completed within this AEC to date, therefore further investigation was undertaken to provide a baseline for soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of fourteen soil investigation bores, ten of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. The distribution of sampling locations within this AEC is presented in *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted outside of the coal stockpile area within this AEC. No staining was detected at any depth through the sampled soil profile but a sulfurous or organic odour was noted in a number of deep soil samples. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 15.2 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.11*.

Table 5.11 ***Field Observations Summary – AEC VJ***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
VJ_MW01	7.5	None	0
VJ_MW02	5	None	0-2.6
VJ_MW03	6.3	Sulfur odour at 4 m bgl	0-15.2
VJ_MW04	7	None	0-10.5
VJ_MW05	8	None	0-2.7
VJ_MW06	8	None	0.2-5.1

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
VJ_MW07	8	None	0
VJ_MW08	6	None	0-0.8
VJ_MW09	6	None	0.2-6.1
VJ_MW10	6	Organic odour	0.2-6.1
VJ_SB01	3	None	0-1.1
VJ_SB02	3	Organic odour	0-2.6
VJ_SB03	3	None	0.2-3
VJ_SB04	3	None	0.2-3

Groundwater field parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Electrical conductivity measurements ranged from 529 to 3049 µS/cm, indicating fresh water to saline conditions. The pH of the groundwater ranged from 4.32 to 6.11, which indicates slightly acidic to acidic conditions in groundwater across the AEC, this, in combination with the sulfurous odours noted may be an indicator of acid sulfate soil conditions.

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

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.j of Annex B.*

Measured concentrations of COPCs were below the adopted human health screening values in all soil samples collected from within this AEC.

The majority of measured concentrations in soil were below the corresponding laboratory LOR with the exception of toluene, PAHs and some TRH fractions. The concentration of toluene was above the corresponding laboratory LOR in soil collected from VJ_MW03 at a depth of 4.0 m bgl; however all concentrations were below the adopted screening values.

Concentrations of PAHs were above the corresponding laboratory LOR in soil collected from VJ_SB04_0.15 m bgl, VJ_SB01_1.0 m bgl, VJ_MW08_1.0 m bgl, VJ_MW07_0.1 m bgl, VJ_MW01_0.2 m bgl, VJ_MW05_1.0; however all concentrations were below the adopted screening values.

Concentrations of some TRH fractions were above the corresponding laboratory LOR in soil collected from VJ_SB04 at a depth of 0.15 m bgl, VJ_SB01 at a depth of 1.0 m bgl, VJ_MW08 at a depth of 1.0 m bgl, VJ_MW01 at a depth of 0.2 m bgl. however all concentrations were below the adopted screening values.

All concentrations were below the adopted screening values with the exception of TRH C_{10}-C_{16} at VJ_MW07 at a depth of 0.1 m bgl which marginally exceeded the adopted ecological screening value.

Concentrations of various heavy metals were identified above the corresponding laboratory LOR in a number of soil samples collected from within this AEC. All concentrations of COPC in soil were below the adopted human health and ecological screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.j of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed with the exception of some TRH fractions, toluene and 3&4-methylphenol at VJ_MW03 and metals in groundwater across the AEC (discussed in *Section 5.4*). The concentrations of TRH, toluene and 3&4-methylphenol at VJ_MW03 were above the corresponding laboratory LOR however all concentrations were below the adopted screening values.

Discussion

No exceedances of the adopted human health screening values were identified in soil samples collected from within this AEC. The ecological screening value was exceeded in one soil sample at VJ_MW07.

The measured concentration of TRH C_{10}-C_{16} marginally exceeded the adopted ecological screening value in the soil sample collected from VJ_MW07 at a depth of 0.1 m bgl. The concentration of TRH in soil was below the adopted human health screening values and TRH was not detected above the laboratory LOR in groundwater at this location. The concentrations of TRH reported in other sampling locations within this AEC did not exceed the adopted screening values. Monitoring well VJ_MW07 was located on the south-western corner of the coal stockpile area approximately 20 m from the edge of the coal stockpile area in an area of unsealed ground around the coal stockpile.

The vegetation in this area is limited to sparse areas of grass but no obvious differences were noted between the vegetation within this TRH impacted area and other similar sampling locations around the Coal Stockpile. On this basis and considering that exceedances of the adopted screening values were not identified in the other soil samples collected from within this AEC, this identified TRH impact is not considered to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a Power Station.

5.3.11 *VK – Mobile Plant Maintenance and Refuelling Areas*

Background

Mobile plant associated primarily with the coal storage area is serviced and refuelled in AEC VK, located directly to the north of the coal storage area. This area also houses a diesel AST, refuse oil AST, a lubricants station and a parts cleaning facility.

The refuelling/maintenance facilities are contained within a bunded area and runoff from this area is directed via an oil separator into a settling pond.

No soil or groundwater investigations are known to have been undertaken to date which specifically target the Mobile Plant Maintenance Area. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of nine soil investigation bores, seven of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. The sampling locations were distributed within this AEC as presented on *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

Field indicators of contamination, such as staining, odours or visibly stressed vegetation were not noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile at other locations within this AEC. Measured concentrations of ionisable volatile compounds via headspace analysis did not exceed 10.3 ppm v (isobutylene equivalent) in soil samples collected from this AEC.

A summary of the field observations from the drilling works are presented within Table *5.12*.

Table 5.12 ***Field Observations Summary – AEC VK***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v)
VK_MW01	8	None	0-0.2
VK_MW02	6	None	0-1.3
VK_MW03	6	None	0-1.1
VK_MW04	6	None	0.1-0.4
VK_MW05	8.3	None	0-10.3
VK_MW06	7	None	0-1.3
VK_MW07	5.4	None	0-0.1
VK_SB01	5.1	None	0-0.9
VK_SB02	3.9	None	0

Field parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B.* Electrical conductivity measurements indicated generally fresh groundwater conditions with brackish conditions at VK_MW05, VK_MW06 and VK_MW07(2648 to 6141 µS/cm). The groundwater within this AEC was slightly acidic to acidic with a pH range between 4.12 and 5.44.

Sheen was observed on groundwater purged fromVK_MW03 during the groundwater sampling event. No other indications of potential contamination, such as sheen or odours, were observed during groundwater sampling at other locations within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 3* of *Annex B.*

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.k* of *Annex B.*

Measured concentrations of COPCs were below the adopted human health screening values in all soil samples collected from within this AEC. Measured concentrations of COPCs were below the adopted ecological screening values in all soil samples collected from within this AEC with the exception of nickel in the soil sample collected from VK_MW04 at a depth of 0.2 m bgl .

The majority of measured concentrations of COPCs were below the corresponding laboratory LOR. Concentrations of some TRH fractions were above the corresponding laboratory LOR in the soil sample collected from VK_MW07 at 1.0 m bgl, however all concentrations were below the adopted screening values. Concentrations of phenanthrene were above the corresponding laboratory LOR in the soil samples collected from VK_MW02 at a depth of 0.2 m bgl, VK_MW04 at a depth of 0.2 m bgl, VK_MW06 at a depth of 0.5 m bgl and VK_MW07 at a depth of 1.0 m bgl, however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.k of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed, with the exception of selected metals in groundwater (discussed in *Section 5.4*).

Discussion

No exceedances of the adopted human health screening values were identified in soil samples collected from within this AEC. The ecological screening value for nickel was exceeded in the soil sample collected from VK_MW04 at a depth of 0.2 m bgl. This soil sample was collected below concrete hardstanding and therefore the identified exceedance for nickel is not considered to represent a significant risk to the terrestrial environment under the ongoing use of the Site as a Power Station.

5.3.12 *VL - Sewage Treatment Plant*

Background

The Vales Point Sewage Treatment system is located outdoors to the west of the operational area and consists of a tank with sedimentation compartment and sludge compartments and three treatment ponds, with a mechanical aeration system. The effluent from the third pond in this system ultimately discharges to the Retention Basin on the northern side of the Ash Dam.

Sewage can contain a variety of contaminants, including nitrates, metals, trace concentrations of toxic chemicals and salts. Potential contamination sources in association with the sewage treatment plant include leakage from the sewage treatment systems, associated pipework or retention basin into the underlying soil or groundwater.

No soil or groundwater investigations are known to have been completed in the vicinity of the sewage treatment plant facilities, therefore further investigation was undertaken to assess potential environmental issues associated with soil and groundwater conditions within this AEC.

AEC Methodology and Investigation Field Observations

A total of three soil investigation bores, all of which were completed as groundwater monitoring wells, were advanced within this AEC and one surface soil sample was collected to assess potential impacts to soil and groundwater. The three groundwater monitoring wells were distributed across the AEC to up gradient, cross-gradient and down gradient of the sewage treatment facility. The soil bore VL_SB01 was abandoned due to the proximity to sub-surface electrical utilities, however a surface soil sample was collected at this location. The sampling locations were distributed within this AEC as presented on *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*. No field indicators of contamination, such as staining, odours or visibly stressed vegetation were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.2 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.13*.

Table 5.13 ***Field Observations Summary - AEC VL***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
VL_MW01	6	None	0- 0.2
VL_MW02	7	None	0-0.1
VL_MW03	6	None	0-0.1
VL_SB01	0.1	None	0

Groundwater field parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Electrical conductivity measurements in groundwater within this AEC were indicative of fresh water conditions, with a range between 292 and 517 µS/cm.

The measured pH ranged between 5.36 and 6.11 which was indicative of slightly acidic groundwater conditions within this AEC.

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

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.1 of Annex B*.

Measured concentrations of COPCs were below the adopted human health and ecological screening values in all soil samples collected from within this AEC. The majority of measured concentrations of COPC were also below or close to the corresponding laboratory LOR. Concentrations of various heavy metals were identified above the corresponding laboratory LOR in a number of soil samples collected from within this AEC, however all concentrations were below the adopted screening values.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.1 of Annex B* . Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

Measured concentrations of the majority of the COPCs were below the laboratory LOR in all groundwater samples analysed. The exceptions to this were some detections of metals within groundwater across this AEC (discussed in *Section 5.4*).

Discussion

No exceedances of the adopted screening values were identified in soil samples collected from within this AEC. Similarly, with the exception of metals, no exceedances of the adopted screening values were identified in groundwater.

5.3.13 *VM - Chlorine Plant*

Background

The Vales Point Power Station generates free chlorine onsite through an electrolytic process using seawater sourced from Lake Macquarie. The chlorine plant is located to the north west of the power block and includes the bulk storage of hydrochloric acid and sodium hypochlorite in ASTs. The transformer oil storage filtration building, associated with the TransGrid Switchyard is also located immediately adjacent to the Chlorine Plant to the north.

The chlorine plant area is bunded and this AEC is predominantly covered by a concrete hardstand to allow access for vehicles and plant machinery.

No soil or groundwater investigations are known to have been completed within this AEC to date and therefore further investigation was undertaken to provide a baseline and to assess soil and groundwater conditions within this AEC. The data collected within this AEC was also used to evaluate COPCs associated with the operation of the adjacent transformer oil storage filtration building.

AEC Methodology and Investigation Field Observations

A total of three soil investigation bores, all of which were completed as groundwater monitoring wells, were advanced within this AEC and three surface soil samples were collected to assess potential impacts to soil and groundwater. Surface soil samples were collected at three locations At three locations where soil bore and monitoring wells could not be advanced, as discussed in *Section 4.1.* The sampling locations were distributed within this AEC as presented on *Figure 6.5* of *Annex A.* . Relevant borehole logs are presented within *Annex D.*

No field indicators of contamination, such as staining or odours were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile, although an organic odour was noted in one deep soil sample. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.5 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.14.*

Table 5.14 *Field Observations Summary – AEC VM*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm)
VM_MW01	6	None	0-0.5
VM_MW02	0.1	None	0
VM_MW03	4.5	None	0-0.2
VM_MW04	4	Organic odour	0-0.5
VM_MW05	0.1	None	0
VM_SB01	02	None	0

Groundwater field parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B.* Electrical conductivity measurements in groundwater within this AEC indicated fresh water to brackish water conditions, with a range from 895 to 3973 µS/cm. The measured pH ranged between pH 5.08 and 6.03 which was indicative of slightly acidic groundwater conditions within this AEC.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 2* of *Annex B.*

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.m of Annex B.*

The majority of measured concentrations of COPCs were below or close to the corresponding laboratory LOR. Concentrations of TRH were identified above the corresponding laboratory LOR in soil samples collected from VM_MW02 at a depth of 0.1 m bgl and VM_MW05 at a depth of 0.1 m bgl,

Concentrations of PAHs including acenaphthylene, benz(a)anthracene, benzo(a) pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, chrysene, fluoranthene and pyrene were identified above the corresponding laboratory LOR in soil samples collected from VM_MW02 at a depth of 0.1 m bgl. All reported PAH and TRH concentrations were below the adopted screening values. Concentrations of various heavy metals were identified above the corresponding laboratory LOR in a number of soil samples collected from within this AEC. The concentration of zinc in a soil sample collected from 0.2 m bgl at VM_MW02 exceeded the adopted ecological screening value.

The measured concentrations of asbestos fines and fibrous asbestos (0.004 %w/w) in the soil sample from VC_MW03 at a depth of 0.1 m bgl exceeded the adopted human health screening value of 0.001 % w/w). Chrysotile and amosite asbestos fines and fibrous asbestos (FA and AF) were detected in one sample at VM_MW02 at a depth of 0.1 m bgl and the laboratory report identified "one piece of friable asbestos cement sheeting approximately 5 x 4 x 2mm plus several loose bundles of friable asbestos fibres approximately 2 x 1 x 0.5mm".

Groundwater

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.m of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9* of *Annex A*

Concentrations of some TRH fractions were detected above the corresponding laboratory LOR in groundwater from monitoring well VM_MW04, however all concentrations were below the adopted screening values.

Concentrations of PFOS and PFOA were detected above the corresponding laboratory LOR in groundwater from monitoring well VM_MW03. The concentration of PFOS in groundwater at VM_MW03 was exceeded the adopted human health (drinking water) screening values.

Discussion

No exceedances of the adopted human health screening values were identified in soil samples collected from within this AEC. The ecological screening value for zinc was exceeded in the soil sample collected from VM_MW02 at a depth of 0.1 m bgl.

VM_MW02 is located in an operational area of open ground immediately adjacent to the outlet canal. The vegetation in this area is limited to a sparse covering of grass and there is limited access to the area by wildlife. On this basis, this area of zinc impact is not considered to represent a significant potential risk to the terrestrial environment under the ongoing use of the Site as a power station.

The measured concentrations of asbestos fines and fibrous asbestos (0.004 %w/w) in the soil sample from VC_MW03 at a depth of 0.1 m bgl exceeded the adopted human health screening value of 0.001 % w/w). It is noted that this sample was collected from unsealed ground adjacent to the chlorine plant on the western side of the canal, and surface soils in this area may be accessible to Site workers and thus may represent a potential health risk if potential exposure pathways are not managed appropriately.

5.3.14 *VN – Wyee Coal Unloader Area and Coal Conveyors*

Background

The Wyee Coal Unloader facility is located to the north of the Ash Dam and adjacent to the Main Northern Rail Line between Wyee and Morisset, approximately 4.5 km to the north west of the operational area. A network of coal conveyors links this facility to the Coal Storage Area (AEC VJ). The operational area of this AEC is surrounded by buffer lands primarily comprised of dense bushland.

The Wyee Coal Unloader facility is comprised of a series of hoppers, feeders and transfer points. At the time of the investigation, the operation of the rail corridor and hopper unloader facility was suspended for maintenance and additional construction.

During the site investigation works, seven ASTs were identified in the operational area of the AEC. Four ASTs located near the Rail to Vales (RV) conveyor were used to hold water and three ASTs located near the office pre-fab buildings and main hopper unloader are used as fire water storage tanks and are connected to the fire hydrants servicing the operational areas and conveyor systems. Two water retention ponds are located to the north east of the main hopper unloaders.

The majority of the RV conveyor system follows ground level, with the RV conveyor gradually becoming elevated towards the transfer towers. The conveyors are covered to reduce the potential for fugitive dust emissions.

One pond of unknown historic use is located in a cleared area, approximately 600 m to the south east of the conveyor loop. This pond is not utilised by Delta and is surrounded by dense vegetation.

Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of fifteen soil investigation bores, ten of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. The sampling locations within this AEC are presented on *Figure 6.1* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

Significant quantities of fly-tipped waste, including drummed oils, household waste, wood, steel and plastic were observed in very close proximity to drilling location VN_MW10, on the eastern Site boundary, as shown in Photograph 47 and 48 of *Annex G*.

This area is accessible by the public via a short gravel road off Rutleys Road and the waste is likely to have been dumped illegally by members of the public.

No staining or unusual odours were detected at any depth through the sampled soil profile in this AEC. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 3.4 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.15*.

Table 5.15 ***Field Observations Summary - AEC VN***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
VN_MW01	7	None	0- 0.6
VN_MW02	4	None	0
VN_MW03	14	None	0
VN_MW05	7.5	None	0-0.9
VN_MW06	11.5	None	0-3.5
VN_MW07	11.5	None	0-1.8
VN_MW08	8	None	0-3.4
VN_MW09	7	None	0-1.6
VN_MW10	13.5	None	0
VN_MW12	5	None	0-0.2
VN_SB01	3	None	0-1.5
VN_SB02	3	None	0-0.1
VN_SB03	1.2	None	0
VN_SB04	3	None	0-0.6
VN_SB05	0.5	None	0.8-1.0

Groundwater field parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Electrical conductivity measurements indicated freshwater conditions in groundwater within this AEC, with a range between 172.3 and 1000 µS/cm. The measured pH ranged between 3.52 and 6, which is indicative of acidic to slightly acidic conditions in groundwater within this AEC. Acidic groundwater conditions at VN_MW12 (pH of 3.52) may indicate the presence of acid sulfate soil conditions in the area. This monitoring well is located immediately to the south of the water retention ponds.

No indications of contamination, such as sheen or odours, were observed during groundwater sampling within this AEC. A summary of field observations from the groundwater sampling works are presented within *Table 2* of *Annex B*.

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.n* of *Annex B.*

Measured concentrations of all COPCs with the exception of zinc were below the adopted screening values in all soil samples collected from within this AEC. The majority of measured concentrations were also below or close to the corresponding laboratory LOR in the soil samples collected from within this AEC. The zinc concentration measured in the soil sample collected from VN_MW08 at a depth of 0.2 m bgl was marginally in excess of the ecological screening value for areas of ecological significance but did not exceed the ecological screening value for commercial/industrial areas.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.n of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*

The majority of measured concentrations of COPCs in groundwater were also below or close to the corresponding laboratory LOR in the samples collected from within this AEC, with the exception of metals (discussed in *Section 5.4*).

Discussion

No exceedances of the adopted human health screening values were identified in soil samples collected from within this AEC. The ecological screening value was exceeded in soil at VN_MW08 for zinc.

The zinc concentration measured in VN_MW08 at a depth of 0.2 m bgl marginally exceeded the screening value adopted for areas of ecological significance. This sampling location was located within the operational area of this AEC The *Delta Coast Land Management Manual* (GHD, 2012) indicated that a number of threatened bat species have been identified in the wooded areas surrounding the operational area but as the zinc concentration in this sample did not exceed the adopted screening value for commercial/industrial areas and zinc concentrations in excess of the screening levels for ecologically significant areas were not identified across the remainder of the AEC, this isolated impact is not considered to be representative of a significant risk to the terrestrial environment.

The US EPA (2013) ProUCL (version 5) software was also used to calculate a 95% UCL value of 16.7 mg/kg for the zinc concentrations in the soil samples collected at depths of less than 1 m bgl across this AEC (calculations provided in *Annex I*). This value is significantly less than the ecological screening level adopted for areas of ecological significance.

5.3.15 *VO – Ash Dam*

Background

The Ash Dam is located to the south-west of the operational area of the Site. A large proportion of the ash which is produced from the Vales Point Power Station is transported by wet sluicing via pipelines to the Ash Dam. The northern portion of the Ash Dam (Ponds 1, 2 and 3) have been filled to capacity and rehabilitated. The central areas of the Ash Dam, known as Pond 4, 5A and 5B, are currently active and receiving wet sluice from the Power Station. Ash settles in these upper reaches of the dam and the water is pumped back to the Power Station via ash return water pumps. Prior to Munmorah Power Station ceasing operations, the Vales Point Ash Dam was also used for the storage of fly ash produced at Munmorah Power Station.

Various other solid and liquid wastes are also permitted to be directed to the Ash Dam under the EPL including coal fines, mill pyrites, residual detergents and oil sheens, sand, concrete products, boiler blowdown, minor chemical spill residues, chemicals for environmental control, ash dam water treatment plant residues, dust returned from the ash recovery plant, marine growth, debris, seaweed, chemical cleaning solutions, oil and chemically impacted soil, desilting of settling basins, dredge spoil, waste wood, wood chips, dirty water drains, treatment plant discharges, coal handling plant stormwater, neutralised demineralisation effluent, polisher plant effluent, spent ion exchange resins, chlorine plant storage vessel precipitates, cable tunnel drainage, fabric filter bags, coal chitter and soil capping materials, coal mine dewatering discharges. Asbestos Containing Material (ACM) was also historically disposed within the dam.

Heavily vegetated areas are located around the boundaries of the Ash Dam. The *Delta Coast Land Management Manual* (GHD, 2012) indicates that threatened flora and fauna has been identified in the buffer lands surrounding the Ash Dam. *State Environmental Planning Policy No. 14* (SEPP 14) wetlands are also located immediately to the north of the Ash Dam toe drain and along the creeks to the north of the Ash Dam. Rural residential areas are located along the north western boundary of the Ash Dam and residential areas are located directly to the west and south of the Ash Dam.

Three existing groundwater monitoring wells installed to the north of the Ash Dam have been monitored on a quarterly basis since 2008 to assess seepage from the Ash Dam. A qualitative review of this data indicates that the groundwater is saline and slightly acidic and that measured concentrations of copper, lead, nickel and zinc consistently exceed the ANZECC (2000) trigger values for marine water quality. As a result, the EPA has requested additional groundwater investigations in this area and a Pollution Reduction Program (PRP) has been implemented under the Site EPL.

AEC Methodology and Investigation Field Observations

Intrusive soil and groundwater investigations within the active or rehabilitated areas of the Ash Dam were not considered necessary, as it is already acknowledged that these areas are impacted with waste materials (primarily ash). The investigations of this AEC therefore focused on identifying COPC that may have migrated from this AEC towards sensitive receptors.

A total of twenty-one soil bores were advanced and nineteen of these were converted into groundwater monitoring wells. Sampling locations were installed around the entire boundary of the Ash Dam, with the exception of an approximately 2 km stretch along the south western side of the Ash Dam, where the presence of a high pressure Jemena gas pipeline prevented the installation of sampling locations. The sampling locations within this AEC are presented on *Figures 6.2, 6.3 and 6.6 of Annex A.* Relevant borehole logs are presented within *Annex D.*

During the additional round of sampling undertaken on 27 May, 2014. Surface water from the toe drain was sampled. It was noted that this water was not flowing and appeared stagnant with orange staining. This sample was analysed for metals. The laboratory results are shown in *Table 5.o* in *Annex B.*

During the sampling program, no staining or odours were noted on the Site surface. Visibly stressed vegetation was noted in the areas within approximately 30 m of the active portion of the Ash Dam, although it is noted that this could be related to a number of factors, potentially including inundation (refer to *Photograph 46* and *47* of *Annex G*).

No staining was detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 5.9 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within Table *5.16*.

Table 5.16 ***Field Observations Summary – AEC VO***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
VO_MW01	4	H_2S odour at 3.2 m bgl	0- 8.7
VO_MW02	7	None	0-0.8
VO_MW03	7.5	H_2S odour at 7 m bgl	0-5.9
VO_MW04	8	None	0
VO_MW05	10	None	0
VO_MW06	2.5	Shale staining	0
VO_MW07	10	None	0
VO_MW08	12.5	None	0
VO_MW09	12	None	0-2.4
VO_MW10	12	None	0-0.6

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
VO_MW11	12	None	0-3.4
VO_MW12	3	None	0
VO_MW13	5.1	None	0
VO_MW14	6	None	0
VO_MW15	5.5	None	0-0.5
VO_MW16	4.6	Possible ash	0-0.2
VO_MW17	4.5	None	0-1.2
VO_MW18	7	None	0-1.0
VO_MW19	5	None	0
VO_MW20	11	None	0-1.7
VO_SB01	3	None	0
VO_SB03	3	None	0-0.1

Groundwater field parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Electrical conductivity measurements indicated that the groundwater within this AEC ranged from fresh to highly saline conditions. The pH measurements in groundwater within this AEC were typically slightly acidic with a range from pH of 3.6 to 6.55. pH values of less than 4 were recorded in monitoring wells VO_MW04, VO_MW06, VO_MW12, VO_MW18 and VO_MW19, which may indicate the presence of ASS conditions. VO_MW04 is located near the Ash Dam toe drain, VO_MW06 is located on the north western boundary of the Ash Dam and VO_MW12 is located near the discharge point for the Ash Dam into Wyee Creek. VO_MW18 and VO_MW19 are located immediately to the east of the Ash Dam.

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

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.0* of *Annex B*.

The concentrations of TRH (C10-C16 excluding naphthalene) measured in soil samples collected from VO_MW06 and VO_MW10 at a depth of 0.2m bgl exceeded the ecological screening values for areas of ecological significance, but not the screening values for commercial industrial areas.

The nickel and zinc concentrations in selected soil samples marginally exceeded the ecological screening value for areas of ecological significance.

Asbestos was not reported in soil within this AEC.

Groundwater Analytical Data

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.0 of Annex B.* Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*

With the exception of metals, all COPCs were measured at concentrations below the laboratory LOR.

Surface Water Analytical Results

The surface water samples collected from within the Ash Dam toe drain reported concentrations of manganese greater than the adopted human health (drinking water) screening values and cobalt and zinc concentrations greater than the adopted ecological screening levels.

A comparison between the metal concentrations measured in the toe drain and those measured in the groundwater monitoring wells located immediately upgradient of the toe drain (including VO_MW02, VO_MW03 and VO_X_MW03) indicated that the manganese concentration in the toe drain were lower by a factor between 3 and 7 and the cobalt concentrations were lower by a factor of between 14 and 19. The zinc concentrations measured in the toe drain were of a similar order of magnitude to those measured in the immediately upgradient groundwater monitoring wells. Arsenic, nickel and selenium were measured at concentrations in excess of the adopted screening values in groundwater monitoring wells located immediately upgradient of the toe drain but not within the toe drain.

Discussion

The concentrations of TRH (C_{10}-C_{16} excluding naphthalene), benzo(a)pyrene, nickel and zinc measured in individual soil samples exceeded the ecological screening values adopted for areas of ecological significance, but not the screening values for commercial industrial areas. These results indicate that concentrations of TRH, PAH, nickel and zinc in soil around the boundary of the Ash Dam may be sufficient in some areas to adversely impact upon sensitive terrestrial organisms.

Overall however, a significant adverse effect on the terrestrial environment is not predicted on the basis of these results, particularly given the operational nature of the Ash Dam and the licensed placement of a variety of waste materials, including ash, within this structure.

Groundwater from monitoring wells within this AEC reported metals concentrations greater than the adopted human health and ecological screening values.

A consolidated discussion of this issue is presented in *Section 5.4*, but the surface water samples collected from within the Ash Dam toe drain indicate that lower concentrations are discharging into the downgradient area or that the surface water has been diluted by other inputs, such as rainfall.

5.3.16 VP - Asbestos Landfills

Background

There are six Asbestos Landfills located within the catchment of the Ash Dam. These Asbestos Landfills (referred to as "Dumps") were closed in approximately 1995. Four of the Dumps (Dumps 1-4) have been closed and covered, revegetated and surveyed. Dump 5 is located entirely within the active area of the Ash Dam. Dump 6 is located predominantly within the active area of the Ash Dam, with a small portion located in bushland to the east of the active portion of the Ash Dam. Dump 4 is located within the previously active area of the Ash Dam which was rehabilitated around 2007. The Asbestos Landfills are fenced with signs to indicate the presence of asbestos contaminated wastes.

Detailed information about the waste materials disposed within the Asbestos Landfills was not available for review as a part of this assessment but it is understood that the primary material disposed within these areas was asbestos. The waste materials contained within the landfill areas have the potential to impact the conditions of underlying soil and groundwater.

Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions around the known delineated extent of the landfills.

AEC Methodology and Investigation Field Observations

Intrusive soil and groundwater investigations within the asbestos landfills were not considered safe or necessary, as it is already acknowledged that these areas are impacted with waste materials. The investigation locations in this AEC were distributed to target the soil and groundwater conditions around the perimeter of the known delineated extent of the landfills, as marked by the security fencing and signage and indicated in plans provided by Delta. The investigations within this AEC focussed on identifying COPCs that may have migrated from this AEC towards sensitive receptors.

A total of twelve soil bores were advanced around the perimeter of the known asbestos landfill areas. Two of these bores were converted to monitoring wells in the area downgradient of the three landfills located to the north of the Ash Dam (Dump 1, Dump 2 and Dump 3).

The installation of monitoring wells in the areas downgradient of the asbestos landfills was limited due to the rough terrain in this area, however the monitoring wells from the adjacent Ash Dam AEC (AEC VO) as well as surface water samples from AEC VR have also been considered. The three landfills known as Dump 4, Dump 5 and Dump 6 are located either within the area currently covered by the active Ash Dam or the rehabilitated part of the Ash Dam. The groundwater in these areas has been considered in the assessment of groundwater conditions in the Ash Dam AEC (AEC VO).

The sampling locations within this AEC are presented on *Figures 6.2* and *6.3* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

As anticipated, ash as well as coal and shale fragments were encountered at several locations in this AEC. Ash was identified from a depth of approximately 0.5 m bgl in the profiles of the three soil bores (VP_SB09 and SP_SB10) around the perimeter of the former "Dump 4", and a thin layer of ash was also encountered between 1.1 and 1.3 m bgl at VP_SB07. All three of these soil bores are located within the rehabilitated ash disposal area. Coal and shale fragments were encountered within the surface soils at three locations, VP_MW02, VP_SB01 and VP_SB02 which are located adjacent to the coal conveyor. There were no further staining or unusual odours detected at any depth through the sampled soil profile in this AEC. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.8 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.17*.

Table 5.17 *Field Observations Summary - AEC VP*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
VP_MW01	9	None	0
VP_MW02	7	None	0-0.1
VP_SB01	1.5	Coal and shale present.	0-0.3
VP_SB02	1.5	Coal and shale present.	0-0.1
VP_SB03	1.5	None	0
VP_SB04	2.1	None	0
VP_SB05	3	Ash	0-0.2
VP_SB06	3	None	0-0.6
VP_SB07	3	Ash	0-0.5
VP_SB08	3	None	0-0.8
VP_SB09	1.5	Ash	0
VP_SB10	0.5	Ash	0

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.p* of *Annex B.*

The majority of measured concentrations of COPC were below the corresponding laboratory LOR, with the exception of TRH, PAH and metals. Measured concentrations of TRH and PAH constituents were detected in soil samples collected from VP_SB02, however the measured concentrations did not exceed the adopted human health or ecological screening values.

Concentrations of various heavy metals were identified above the corresponding laboratory LOR in a number of soil samples collected from within this AEC. However all concentrations were below the adopted screening values with the exception of copper and zinc. The measured concentrations of copper and zinc in the soil sample collected from VP_SB01 at a depth of 0.2 m bgl exceeded the adopted ecological screening values.

Asbestos was detected in two soil samples collected from within this AEC at VP_MW02 at a depth of 2 m bgl and VP_SB02 at a depth of 0.2 m bgl. In both soil samples there were no visual indicators of potential ACM during the sample collection in the field. In the soil sample collected from VP_SB02 at a depth of 0.2 m bgl, the laboratory identified "several pieces of friable asbestos cement sheeting approximately 5 x 4 x 4 mm plus several loose bundles of friable asbestos fibres approximately 2 x 1 x 0.5 mm". The laboratory reported that amosite, crocodilite and chrysotile asbestos were present in the soil sample.

The asbestos quantification results reported that fibrous asbestos was detected at 0.034 % w/w and that asbestos fines and fibrous asbestos (<7 mm) were detected at 0.009 % w/w which is above the adopted human health screening criteria. In the soil sample collected from VP_MW02 at a depth of 2 m bgl the laboratory identified "several pieces of friable asbestos cement sheeting approximately 4 x 3 x 2 mm plus several loose bundles of friable asbestos and unidentified mineral fibres approximately 2 x 1 x 0.5 mm". The laboratory reported that amosite and crocodilite asbestos were present in the soil sample. The asbestos quantification results reported that fibrous asbestos was detected at 0.117 % w/w and that asbestos fines and fibrous asbestos (<7mm) were detected at 0.035 % w/w which is above the human health screening criteria.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.p of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

Measured concentrations of the majority of the COPCs were below the adopted screening values in the groundwater samples collected from within this AEC.

Benzene was detected at a concentration that marginally exceeded the adopted human health (drinking water) screening values in a single groundwater sample collected from VP_MW01. This well was re-sampled eight weeks later and again benzene was detected at a concentration exceeding the adopted human health (drinking water) screening values Copper and zinc were also detected at concentrations marginally exceeded the adopted ecological screening values in a groundwater sample VP_MW02.

Discussion

The copper and zinc concentrations in the shallow soil sample collected from VP_SB01 exceeded the adopted ecological screening values. These results may suggest a hotspot of metal impact in the vicinity of the asbestos landfill. The absence of elevated metal concentrations in other soil samples collected from within this AEC however, suggests that metal impacts are unlikely to be widespread in the areas surrounding the asbestos landfills. Concentrations of copper and zinc in excess of the ecological screening levels were identified in groundwater collected from this AEC. However the measured concentrations were consistent with those measured in monitoring wells up-gradient of the landfills in AEC VJ and VK.

The measured concentrations of benzene exceeded the adopted human health (drinking water) screening values in groundwater when sampled on two occasions. The monitoring well (VP_MW01) is located downgradient of an asbestos landfill area. In the absence of potable groundwater use in this area, this exceedance is not considered representative of a significant potential risk to human health however may be indicative of a benzene source within the asbestos landfill. It is noted that the adopted recreational screening levels were not exceeded on either of the two sampling events.

Groundwater from monitoring wells within this AEC reported copper and zinc concentrations greater than the adopted ecological screening values. As metals have been identified at concentrations exceeding the adopted screening criteria in groundwater within all AECs a consolidated discussion of this issue is presented in *Section 5.4.*

5.3.17 VQ – Dust Line

Background

The Dust Line is an aboveground pipeline which transfers dust from the operational area of the Site to the Ash Dam. The asbestos register for the Site indicates that the dust pipes are constructed of asbestos containing materials (ACM).

Site personnel indicated that the pipe had been treated with paint to minimise the release of ACM to the environment. Investigations were undertaken to assess whether soil in the vicinity of the pipeline has been impacted by asbestos fibres, from the degradation of this equipment.

AEC Methodology and Investigation Field Observations

Twelve surface soil samples were collected from immediately beneath the Dust Line along the accessible aboveground section which is approximately 1.2 km in length. The sampling density is approximately 1 sample per 100 m along the targeted length of the pipework. A grid based inspection, in accordance with Western Australian (WA) Department of Health (DOH) (2009) *Guidance for the Assessment, Remediation and Management of Asbestos-Contaminated Sites,* could not be achieved due to the physical presence of piping (including asbestos) within the immediate vicinity.

Groundwater in this AEC was considered as part of adjacent AECs, and there were no monitoring wells targeted to this AEC. The sampling locations within this AEC are presented on *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining or odours were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.18*.

Table 5.18 Field Observations Summary - AEC VQ

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
VQ_SB01	0.2	None	0
VQ_SB02	0.2	None	0
VQ_SB03	0.2	None	0
VQ_SB04	0.2	None	0
VQ_SB05	0.2	None	0
VQ_SB06	0.2	None	0
VQ_SB07	0.2	None	0
VQ_SB08	0.2	None	0
VQ_SB09	0.2	None	0
VQ_SB10	0.2	None	0
VQ_SB11	0.2	None	0
VQ_SB12	0.2	None	0

Soil Analytical Results and Discussion

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 6* of *Annex B*.

Fibrous asbestos detected in three soil samples from this AEC (VQ_SB06_0.1, VQ_SB11_0.2, VQ_SB12_0.2). However, the measured concentrations of asbestos fines and fibrous asbestos (%w/w) did not exceed the adopted human health screening value.

Fibrous chrysotile asbestos was detected in a soil sample from VQ_SB06 at a depth of 0.1 m bgl and the laboratory report identified "several loose bundles of friable asbestos fibres approximately 2 x 1 x 0.5 mm". Fibrous chrysotile and amosite asbestos was detected in a soil sample from VQ_SB11 at a depth of 0.2 m bgl and the laboratory report identified "several loose bundles of friable asbestos fibres approximately 2 x 1 x 0.5 mm". Amosite asbestos was detected in a soil sample from VQ_SB12 at a depth of 0.2 m bgl and the laboratory report identified "two loose bundles of friable asbestos fibres approximately 3 x 1 x 0.5 mm".

It is noted that this asbestos assessment is considered indicative in nature, and additional analysis, in accordance with ASC NEPM (2013) would need to be undertaken to comprehensively delineate asbestos impacts associated with this pipework. Given the presence of asbestos in the matrix of the pipeline materials, appropriate ongoing Workplace Health and Safety (WHS) management should be maintained.

5.3.18 *VR – Sediments in Surrounding Waterways*

Background

The Site is located in the Lake Macquarie catchment area, with Lake Macquarie identified as the main local hydrological feature. There are four Licensed Discharge Points (LDPs) for water from the Power Station under Environmental Protection License (EPL) 761, including;

- LDP 1 - Cooling Water outlet to Wyee Bay;
- LDP 2 - Discharges to the cooling water outlet from the ash water recycle system;
- LDP 4 – Release of seepage from Ash Dam rehabilitated area at the v-notch weir located at the toe of the Dam; and
- LDP 18 – Over boarding of the Ash Dam into the Wyee Creek diversion channel and Wyee Creek.

All B Station drains are also ultimately discharged via the Chain Valley Retention Basin A ('Lake Rodham') to Chain Valley Bay.

Lake Macquarie sediments and surface water have been identified as a potential AEC due to the discharges that these waterways receive from the Power Station, which include:

- cooling water that has passed through the plant and therefore:
    - has been treated with biocides and anti-scale chemicals;
    - is heated;
    - may contain traces of oil;
    - has potentially elevated salts and metals due to concentration created by evaporation.
- treated effluent from the oil-water separator associated with the operational site drainage network;
- overflow and potential seepage from the Ash Dam and associated tributary streams;
- stormwater runoff from across the Site; and
- groundwater from across the Site.

Surface water samples are collected from Lake Macquarie on a regular basis, as a part of the EPL conditions associated with the operation of the Site but the parameters analysed generally have not included metals (Delta Electricity, 2014). Discharges to Wyee Creek are also monitored when they exceed 2 hours in duration. These monitoring events identified exceedances of the ANZECC (2000) trigger values for marine water for metals and concentrations of selenium in excess of the ANZECC (2000) low reliability trigger value for marine water.

While some environmental assessment has been undertaken in this area, it is not considered that suitable characterisation of environmental conditions has been established. Given the absence of sufficient previous detailed environmental characterisation work at the Site, the numerous discharge points and sources of potential contaminants, further investigation was considered to be required to provide a baseline assessment of sediment and surface water conditions in this AEC.

This investigation focused on Chain Valley Bay, Mannering Bay, Wyee Bay, and Wyee Creek. Chain Valley Bay is located immediately to the north east of the Site. Mannering Bay, with Wyee Bay immediately beyond, is located to the north of the Site. Wyee Creek and the Wyee Creek diversion channel are located along the north western site boundary and function as part of the Ash Dam overflow system.

Recreational fishing and boating activities are undertaken in Lake Macquarie. Chain Valley Bay Reserve is located 1 km south of the operational area. This reserve is publically accessible, however it was noted during these investigation works that public use of this area appeared to be infrequent. Further to this, the reserve is heavily vegetated in most areas, with small clearings available for public use and few amenities which would suggest that the reserve is not frequently used.

The *Delta Coast Land Management Plan* (GHD, 2012) identified a number of sensitive aquatic environments within the Site buffer zones and adjacent areas. *State Environmental Planning Policy No. 14* (SEPP 14) wetlands are located in the vicinity of the Site; immediately to the north of the Ash Dam toe drain around the fringes of Mannering Bay, on the northern edge of Mannering Bay and along the waterways within the northern buffer zones.

During the additional round of sampling undertaken on 27 May 2014, surface water from the toe drain was sampled. It was noted that this water was not flowing and appeared stagnant with orange staining. This sample was analysed for metals. The laboratory results are shown in Table 5o, as the toe drain is located in Ash Dam AEC (VO).

AEC Methodology and Investigation Field Observations

Sediment and surface water were collected from 23 sampling locations. Sampling locations were distributed around the AEC as illustrated in *Figures 6.2 and 6.4* of *Annex A*.

The field notes recorded during the sediment and surface water sampling activities are presented in *Annex E*. Logs of the sediment cores are presented in *Annex D*. A summary of the field parameters recorded during the surface water sampling is presented in *Table 3* of *Annex B*.

The sediment collected in Wyee Creek and Mannering Bay were typically silty or sandy clay, with the exception of sample VR_M_SS05 where the top 50 cm was reported to comprise silty sand and gravelly sand. Sediments in Chain Valley Bay and Wyee Bay comprised of silt.

No field indicators of contamination, such as staining, sheen, or odours were noted within this AEC.

Sediment Analytical Results

The sediment analytical results compared to the adopted screening values are presented in *Table 4.r of Annex B*.

Measured concentrations of Total Recoverable Hydrocarbons were detected above the LOR in a number of individual samples collected from within Wyee Creek and Wyee Bay, however the measured concentrations did not exceed the adopted screening values. Measured concentrations of BTEX in sediment samples analysed were also below the corresponding laboratory LORs.

Phenols were detected at concentrations marginally above the laboratory LORs in two of the sediment samples collected from within Wyee Creek. Screening criteria for the individual phenols detected were not available, but the total concentration of phenols measured in the samples did not exceed the RIVM (2001) ecological serious risk concentration for phenol.

Polycyclic Aromatic Hydrocarbons were detected at concentrations marginally above the corresponding laboratory LORs but below the adopted screening values in a number of individual samples collected from across the AEC. Exceedances of the ISQG-low values for acenaphthene, anthracene, naphthalene, fluorene and/or phenanthrene were recorded in all of the samples collected from within Wyee Bay. Total PAHs only marginally exceeded the ISQG-Low value of 4 mg/kg in the sediment samples collected from depths up to 0.2 m below the sediment surface at VR_W_SS02 (5.38 mg/kg) and VR_W_SS03 (5.05 mg/kg), which are located in the central portion of Wyee Bay, in close proximity to the mouth of Mannering Bay. The source of these PAH impacts has not been identified, but could potentially include inputs from the Power Station or a range of external sources, such as recreational boating or mining within surrounding areas.

Measured TOC values in Wyee Bay were reported between 5.23% and 15.6%. ANZECC (2000) recommends normalizing the ISQG values to TOC to account for the reductions in bioavailability that can be associated with the presence of organic matter in sediment. Following the normalisation of the measured PAH concentrations to 1% TOC, the resultant values did not exceed the adopted screening values.

Metal concentrations in sediment were generally below the adopted screening values. Cadmium was identified in individual samples collected from within Wyee Creek, the control area and Wyee Bay at concentrations marginally in excess of the ISQG-low value. Two sediment samples collected from within Wyee Bay also returned copper concentrations marginally in excess of the ISQG-low values.

In the absence of ANZECC/ARMCANZ (2000) ISQG values for selenium, the sediment results were compared against the British Columbia (2001) sediment guideline for selenium in marine sediment 2 mg/kg. Exceedances of this screening value were identified in numerous samples collected from within the lower reached of Wyee Creek and within Mannering Bay. A single sample from the control area also demonstrated a selenium concentration of 4 mg/kg.

The maximum selenium concentration reported in Wyee Creek was 26 mg/kg, with this result recorded at VR_C_SS02, located in the portion of the creek that flows along the northern edge of Mannering Bay. The selenium concentrations measured in sediment samples collected from within Wyee Creek generally increased along the Creek towards Mannering Bay. The most elevated selenium results within the Wyee Creek sediment were generally recorded in the surface samples.

Relatively consistent concentrations of selenium were recorded throughout Mannering Bay, with between 4 and 8 mg/kg reported in the surface samples and between < 1 mg/kg and 6 mg/kg reported in the deeper samples.

Surface Water Analytical Results

The surface water analytical results were compared to the adopted ecological and human health (recreational) screening values, as presented in *Table 5.r* of *Annex B*.

The measured concentrations of phenols, BTEX, TRH and PAH were less than the corresponding laboratory LORs and the adopted screening values in all of the surface water samples analysed.

Zinc and copper concentrations exceeded the adopted ecological screening values in approximately 60% the surface water samples. The copper exceedances were generally marginal, at less than twice the adopted screening values whereas the zinc concentrations were up to approximately 4.5 times the screening value.

Three marginal exceedances of the cobalt screening values were recorded in surface water samples collected from within Wyee Creek. The metal concentrations did not exceed the adopted human health (recreational) guidelines in any of the surface water samples.

Discussion

Sediment

As noted in Simpson *et al.* (2005), the ISQG-low values represent concentrations below which the frequency of adverse biological effects is expected to be very low, while the ISQG-high represents concentrations above which adverse biological effects are expected to occur more frequently.

If a detected concentration exceeds the relevant ISQG, it does not necessarily mean that adverse biological effects will occur, but rather that more detailed consideration of the results may be required.

Cadmium was identified in individual samples collected from within Wyee Creek, the control area and Wyee Bay at concentrations marginally in excess of the ISQG-low value. Two sediment samples collected from within Wyee Bay also returned copper concentrations marginally in excess of the ISQG-low values. The distribution of these impacts is not suggestive of significant cadmium and cobalt impacts in Lake Macquarie sediments as a result of the operation of the Vales Point Power Station.

Selenium enrichment in sediment has previously been assessed in Lake Macquarie and has been attributed to atmospheric deposition from the power stations, dispersion of dissolved or particulate-bound selenium from fly ash, urban runoff and sewage (Kirby *et al.*, 2001). Selenium concentrations as high as 17.2 mg/kg were reported in Mannering Bay in a published scientific report (Peters *et al.*, 1999). Exceedances of the selenium screening value were identified in numerous samples collected from within the lower reached of Wyee Creek and within Mannering Bay. The maximum selenium concentration reported in Wyee Creek was 26 mg/kg, with the selenium concentrations measured in sediment samples collected from within Wyee Creek generally increasing along the Creek towards Mannering Bay. Relatively consistent concentrations of selenium were recorded throughout Mannering Bay, at up to 8 mg/kg.

It is considered likely that discharges from the Ash Dam, potentially including licensed discharges, runoff and groundwater flow have contributed to the selenium impacts identified in Wyee Creek and Mannering Bay. Other potential sources within the catchment include mines, other power stations and other industries. The selenium concentrations identified in the current assessment were of the same order of magnitude as those identified in historic investigations (e.g. Peters *et al.*, 1999), suggesting that the selenium load in Wyee Creek and Mannering Bay sediments have not increased significantly in recent years.

Surface Water

Overall, the surface water results do not suggest that there has been significant impact on surface water quality within Wyee Creek, Mannering Bay, Wyee Bay, or Chain Valley Bay as a result of inputs from the Site.

Copper and cobalt concentrations marginally exceeded the adopted ecological screening values were identified in a number of samples, but a clear link between these samples and the Site was not apparent in the data. Zinc concentrations exceeded the adopted ecological screening values in approximately 60% the surface water samples, suggesting that background conditions may contribute to these concentrations.

The samples collected from the upper reaches of Wyee Creek generally demonstrated the highest zinc concentrations, which may reflect a contribution from the Ash Dam but which may also reflect the fact that these samples were collected in a riparian rather than estuarine environment and as such are more likely to be influenced by factor such as runoff and erosion.

5.3.19 *VS – TransGrid Switchyard*

Background

The TransGrid Switchyard is located on the western side of the cooling water canal, adjacent to the chlorine plant, hydrogen plant and Site canteen. The Vales Point Fire Training Area is located adjacent to the TransGrid Switchyard to the south east. The Switchyard is fenced and largely covered with hardstanding. The TransGrid Switchyard is not owned or operated by Delta Electricity. The COPC within the switchyard are related to the current use and storage of transformer oil and historically the transformer oil may have contained PCBs. The investigations within this AEC included the non-operational lands outside the TransGrid Switchyard and were distributed around the perimeter the target migration of potential contaminants from this AEC towards sensitive receptors.

No soil or groundwater investigations are known to have been completed within this AEC to date. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of six soil investigation bores, five of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. The investigations within this AEC included the non-operational lands outside the TransGrid Switchyard and were distributed around the perimeter the target migration of potential contaminants from this AEC towards sensitive receptors.

Data collected from this AEC has also been used to evaluate the presence of COPCs in soils and groundwater that may be associated with the Vales Point Fire Training Area.

No field indicators of contamination, such as staining or odours were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 8.8 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.19.*

Table 5.19 ***Field Observations Summary – AEC VS***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
VS_MW01	5	None	0-0.8
VS_MW02	6.0	None	0–1.4
VS_MW03	6.3	None	0.1-0.9
VS_MW04	5.0	None	0- 0.3
VS_MW05	5.0	None	0.1-8.8
VS_SB01	3.0	None	0-0.2

Groundwater parameters recorded during the groundwater sampling works are presented in *Table 3* of *Annex B.* Field parameters indicated brackish and slightly acidic groundwater conditions.

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

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.s of Annex B.*

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

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

Asbestos was not detected in any of the soil samples analysed from this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.s of Annex B.* Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*

Measured concentrations of the majority of the COPCs were below the laboratory LOR and adopted ecological and human health screening values in all groundwater samples analysed, with the exception of metals in groundwater.

Discussion

No exceedances of the adopted screening values were identified in soil samples collected from within this AEC.

Groundwater from monitoring wells within this AEC reported metal concentrations greater than the adopted ecological screening values and a consolidated discussion of this issue is presented in *Section 5.4*.

5.3.20 *VT - Fly Ash Plant*

Background

The Fly Ash Plant is located immediately adjacent to the Power Station for the purpose of reusing the fly ash that is produced as a by-product of generating power. The majority of this AEC is covered in hardstanding and comprises a truck turning circle. Also located within this AEC are a weigh bridge and overhead silos.

It is understood that the Plant is not operated by Delta and that fly ash is transferred directly from the Power Station into the overhead silos located above a weighbridge. Trucks are then filled from overhead while stationed on the weighbridge. The fly ash is then trucked from the Site.

The Fly Ash Plant is a potential AEC due to the storage and handling of ash within the area and heavy vehicle traffic passing through the area. No soil or groundwater investigations are known to have been completed within this AEC to date. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of three soil investigation bores, two of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater. The sampling locations within this AEC are presented on *Figure 6.5* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

No field indicators of contamination, such as staining or odours were noted within this AEC. No staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1.9 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.20*.

Table 5.20 ***Field Observations Summary – AEC VT***

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
VT_MW01	7.5	None	0-1.0
VT_MW03A	1.5	None	0-0
VT_MW03B	7.0	None	0-1.9

Groundwater samples were collected from the two groundwater monitoring wells present within the AEC. Groundwater parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B*. Field parameters indicated fresh to brackish groundwater conditions and pH values of 4.1 were recorded in both monitoring wells indicating slightly acidic groundwater conditions.

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.t of Annex B*.

The majority of measured concentrations of COPCs were also below or close to the corresponding laboratory LOR.

Measured concentrations of various heavy metals were reported above the corresponding laboratory LOR in a number of soil samples collected from within this AEC. All concentrations were however below the adopted screening values, with the exception of copper and zinc in the soil sample collected from VT_MW01 at0.2 m bgl which exceeded the adopted ecological screening values for commercial/industrial sites.

Asbestos was not detected in any of the soil samples collected from within this AEC.

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.t of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

With the exception of metals, the measured concentrations of the COPCs were below the adopted screening values in all groundwater samples analysed from within this AEC.

Discussion

Exceedances of the adopted screening values for zinc and copper were identified in a shallow soil samples collected from within this AEC.

Given the operational nature of this AEC and the fact that it is fenced and primarily covered in hardstanding, these exceedances are not considered to represent a significant risk to the environment under the ongoing use of the Site as a Power Station.

Groundwater from monitoring wells within this AEC reported metal concentrations greater than the adopted ecological screening values and a consolidated discussion of this issue is presented in *Section 5.4*.

5.3.21 *VU - Buffer Lands and Boundaries*

Background

Much of the area surrounding the operational areas of the Site and the Ash Dam is a buffer zone. Land within this AEC is largely undeveloped and is currently dominated by bushland and decommissioned and operational coal mines. The *Delta Coast Land Management Manual* (GHD, 2012) indicates that threatened flora and fauna has been identified in the buffer lands surrounding the Ash Dam and Wyee Rail Coal Unloader.

No soil or groundwater investigations are known to have been completed within this AEC to date. Given the absence of previous environmental characterisation work, further investigation was considered to be required to provide a baseline assessment of soil and groundwater conditions in this area.

AEC Methodology and Investigation Field Observations

A total of twenty-two soil investigation bores, seventeen of which were completed as groundwater monitoring wells, were advanced within this AEC to assess potential impacts to soil and groundwater.

The sampling locations within this AEC are presented on *Figure 6.1 to 6.6* of *Annex A*. Relevant borehole logs are presented within *Annex D*.

Ash, shale and black staining were observed at VU_MW18 at a depth of 0.8-0.9 m bgl. An organic odour was noted at VU_MW19 at a depth of 0.4 to 0.65 m bgl and was associated with a sandy clay. The laboratory results did not indicate the presence of COPCs in soil above the screening values associated with the observed black staining or organic odour. No other field indicators of contamination, such as staining or odours were noted within this AEC. No further staining or unusual odours were detected at any depth through the sampled soil profile. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 1.9 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table 5.21*.

Table 5.21 *Field Observations Summary – AEC VU*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v -isobutylene equivalents)
VU_MW01	3.9	None	0-1.9
VU_MW02	6.5	None	0-9.6
VU_MW03	12	None	0-3.9
VU_MW04	9	None	0-6.4
VU_MW05	9.5	None	0-2.8
VU_MW06	10	None	0-3.8
VU_MW07	8.7	None	0-2.2
VU_MW08	13.4	None	0-7.6
VU_MW09	15	None	0-2.3
VU_MW10	5.5	None	0-3.8
VU_MW11	0.1	None	0
VU_MW12	7	None	0-2.1
VU_MW13	11	None	0-3.3
VU_MW14	12	None	0-0.1
VU_MW15	6	None	0-0.1
VU_MW16	9.5	None	0-2.4
VU_MW17	7.5	None	0-1.9
VU_MW18	1.5	Black staining	0-0.2
VU_MW19	1.4	Organic odour	0-0.4
VU_MW20	13	None	0-1.6
VU_SB01	0.4	None	0-0.1
VU_SB02	1.5	None	0
VU_SB03	3	None	0-0.1

Groundwater parameter measurements collected during the groundwater sampling works are presented in *Table 3* of *Annex B.* Electrical conductivity measurements indicated fresh to brackish groundwater conditions. Groundwater samples collected from VU_MW02, VU_MW15 and VU_MW16 reported pH values of less than 4, which may be indicative of Acid Sulfate Soil (ASS) conditions. VU_MW02 is located to the north east of the operational area adjacent to Lake Macquarie and VU_MW15 is located to the north west of the TransGrid Switchyard (AEC VS). VU_MW16 is located to the east of the Ash Dam. Field pH measurements recorded across the remainder of this AEC indicated acidic to neutral groundwater conditions.

Soil Analytical Results

The soil analytical results have been compared to the adopted human health and ecological screening values as presented in *Table 4.u of Annex B.*

Measured concentrations of COPCs were below the adopted human health screening values in all soil samples collected from within this AEC. Concentrations of TRH were reported above the laboratory LOR in two samples, VU_MW20 at a depth of 0.5 m bgl and VU_MW01 at a depth of 1.5 m bgl however the concentrations did not exceed the adopted human health screening values.

Measured concentrations of COPCs were below the adopted ecological screening values (commercial/industrial) in all soil samples collected from within this AEC. Concentrations of copper, nickel and zinc exceeded the adopted ecological screening values for areas of ecological significance in a number of soil samples collected across this AEC, including deep samples (> 2 m bgl) in VU_MW17, VU_MW04, VU_MW14 and VU_MW10 and shallow samples (< 2 m bgl) in VU_MW01, VU_MW03 and VU_SB03. .

Groundwater Analytical Results

Groundwater analytical results compared to the adopted screening values are presented in *Table 5.u of Annex B*. Exceedances of the adopted screening values are also graphically presented in *Figure 9 of Annex A*.

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

Discussion

No exceedances of the adopted human health screening values were identified in soil samples collected from within this AEC. Concentrations of copper, nickel and zinc exceeded the adopted ecological screening values for *areas of ecological significance* (as defined in ASC NEPC, 2013) in a number of deep soil samples (>2 m bgl) and shallow soil samples (<2 m bgl). However, the concentrations of copper, nickel and zinc in all soil samples analysed in this AEC were below the adopted ecological screening values for commercial/industrial sites.

The EILs apply principally to contaminants in the top 2 m (i.e. shallow soil samples) (ASC NEPC, 2013) and therefore the screening value exceedances identified in the deep samples are not considered to be representative of a significant potential risk to the terrestrial environment of these areas.

The shallow soil samples demonstrating exceedances of the ecological screening values for *areas of ecological significance* (VU_MW01, VU_MW03 and VU_SB03) are located on the eastern side of the operational area. The *Delta Coast Land Management Manual* (GHD, 2012) did not identify threatened or endangered species in this area and hence the adoption of the screening values for the protection of *areas of ecological significance* is overly conservative for these samples. Therefore, on the basis that the measured concentrations did not exceed the ecological screening values for commercial/industrial areas, the measured metal concentrations are not considered to represent a significant potential risk to the environment under the ongoing use of the Site as a Power Station.

5.4 *METAL AND METALLOID CONCENTRATIONS IN GROUNDWATER*

Metals and metalloids can occur naturally in groundwater, and an assessment of background conditions forms an integral part of the evaluation of metal and metalloid concentrations reported. This is especially relevant where potential off-site sources of metals and metalloids exist, including historical and current underground coal mining works which occur extensively in the area surrounding and underlying the majority of the Site, including the Ash Dam.

For the purposes of this assessment, the following monitoring wells have been put forward as background monitoring wells; VO_MW09 to VO_MW11 and VU_MW17. These monitoring wells are located up-hydraulic gradient of all identified on-site sources. pH levels and ORP (two key controls on metal and metalloid solubility) in the aforementioned monitoring wells fell within the mid-range of measurements recorded across the monitoring well network at the Site, with pH measurements from the background monitoring wells varying between 3.8 to 5.7 and ORP between -82 mV and 318 mV (site-wide groundwater pH and ORP measurements varied between 3.3 and 6.8 and -259 mV and 500 mV respectively).

These monitoring wells were considered as the general background data points for the Site and are referred to as the *Background Monitoring Wells* in the remainder of the report.

The concentrations of metals in groundwater have been compared to the *Background Monitoring Wells* (as applicable), and for the purposes of this assessment, concentrations equalling or exceeding the maximum background concentrations by a factor of two were considered as potentially indicative of concentrations above background values. It is noted that a limited number of monitoring wells are available as background monitoring wells and that only one round of data is available for comparison of reported concentrations from these monitoring wells to the rest of the monitoring network established during the Stage 2 ESA.

The evaluation of metal(loid) concentrations in relation to background conditions based on the approach outlined here should therefore be seen as a preliminary review of background conditions given the relatively limited nature of the background dataset. While the background dataset is limited, the approach does allow for the preliminary identification of potential background conditions.

Note that all the metal and metalloid (including arsenic and selenium) concentrations described below are for field filtered samples (filtered with single-use 0.45 μm filters), with concentration ranges and averages based on primary samples only.

Arsenic

Arsenic concentrations ranged from the LOR of <1 µg/L to 184 µg/L with an average concentration of 5.5 µg/L across the monitoring well network. Concentrations equalling or exceeding the lowest adopted screening value of 10 µg/L (drinking water criteria) were limited to 12 of the 117 monitoring wells sampled. Samples with exceedances of the adopted screening values were taken from one monitoring well located at the vehicle refuelling depot, and a number of monitoring wells located downgradient of the ash dam.

In the *Background Monitoring Wells* arsenic concentrations averaged 1 µg/L with a maximum reported concentration of 3 µg/L. Background concentrations were below the assessment criteria and the elevated arsenic concentrations are therefore not considered attributable to background concentrations.

Cobalt

Cobalt concentrations ranged from the LOR of 0.9 µg/L to 169 µg/L with an average concentration of 19 µg/L across the groundwater monitoring well network. Concentrations equalling or exceeding the lowest adopted screening values of 1 µg/L (marine adopted ecological screening values) were reported for 58 of the 64 monitoring wells sampled for cobalt.

Samples with exceedances of the adopted screening values were taken from monitoring wells spread across the Site, including the former A Station power block, the water treatment plant, transformer area, vehicle refuelling area, waste oil storage area, Wyee rail coal unloader area, coal storage area and ash dam.

Cobalt concentrations In the *Background Monitoring Wells* averaged 35 µg/L with a maximum reported concentration of 43 µg/L. Reported concentrations a factor of two above the maximum reported background concentration were limited to two monitoring wells (VO_MW04 and VO_MW06) located downgradient of the ash dam and one monitoring well (VJ_MW09) located at the coal storage area. Reported concentrations above what can be considered as the background levels are therefore highly localised to either the coal storage area or the ash dam compared to the number of samples exceeding the adopted assessment values.

Copper

Copper concentrations ranged from the LOR of <0.5 µg/L to 596 µg/L across the groundwater monitoring well network, with an average concentration of 13 µg/L. Concentrations equalling or exceeding the lowest adopted screening values of 1.3 µg/L (marine adopted ecological screening values) were recorded in samples from 91 of the 117 monitoring wells sampled.

Samples reporting exceedances of the adopted screening values for copper were collected from monitoring wells spread across the Site, including the former A Station and B Station power blocks, the transformer area, vehicle refuelling area, waste oil storage area, Wyee rail coal unloader, coal storage area, sewage treatment plant and Ash Dam.

Copper concentrations in *Background Monitoring Wells* averaged 7 µg/L with a maximum reported concentration of 18 µg/L. Reported concentrations a factor of two above the maximum reported background concentration were limited to a total of eight monitoring wells located at the vehicle refuelling depot, the fuel oil installation area and downgradient of the Ash Dam.

Lead

Lead concentrations ranged from the LOR of <1 µg/L to 231 µg/L across the groundwater monitoring well network, with an average concentration of 12 µg/L. Concentrations equalling or exceeding the lowest adopted screening values of 4.4 µg/L (marine adopted ecological screening values) were identified in samples from 35 of the 117 monitoring wells sampled. Monitoring wells with samples exceeding the adopted screening values were located predominantly in the vehicle refuelling area, mobile plant maintenance area, Wyee rail coal unloader and at the ash dam. Exceedances were however also noted at the former A Station power block, sewage treatment plant, contaminated wastewater treatment system and waste oil storage area.

In the *Background Monitoring Wells* lead concentrations averaged 7 µg/L with a maximum reported concentration of 20 µg/L. Reported concentrations a factor of two above the maximum reported background concentration were limited to a total of eight monitoring wells, located in the mobile plant maintenance area, the switchyard and downgradient of the ash dam.

Manganese

Manganese concentrations ranged from below the LOR of 11 µg/L to 17 300 µg/L across the groundwater monitoring well network, with an average concentration of 1287 µg/L. Concentrations exceeding the adopted screening values of 500 µg/L (drinking water criteria) were identified in samples from 23 of the 64 monitoring wells sampled. Samples with exceedances of the adopted screening values were taken from monitoring located in the Wyee rail coal unloader area, the mobile plant maintenance area, the coal storage area and ash dam.

Manganese concentrations in the *Background Monitoring Wells* averaged 1187 µg/L with a maximum reported concentration of 2290 µg/L.

Reported concentrations a factor of two above the maximum reported background concentration were limited to three monitoring wells; one monitoring well located at the mobile plant maintenance area (VK_MW07), one monitoring well at the coal storage area (VJ_MW09) and one monitoring well located downgradient of the ash dam (VO_MW06).

Nickel

Nickel concentrations ranged from below the LOR of <0.5 μg/L to 133 μg/L across the groundwater monitoring well network, with an average concentration of 15 μg/L. Concentrations exceeding the lowest adopted screening value of 20 μg/L (drinking water criteria) were identified in samples from 32 of the 117 monitoring wells sampled. Samples with exceedances of the adopted screening values were taken from monitoring wells spread across the Site, including the former A Station and B Station power blocks, the main store, vehicle refuelling area, mobile plant maintenance area, the coal storage area, chlorine plant and ash dam.

Nickel concentrations in the *Background Monitoring Wells* averaged 14 μg/L with a maximum reported concentration of 32 μg/L. Reported concentrations a factor of two above the maximum reported background concentration were limited to three monitoring wells located downgradient of the ash dam (VO_MW04, VO_MW06 and VO_X_MW02).

Selenium

Selenium concentrations ranged from below the LOR to 276 μg/L across the groundwater monitoring well network, with an average concentration of 16 μg/L. Concentrations exceeding the screening value of 10 μg/L (drinking water criteria) were identified in samples from nine of the 63 monitoring wells sampled for selenium. Monitoring wells with samples that exceeded the adopted screening values were limited to one location (VK_MW06) at the mobile plant maintenance area and eight monitoring wells at the ash dam.

Selenium concentrations in the *Background Monitoring Wells* were below the laboratory LOR (which varied between <0.1 μg/L to <10 μg/L) with the highest reported concentration being 10 μg/L (on a sample with a laboratory LOR of 10 μg/L). Reported concentrations measuring a factor of two above the maximum reported background concentration included samples taken from eight monitoring wells, all located downgradient of the ash dam.

Zinc

Zinc concentrations ranged from 6 µg/L to 1200 µg/L across the groundwater monitoring well network, with an average concentration of 63 µg/L. The majority of monitoring wells (108/117) exceeded the adopted screening values of 15 µg/L (marine adopted ecological screening values).

Zinc concentrations in the *Background Monitoring Wells* averaged 65 µg/L, with a maximum reported concentration of 116 µg/L. Reported concentrations measuring a factor of two above the maximum reported background concentration included samples taken from one monitoring well, VO_MW04 located downgradient of the ash dam.

Potential Influence of Acid Sulfate Soils

Quaternary alluvial sediments that may contain sulfides liable to the creation of acid sulfate soil conditions when oxidised have been identified in locations near the marine environment, specifically in the vicinity of VO_MW04 where a pH of 3.6 has been measured and discoloured water ponding typical of acid sulfate soil conditions observed.

The ash dam was built in the course of Mannering Creek and the ash dam deposits are therefore expected to be largely underlain by quaternary alluvial sediments. Disturbance of the sediments during construction of the ash dam, and/or infiltration of ash dam water (that would be expected to be largely oxygenated) into the underlying sediments, may have resulted in the creation of acid sulfate soil conditions with naturally occurring sediments contributing to the elevated metal concentrations observed in groundwater.

pH values of less than 4 were recorded in monitoring wells VO_MW04, VO_MW06, VO_MW12, VO_MW18 and VO_MW19, which may indicate the presence of ASS conditions. VO_MW04 is located near the Ash Dam toe drain, VO_MW06 is located on the north western boundary of the Ash Dam and VO_MW12 is located near the discharge point for the Ash Dam into Wyee Creek. VO_MW18 and VO_MW19 are located immediately to the east of the Ash Dam.

It is noted that relatively acidic groundwater conditions (with pH levels below 4.5) have been observed in a relatively large number of groundwater monitoring well locations across the Site, including a number of monitoring wells installed in the Munmorah Conglomerate and located away from the alluvial sediments (including background monitoring well VU_MW17 with a pH of 3.8). Relatively acidic conditions are therefore not restricted to areas where disturbed alluvial sediments may be located, as a result of the construction of the ash dam.

Summary

Based on the preliminary assessment of background conditions outlined in this report, metal concentrations seen as indicative of background values were generally higher than the lowest adopted screening criteria. The majority of monitoring wells across the Site reported metal concentrations that did not exceed concentrations seen as indicative of background conditions. Specifically for cobalt, copper, nickel and zinc, the number of monitoring wells with samples that have concentrations above background values were generally an order of magnitude less than the number of monitoring wells with exceedances of the adopted assessment criteria (i.e. one tenth of the number of samples exceeding the adopted screening criteria). For lead and manganese, the number of samples with concentrations above background values was at least a factor of four less than the number of samples exceeding the adopted screening criteria.

Conversely, based on the approach to assessing background conditions as discussed above, the arsenic exceedances and the majority of selenium exceedances of the assessment criteria cannot be attributed to background conditions. Where concentrations of metal(loids) in groundwater were measured above background values, impact generally appears to be localised in distinct areas of the site with the main potential source areas being the vehicle refuelling depot, the coal storage area and the ash dam. The majority of samples with concentrations reported above the background values were taken from monitoring wells located downgradient of the ash dam.

Based on the assessment outlined in the report the ash dam appears to present a primary source of arsenic and selenium to groundwater. The data further indicates that the ash dam may act as a secondary source of cobalt, copper, lead, manganese, nickel, and zinc, contributing to metal concentrations that are generally elevated in background conditions.

If disturbed alluvial sediments underlie the ash dam, these sediments may be contributing to elevated metal(loid) concentrations with potential sulfide oxidation in sediments resulting in acid sulfate conditions. As historical and current underground coal mining works occur extensively in the area surrounding and underlying the majority of the Site (including the ash dam), the mine works and related subsidence effects (which could enlarge fracture surfaces within bedrock) may further have contributed to elevated metal(loid) concentrations observed in groundwater. The long term disposal of waste ash materials, which are known sources of metal contaminants, within the Ash Dam, may also have contributed to metal impacts in the underlying groundwater. The long term storage of coal materials within the Coal Storage Area may also have contributed to the observed metal impacts in groundwater in this area.

Acidic groundwater conditions in the vicinity of the Vehicle Refuelling Area appear to have contributed to the presence of elevated metal concentrations in groundwater, although it is noted that there are also areas of the Site where low pH conditions in groundwater have not resulted in metal concentrations in excess of background conditions.

5.5 *DATA QUALITY*

The data presented in the ESA was considered to generally be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site. Whilst some minor non-conformances have been identified in relation to field and laboratory QA/QC, these are not considered to have a material impact on the outcomes of this assessment. A detailed review of the Data Quality of this assessment is provided in *Annex F*.

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

- Some volatile organic compounds in water (including vinyl chloride, chloromethane, bromomethane, 1,2-Dichloroethane, hexachlorobutadiene, 1,2,3-trichlorobenzene and 1,2-dibromomethane) and pentachlorophenol have LORs marginally above the adopted ecological protection criteria and/or above the drinking water guidelines. The assessment results do not suggest that these contaminants are key contaminants of concern.
- PAHs in water, including Benzo(a) pyrene and Carcinogenic PAHs (as BaP TEQ), have LORs above the drinking water and recreational guidelines. The LORs are within the same order of magnitude as the recreational screening value and an order of magnitude above the drinking water guideline. The assessment suggests that these contaminants are not key COPC, as PAH compounds in excess of the screening values have not been identified in groundwater in this assessment.
- TRH (>C10-C16 minus naphthalene) in soils have LORs above the adopted ESL for areas of ecological significance by a factor of 2. This threshold does not apply to soils across the whole site, only being applicable to areas of the Ash Dam (AEC VO) and Wyee Rail Coal Unloader (AEC VN).

Selenium in groundwater has an LOR above the adopted ecological screening value but above the adopted human health screening values. The LOR for selenium in surface water samples collected from within the inlet/outlet canal fell below the adopted ecological screening value and exceedances of the screening criteria were not observed in the surface water samples. On this basis, the LOR non-conformances for selenium in groundwater are not considered to represent a significant data gap in this assessment.

6 OVERALL DISCUSSION

The primary objective of this Stage 2 ESA was to develop a baseline assessment of environmental conditions at the Site and within the immediate surrounding receiving environments at or near the time of the transaction. The results of the assessment have also been used to assess:

- The nature and extent of soil and/or groundwater impact on / beneath the Site and in relation to neighbouring sensitive receptors.
- Whether the impacts at the Site represent a risk to human health and/or the environment, based on the continuation of the current use.
- Whether the impact at the Site is likely to warrant notification /regulation under the *CLM Act 1997*.
- Whether material remediation is considered likely to be required.
- Whether the data collected during the assessment was of a suitable quality and completeness to provide a baseline of environmental conditions at the Site.

The overall results of the assessment are discussed herein, with reference to these objectives.

6.1 SUMMARY – THE NATURE AND EXTENT OF SOIL, SEDIMENT, GROUNDWATER AND SURFACE WATER IMPACT

A CSM was developed and refined, which identified the following ecological and human receptors:

- indoor and outdoor human health receptors in the form of onsite and offsite workers;
- intrusive maintenance workers both on and offsite;
- offsite residential receptors, living in the vicinity of the operational area or Ash Dam;
- recreational users of Mannering Bay, Wyee Bay and Chain Valley Bay;
- recreational users of Tom Barney Oval;
- aquifers beneath the Site and nearby potable and stock watering wells; and
- ecological receptors, including those in the vegetated buffer lands and aquatic environments of Mannering Bay, Wyee Creek, Wyee Bay and Chain Valley Bay.

Soil, sediment, surface water and groundwater data were compared against published environmental quality levels to provide a screening level assessment of potential risks to these identified receptors. The findings of the screening process indicated that concentrations in soil, sediment, surface water and groundwater generally complied with the adopted screening values, with some exceptions as discussed in the following sections.

6.1.1 *Onsite Soil*

- The shallow fill material in a single sample from the boundary of the B Station Power Block (AEC VA) at a depth of approximately 0.2 to 0.3 m bgl was observed to have black staining and a hydrocarbon odour. The corresponding laboratory results exceeded the human health screening level for carcinogenic PAHs.

- TRH C_{10}-C_{16} (excluding naphthalene) was detected at concentrations in excess of the adopted ecological screening value for commercial/industrial areas in individual soil samples collected from the boundary of the former A Station Demolition Area (AEC VB), the Fuel Oil Installation (AEC VG) and Coal Storage Area (AEC VJ).

- Benzo(a)pyrene was detected at concentrations in excess of the adopted ecological screening value for commercial/industrial areas in individual samples collected from the B Station Power Block (AEC VA) and Fuel Oil Installation (AEC VG) at a depth of 0.1 m bgl.

- Copper and zinc concentrations in excess of the ecological screening levels adopted for commercial/industrial areas were identified in individual soil samples collected from the B Station Power Block (AEC VA), Waste Oil Storage area (AEC VF), Fuel and the Water Treatment Plant Area (AEC VI), Chlorine Plant (AEC VM), Asbestos Landfills (AEC VP) and Fly Ash Plant (AEC VT). These impacts were not necessarily attributed to background conditions at the Site and could be related to onsite sources.

- Copper, nickel, zinc and bezo(a)pyrene in excess of the ecological screening levels adopted for ecologically significant areas were identified in individual samples collected from the Wyee Coal Unloader Area (AEC VN), Ash Dam (AEC VO) and Site Buffers and Boundaries (AEC VU).

- Significant quantities of fly-tipped waste, including drummed oils, household waste, wood, steel and plastic were observed in close proximity to the eastern boundary of the Wyee Coal Unloader Area (AEC VN). This area is accessible to the public via a short gravel road off Rutleys Road and the waste is likely to have been dumped illegally by members of the public.

- Asbestos was detected in individual shallow soil samples collected from within the Transformer Area (AEC VC), Chlorine Plant (AEC VM) and in the vicinity of the Asbestos Landfill (AEC VP) at concentrations in excess of the adopted human health screening values for fibrous asbestos and asbestos fines.

The results of the assessment do not suggest the presence of widespread asbestos contamination at the Site. It is noted however that as identified in the ASC NEPM (2013) the vertical boring of soils is not a comprehensive method via which to identify asbestos, however given the objectives of this assessment and the operational constraints, the assessment methodology adopted was considered appropriate. The absence of asbestos impacts across the Site cannot however be guaranteed on the basis of the results of this assessment. Similarly, as with any investigation of this nature, the potential exists for unidentified contamination to exist between the completed sampling locations both within and between AECs.

6.1.2 *Onsite Groundwater*

- TRH and chlorinated hydrocarbons were reported above the laboratory LOR in groundwater samples collected monitoring wells located around the boundary of the former A Station Demolition Area (AEC VB). The measured concentrations did not exceed the adopted screening values but may be indicative of the presence of unidentified impacts within the former A Station area.

- Groundwater samples form monitoring wells located around the boundary of the former A Station Demolition Area (AEC VB) and Chlorine Plant Area (AEC VM) reported PFOS concentrations in excess of the adopted human health screening level but not the adopted ecological screening level.

- Benzene was detected at concentrations in excess of the adopted human health (drinking water and recreational) screening values in groundwater samples collected from monitoring wells located in the Vehicle Refuelling Area (AECs VH) and a single sample collected from a well downgradient of the Asbestos Landfills (AEC VP).

- Where concentrations of metal(loids) in groundwater were measured above background values, impact generally appears to be localised in distinct areas of the site with the main potential source areas being the Coal Storage Area (AEC VJ) and the Ash Dam (AEC VO). Acidic groundwater conditions in the vicinity of the Vehicle Refuelling Area also appear to have contributed to the presence of elevated metal concentrations in groundwater, although it is noted that there are also areas of the Site where low pH conditions in groundwater have not resulted in metal concentrations in excess of background conditions.

- The majority of groundwater samples that reported concentrations of metals above the background values were collected from monitoring wells located downgradient of the Ash Dam which appears to present a primary source of arsenic and selenium to groundwater. The assessment results also suggest that the Ash Dam is a secondary source of cobalt, copper, lead, manganese, nickel and zinc, contributing to metal concentrations that are already generally elevated in background conditions. The highest concentrations were generally located in the vicinity of the toe drain, along the north western boundary of the Ash Dam and directly to the east of the Ash Dam.

- If disturbed alluvial sediments underlie the ash dam, these sediments may be contributing to elevated metal(loid) concentrations with potential sulfide oxidation in sediments resulting in acid sulfate conditions. Historical and current underground coal mining works in the area surrounding and underlying the majority of the Site could also have enlarge fracture surfaces within bedrock), further contributing to elevated metal(loid) concentrations observed in groundwater. The long term disposal of waste ash materials, which are known sources of metal contaminants, within the Ash Dam, may also have contributed to metal impacts in the underlying groundwater. The long term storage of coal materials within the Coal Storage Area may also have contributed to the observed metal impacts in groundwater in this area.

6.1.3 *Offsite Sediments and Surface Waters*

- Cadmium was identified in individual samples collected from within Wyee Creek, the control area and Wyee Bay at concentrations marginally in excess of the ISQG-low value. Two sediment samples collected from within Wyee Bay also returned copper concentrations marginally in excess of the ISQG-low values. The distribution and magnitude of these impacts is not suggestive of significant cadmium, copper and cobalt impacts in Lake Macquarie sediments as a result of the operation of the Vales Point Power Station.

- Exceedances of the adopted selenium ecological screening level were identified in numerous sediment samples collected from within the lower reached of Wyee Creek and within Mannering Bay. The maximum selenium concentration reported in a sediment sample collected from Wyee Creek was 26 mg/kg, with the selenium concentrations measured in sediment samples collected from within Wyee Creek generally increasing along the Creek towards Mannering Bay. Relatively consistent concentrations of selenium were recorded throughout Mannering Bay, at up to 8 mg/kg.

- Copper and cobalt concentrations marginally in excess of the adopted ecological screening levels were identified in a number of surface water samples, but a clear link between these samples and the Site was not apparent in the data. Zinc concentrations exceeded the adopted ecological screening values in approximately 60% the surface water samples, including a number of the control area samples suggesting that background concentrations are elevated. Elevated background zinc concentrations may contribute to these concentrations in surface water. The samples collected from the upper reaches of Wyee Creek generally demonstrated the highest zinc concentrations, which may reflect a contribution from the Ash Dam but which may also reflect the fact that these samples were collected in a riparian rather than estuarine environment and as such are more likely to be influenced by increased sediment load.

6.2 SUMMARY – DOES THE IDENTIFIED IMPACT REPRESENT A RISK TO HUMAN HEALTH AND/OR THE ENVIRONMENT?

The approach to the screening of the data gathered in this assessment was to initially adopt the most conservative potential assessment values. The exceedances of the screening values outlined in *Section 4.10* were subsequently assessed on a case by case basis, in light of the specific characteristics of the individual samples and the AEC from which those samples were collected. The conclusions of these further assessments are presented in the following sections.

6.2.1 Onsite Soil

Benzo(a)pyrene was detected at concentrations in excess of the adopted human health and ecological screening level in a shallow soil sample on the boundary of the B Station Power Block (AEC VA). A single shallow soil sample collected in the vicinity of the Fuel Oil Installation (AEC VG) also reported benzo(a)pyrene at a concentration in excess of the adopted ecological screening level.

Benzo(a)pyrene is a non-volatile compound and therefore exposure to this chemical could only occur through direct contact with the soil or exposure to dust. The majority of these AECs are covered in hardstanding, including the area in which the impacted sampling locations were installed. On this basis, the PAH impacts identified in this location are considered unlikely to represent a significant risk to human health or the environment under the ongoing use of the Site as a Power Station. Actions to prevent direct contact with benzo(a)pyrene impacted soil should however be implemented during any subsurface works undertaken within the affected area of AEC VA, to minimise potential health risks to intrusive workers.

TRH C_{10}-C_{16} (excluding naphthalene) was detected at concentrations in excess of the adopted ecological screening value for commercial/industrial areas in individual soil samples collected from the boundary of the former A Station Demolition Area (AEC VB), the Fuel Oil Installation (AEC VG) and Coal Storage Area (AEC VJ). The ground surface within AEC VB and AEC VG was largely covered in hardstanding or gravel, including the area in which the impacted sampling locations were installed. The sampling location in AEC VJ was located on the south-western corner of the Coal Stockpile Area approximately 20 m from the edge of the stockpile area in an area of unsealed ground. PAH compounds were also detected in this sample, suggesting the possible contribution of stored coal to the identified TPH impacts in the vicinity of the Coal Stockpile, although visible coal particles were not identified in the sample. The vegetation in this area is limited to sparse areas of grass. On this basis, TRH impacts identified within these AECs are not considered to represent a significant risk to the terrestrial environment.

Copper and zinc concentrations in excess of the ecological screening levels adopted for commercial/industrial areas were identified in individual samples collected from the B Station Power Block (AEC VA), Waste Oil Storage area (AEC VF), Fuel and the Water Treatment Plant Area (AEC VI), Chlorine Plant (AEC VM), Asbestos Landfills (AEC VP) and Fly Ash Plant (AEC VT). With the exception of AEC VP, all of these exceedances were identified in fenced operational areas, either in areas covered with hardstanding or in areas with only limited vegetation. These impacts are therefore considered unlikely to represent a significant risk to the terrestrial environment assuming ongoing commercial industrial use in the current or similar configuration.

The copper and zinc concentrations in the shallow soil sample collected from AEC VP may suggest a hotspot of metals impact in the vicinity of the asbestos landfill, possibly as a result of the waste material buried in this area. The absence of elevated metal concentrations in other soil samples collected from within this AEC however, does not suggest widespread metal impacts in the areas surrounding the asbestos landfills.

Copper, nickel and zinc in excess of the ecological screening levels adopted for ecologically significant areas were identified in individual samples collected from the Wyee Rail Coal Unloader Area (AEC VN) and Site Buffers and Boundaries (AEC VU). The soil samples demonstrating exceedances of the ecological screening levels for areas of ecological significance within AEC VN and AEC VU are located within operational areas. The *Delta Coast Land Management Manual* (GHD, 2012) did not identify threatened or endangered species in these specific areas and hence the adoption of the screening values for the protection of areas of ecological significance is overly conservative for these samples.

As the measured concentrations did not exceed the adopted screening level for commercial/industrial areas, these impacts are not considered to be representative of a significant risk to the terrestrial environment under the ongoing use of the Site as a Power Station.

The concentrations of TRH (C10-C16 excluding naphthalene), benzo(a)pyrene, nickel and zinc measured in individual soil samples around the boundary of the Ash Dam (AEC VO) exceeded the ecological screening levels adopted for areas of ecological significance but not the commercial/industrial ecological screening levels. These results indicate that concentrations of TRH, PAH, nickel and zinc in soil around the boundary of the Ash Dam may be sufficient in some areas to adversely affect sensitive terrestrial organisms. Overall however, a significant adverse effect on the terrestrial environment is not predicted on the basis of these results. It is also noted that the Ash Dam receives licensed discharges of a variety of waste materials, including ash.

Chrysotile and amosite asbestos was detected in individual shallow soil samples collected from within the Transformer Area (AEC VC), Chlorine Plant (AEC VM) and the Asbestos Landfill (AEC VP) at concentrations in excess of the adopted human health screening values. The sampling locations within AEC VC and AEC VM are both in areas of bare gravel within the operational and are therefore accessible to Site employees. The sampling locations within AEC VP are also in areas of open ground and therefore accessible but are outside of the operational area, in a part of the Site known to be impacted by asbestos and only infrequently visited by Site employees.

All of these areas of asbestos impact may however represent a health risk if Site employees were to come into contact with them. ERM understands that Delta has subsequently recorded these areas in its Asbestos Register, for future management in line with the Delta Asbestos Management Procedures. The absence of asbestos within fill materials or upon surface soils in other areas across the Site also cannot be guaranteed on the basis of the results of this assessment.

6.2.2 *Onsite Groundwater*

Beneficial Uses

Groundwater beneath the Site is not extracted for potable use and a search of licensed groundwater bores has not identified any potential groundwater extraction receptors in the immediate vicinity of the Site. The nearest registered groundwater bores to the Site are a domestic bore located approximately 700 m north of the operational area in Mannering Park and a stock watering bore located approximately 600 m north of the Ash Dam. The potential does however exist for unidentified groundwater bores to be present in the residential areas located immediately to the north, west and south of the Ash Dam and to the east of the Rail Coal Unloader Area.

The groundwater beneath the Site is not considered to be an aquatic environment of significance. Based on the topography and available hydrological information, groundwater beneath the operational area of the Site flows towards the outlet/inlet canal and the groundwater beneath the Ash Dam flows both to the north towards Mannering Bay and to the west towards Wyee Creek. The groundwater beneath the Wyee Rail Coal Unloader Area appears to flow to the east towards Lake Macquarie.

The ANZECC (2000) *marine ecological trigger values* were adopted in this assessment to evaluate risks to the marine environment (i.e. the inlet/outlet canal, Lake Macquarie, Wyee Creek and Mannering Bay). These screening levels also fulfil the requirement to report groundwater contamination across the Site, in accordance with the DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (refer to *Section 4.10.2*).

The NHMRC (2008) recreational screening values were adopted in this assessment to evaluate potential risks to recreational users of Mannering Bay and Lake Macquarie.

The NHMRC (2013) drinking water screening values were also adopted to evaluate potential risks to groundwater users in nearby residential communities. These values also fulfil the requirement to report groundwater contamination across the Site, in accordance with the DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (refer to *Section 4.10.2*).

Hydrocarbons in Groundwater

TRH and chlorinated hydrocarbons were reported above the laboratory LOR in groundwater samples collected from monitoring wells installed around the boundary of the former A Station Demolition Area (AEC VB). The measured concentrations did not exceed the adopted screening values but may be indicative of the presence of unidentified impacts within the former A Station area.

It is understood that once the demolition is complete, the A Station basement level concrete will remain and in other areas the ground surface will be covered with recycled crushed concrete and left vacant. On this basis unidentified hydrocarbon impacts within this area are unlikely to represent a risk to human health (i.e. assuming the land is left vacant and fenced).

Due to the presence of underground and overhead services and thick concrete (>0.6 m) on the transformer runways, a number of proposed sampling locations were unable to be installed along the northern boundary of the Former A Station. On this basis, the absence of hydrocarbons along the north western boundary of the former A Station Demolition Area could not be confirmed. Significant hydrocarbon impacts were not however identified in sediment or surface water samples collected from the mouth of the inlet/outlet canal. On this basis, potential unidentified hydrocarbon impacts within the former A Station Demolition Area do not appear to be resulting in significant impacts to the wider estuarine environment.

Benzene was detected at concentrations in excess of the adopted human health (drinking water) screening value in two groundwater sample collected from the Vehicle Refuelling Area (AECs VH). One of the benzene detections exceeded the adopted recreational screening values. The inferred groundwater flow direction in the area of the Vehicle Refuelling Depot is north east below the former A Station Power Block towards the inlet/outlet canal. In the absence of potable groundwater use in this area of the Site, these impacts are not considered to represent a significant potential risk to human health under the ongoing use of the Site as a Power Station. Benzene impacts were also not identified in sediment or surface water samples collected from the mouth of the inlet/outlet canal, indicating that these impacts are not likely to be impacting upon recreational users of Lake Macquarie.

Benzene was also identified in a single monitoring well in two samples collected from downgradient of the Asbestos Landfills (AEC VP) at a concentration marginally in excess of the adopted human health (drinking water) screening value. These detections may be related to the migration of impact associated with the waste materials disposed within the landfill. In the absence of potable groundwater use in this area, these marginal exceedances are not considered representative of a significant potential risk to human health.

PFOS in Groundwater

Wells located around the boundary of the former A Station Demolition Area (AEC VB) and Chlorine Plant Area (AEC VM) reported PFOS concentrations in excess of the adopted human health (drinking water) screening level but not the adopted ecological screening level. In the absence of potable groundwater use in this area, these exceedances are not considered representative of a significant potential risk to human health.

PFOS was detected in two monitoring wells around the boundary of the former A Station, both of which were located to the south east. PFOS was not detected in the monitoring wells located on the northern and western corners of the Former A Station Area.

As discussed above, a number of proposed sampling locations were unable to be installed along the northern boundary of the Former A Station and therefore the absence of PFOS in these areas cannot be confirmed.

Metals in Groundwater

Exceedances of the adopted human health (drinking water and recreational) screening levels were reported in groundwater for arsenic, lead, nickel manganese and selenium and exceedances of the adopted ecological screening levels were also reported for cobalt, copper, lead, nickel, selenium and zinc.

Where concentrations of metal(loids) in groundwater were measured above background values, impact generally appears to be localised in distinct areas of the site with the main potential source areas being the Vehicle Refuelling Depot (AEC VH), the Coal Storage Area (AEC VJ) and the Ash Dam (AEC VO). The majority of samples with concentrations reported above the background values were taken from monitoring wells located downgradient of the Ash Dam which appears to be a primary source of arsenic and selenium to groundwater and a secondary source of cobalt, copper, lead, manganese, nickel and zinc.

Potential risks to the marine environment and recreational users of the marine environment that may be associated with these metal impacts in groundwater are discussed in *Section 6.2.3*, with reference to the sediment and surface water data.

Licensed groundwater bores located within the vicinity of the Site are limited to a domestic bore located approximately 700 m north of the Site in Mannering Park and a former stock bore located approximately 1 km south west of the Power Station operational area and 600 m north of the Ash Dam in a Delta-owned wetland area. The inferred groundwater flow direction in the area of the Vehicle Refuelling Depot and Coal Storage Area is north east towards the inlet/outlet canal and Lake Macquarie. In the absence of potable groundwater use in the areas downgradient of the Vehicle Refuelling Area and Coal Storage Area, these elevated metal impacts in groundwater impacts are not considered to represent a significant potential risk to groundwater users.

Licensed groundwater bores are not present in the immediate vicinity of the Ash Dam, but rural residential and residential communities are located immediately to the north, west and south of the Ash Dam. The extraction of groundwater for potable, domestic, stock watering or commercial purposes in these areas may therefore potentially occur in the future. Risk to human health may be associated with the extraction of groundwater for use in the vicinity of the Ash Dam, particularly if that water were used for domestic purposes, although given the general elevated background metal concentrations measured across the Site, the groundwater beneath the adjacent properties is also likely to be generally unsuitable for potable use

It is recommended that this issue is discussed with the NSW EPA and NSW Office of Water, with the aim of implementing control measures to prevent the potable use of groundwater in the vicinity of the Ash Dam.

6.2.3 *Offsite Surface Water and Sediment*

Sediment and surface water samples were collected from within Wyee Creek, Mannering Bay, Wyee Bay and Chain Valley Bay to assess whether discharges from the Power Station, including runoff, groundwater discharge and operational surface water discharges have had an adverse effect on the marine environment surrounding the Site.

Exceedances of the adopted sediment screening levels for cadmium and copper were identified in individual samples but the distribution of these impacts is not suggestive of significant cadmium and cobalt impacts in Lake Macquarie sediments as a result of the operation of the Vales Point Power Station. Similarly, copper and cobalt concentrations marginally in excess of the adopted ecological screening levels were identified in a number of surface water samples, but a clear link between these samples and the Site was not apparent in the data. With the exception of selenium, the sediment and surface water results do not suggest that discharges from the Power Station have resulted in widespread significant risks to the marine environment or recreational users of the adjacent waterways, although it is noted that isolated areas of elevated impact may be present in close proximity to discharge points from the Site.

Exceedances of the adopted ecological selenium screening level (2 mg/kg) were identified in numerous sediment samples collected from within the lower reached of Wyee Creek and within Mannering Bay. The maximum selenium concentration reported in a sediment sample collected from Wyee Creek was 26 mg/kg, with the selenium concentrations measured in sediment samples collected from within Wyee Creek generally increasing along the Creek towards Mannering Bay. Relatively consistent concentrations of selenium were recorded in sediment samples collected from throughout Mannering Bay, at up to 8 mg/kg. It is considered likely that discharges from the Ash Dam, potentially including licensed discharges, runoff and groundwater flow have contributed to these selenium impacts, although other potential sources within the catchment include mines, other power stations and other industries. The selenium concentrations measured in sediments located in Wyee Creek and Mannering Bay are therefore considered to have the potential to adversely impact upon marine organisms in these areas.

The *Delta Coast Land Management Manual* (GHD, 2012) indicates that State Environmental Planning Policy No. 14 (SEPP 14) wetlands are also located immediately to the north of the Ash Dam toe drain and along the creeks to the north of the Ash Dam. On the basis of the data collected in this assessment, these areas may potentially be adversely impacted upon by elevated selenium concentrations.

The identified impacts which do exceed the relevant screening values and are considered to warrant further consideration with regards to whether a duty to report may exist under the CLM Act include the following:

- Benzene detected at concentrations in excess of the adopted human health (drinking water and recreational) screening levels in two groundwater samples collected from the Vehicle Refuelling Area (AECs VH) and a single sample collected from downgradient of the Asbestos Landfills (AEC VP).
- PFOS detected at concentrations in excess of the adopted human health (drinking water) screening levels in a groundwater sample collected from around the boundary of the Former A Station Demolition Area (AEC VB) and a groundwater sample collected near the Chlorine Plant (AEC VM).
- Metals in groundwater detected at concentrations in excess of the adopted human health and/or ecological screening levels and not attributable to background conditions in groundwater at various locations across the Site. Metal impacts in groundwater generally appears to be localised in distinct areas of the site with the most likely potential source areas being the Vehicle Refuelling Depot (AEC VH), the Coal Storage Area (AEC VJ) and the Ash Dam (AEC VO).
- Exceedances of the selenium ecological screening level identified in numerous sediment samples collected from within the lower reaches of Wyee Creek and within Mannering Bay.

Each of these issues is discussed in further detail below.

6.3.1 *Benzene in Groundwater - AEC VH and VP*

Benzene was detected in groundwater at concentrations above the adopted human health (drinking water) screening levels in two wells within the Vehicle Refuelling Area (AEC VH) and a single well installed downgradient of an Asbestos Landfill (AEC VP). It is considered likely that the benzene impacts in AEC VH are associated with the presence of USTs in this area and that the benzene impact in AEC VP is associated with the material buried within the asbestos landfill.

The concentrations of benzene measured in AEC VP were only marginally above the adopted screening level but were confirmed in a second round of sampling (May 2014). Notification to NSW EPA is therefore considered likely to be required.

Groundwater monitoring has been ongoing within AEC VH since 2010, when TRH(C_{10} - C_{36}) was identified at a concentration of 2540 µg/L, in a well installed to the north of the USTs. Hydrocarbon detections in the current assessment were limited to BTEX constituents and do not suggest the presence of a significant ongoing release in this area of the Site. Notification to NSW EPA is however considered likely to be required, as the detected concentration are significantly greater than the human health (drinking water) screening values and are likely to remain so for the foreseeable future.

It is considered unlikely in ERM's opinion that these impacts would be considered significant enough to warrant regulation by the NSW EPA given the absence of groundwater use onsite and the isolated nature of the detections. The inferred groundwater flow direction in the area of the Vehicle Refuelling Depot is north east below the former A Station Power Block towards the inlet/outlet canal and the Vehicle Refuelling Area is approximately 150 m from the canal.

6.3.2 *PFOS in Groundwater*

PFOS and PFOA were detected in groundwater at concentrations in excess of the adopted human health (drinking water) and ecological screening levels within the Former A Station Demolition Area (AEC VB) and Chlorine Plant (AEC VM). The likely sources of these impacts are fire training activities undertaken near the Chlorine Plant and the storage or use of firefighting foams within the operational area.

The adopted human health (drinking water) screening levels were obtained from US EPA (2014), with the adopted values being provisional health advisory concentrations, rather than regulatory guidelines. Similarly, the adopted ecological screening levels were obtained from RIVM (2010), with the adopted values only having been proposed as water quality standards in the Netherlands. As such, these values are not called up by section 60 of the CLM (1997) Act as prescribed levels of contamination requiring notification. It is also noted that the identified PFOS impacts are located within the operational area and do not appear to be migrating offsite. On this basis it is considered unlikely in ERM's opinion that these impacts would be considered significant enough to warrant regulation by the NSW EPA

6.3.3 *Metals in Groundwater*

Various metals were detected at concentrations above the human health (drinking water) and / or ecological screening values at a number of locations across the Site. Whilst some of the metals exceedances can be related to background concentrations, some elevated concentrations related to on-site sources have been identified.

The creation of ASS through the disturbance of alluvial sediments underlying the ash dam, historical and current underground coal mining works and the long term storage of waste ash materials and coal may have contributed to the observed metal impacts in groundwater in this area.

Where metals were identified in groundwater at concentrations above background levels, impact generally appears to be localised in distinct areas of the Site. Potential source areas appear to include the Coal Storage Area and the Ash Dam. Acidic groundwater conditions in the vicinity of the Vehicle Refuelling Area also appear to have contributed to the presence of elevated metal concentrations in groundwater.

With the exception of selenium discharges from the Ash Dam, the available data suggests that these impacts have not resulted in significant sediment or surface water contamination following discharge into the estuarine environment (see *Section 6.1.3*).

In ERM's professional experience it is NSW EPA's preference to regulate issues such as these under either the *POEO Act* (1997) or the *CLM Act* (1997) rather than both, and, in the case of licensed premises, it is usually the *POEO Act* (1997) which is preferred.

The majority of samples with concentrations reported above the background values were collected from monitoring wells located adjacent to the Ash Dam which appears to be a potential source of arsenic, selenium, and to a lesser extent cobalt, copper, lead, manganese, nickel and zinc. Seepage from the Ash Dam rehabilitated area at the v-notch weir located at the toe of the Ash Dam is currently regulated under the Site EPL. Similarly, the overboarding of the Ash Dam into the Wyee Creek diversion channel is a licensed discharge point for the Site. Groundwater monitoring down-gradient of the Ash Dam has been undertaken by Aurecon (2014) in response to a NSW EPA request for an additional investigation in the form of a Pollution Reduction Programme (PRP) related to the elevated metal concentrations identified in groundwater.

ERM therefore considers that NSW EPA would most likely continue to manage this issue under the *POEO Act* (1997) via the Site EPL and associated PRP(s) and hence would not require formal notification under the CLM Act.

On 6 May 2014, Delta received a Vales Point Licence Variation Notice from the NSW EPA. The previous condition requirements to (a) identify any mitigation measures to be carried out to reduce the levels of parameters identified in groundwater and (b) provide estimated costings and proposed timeframes for implementation of mitigation measures, were removed as a part of this variation notice. This variation notice also included the requirement for monthly groundwater monitoring in the vicinity of the Ash Dam throughout 2014. It is recommended that Delta include groundwater results from within the Ash Dam Area (AEC VO) in the next scheduled report to the NSW EPA.

6.3 SUMMARY – DOES THE IMPACT WARRANT NOTIFICATION UNDER THE CONTAMINATED LAND MANAGEMENT ACT 1997?

Under Section 60 of the *CLM Act (1997)*, a person whose activities have contaminated land or a landowner whose land has been contaminated is required to notify NSW EPA when they become aware (or ought reasonably have been aware) of the contamination. The DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997,* state that a landowner or a person whose activities have contaminated land is required to notify NSW EPA that the land is contaminated if;

- the level of the contaminant exceeds the appropriate published screening level with respect to a current or approved use of the land, **and** people have been, or foreseeably will be, exposed to the contaminant; or
- the contamination meets a specific criterion prescribed by the regulations; or
- the contaminant has entered, or will foreseeably enter, neighbouring land, the atmosphere, groundwater or surface water, **and** the contamination exceeds, or will foreseeably exceed, an appropriate published screening value and will foreseeably continue to remain above that level.

The soil and groundwater results obtained in this assessment have been compared against the screening values specified in NSW DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* and a number of exceedances have been identified.

Every exceedance of these screening values is not, however, required to be reported to the NSW EPA. If the exceedance is representative of background conditions; or offsite migration of contamination to an adjoining property has not occurred and any onsite contamination has been adequately addressed under the Environmental Planning and Assessment Act then reporting under the CLM Act is not required. Further to this, in the case of onsite soil contamination, if no plausible exposure pathway to people or the environment is present, reporting is also not required.

On the basis of the discussions outlined in *Section 6.1*, the constituents that have been identified in onsite soil, sediment, surface water and groundwater are generally not exceeding the relevant screening values as cited in NSW DECC (2009).

It is suggested that the NSW EPA should manage ongoing communications around the potable use of potentially impacted groundwater in the vicinity of the Ash Dam and downgradient areas, given the range of potential sources of metals in groundwater in this area and potential for the wider distribution of metals in groundwater.

6.3.4 *Selenium in Sediment*

Selenium concentrations above the adopted screening levels and above background levels were identified in numerous sediment samples collected from within the lower reaches of Wyee Creek and within Mannering Bay. It is considered likely that discharges from the Ash Dam, potentially including licensed discharges, runoff and groundwater flow have contributed to these impacts. Other potential sources within the catchment include mines, other power stations and other industries.

It is noted that the sediment concentrations measured in the current investigation were of the same order of magnitude as those identified in historic investigations (e.g. Peters et al., 1999), suggesting that the selenium load in Wyee Creek and Mannering Bay sediments have not increased significantly in recent years. This is consistent with the history of the operation of the Ash Dam; prior to 1981 Vales Point discharged ash dam water direct to Mannering Bay and until 1996 ash dam water was diverted into Wyee Creek. From 1996, an ash return water system limited discharges into Wyee Creek and Mannering Bay, with discharges only occurring intermittently due to plant issues or significant rainfall events.

Delta has had a long history of consultation with the EPA and other authorities about selenium in local water bodies. Roach (2005) is a scientific paper published by the NSW EPA on the assessment of metals in sediments from Lake Macquarie and has a particular focus on the selenium impacts to sediment as a result of discharges from Power Stations. Aurecon (2010) indicated that data on the earlier testing of fish was provided by Delta and indicated that the selenium concentrations measured in bream were above the Generally Expected Levels (GELs) published by Food Standards Australian and New Zealand (2001). ERM understands that as a consequence of these results and subsequent communications between Delta and the NSW EPA (1998), warning signs were erected at Mannering and Wyee Bays in relation to long-term fish consumption for those areas.

The adopted sediment screening levels were obtained from the British Columbia Ministry of Environment (2001) Ambient Water Quality Guidelines. These values are not called up by section 60 of the CLM (1997) Act as prescribed levels of contamination requiring notification.

It is noted that the levels of selenium in the sediment are lower than the levels prescribed in the ASC NEPM (2013) for the assessment of residential soil (200 mg/kg) and therefore would not trigger notification if the offsite sediment was evaluated as 'soil on neighbouring land' for the purposes of assessing the duty to report requirements under the CLM Act (1997).

On the basis of the above factors, it is considered that the selenium impacts in sediment in Wyee Creek and Mannering Bay do not require notification to the NSW EPA under the CLM Act (1997).

6.3.5 Summary – Is Material Remediation or Management Likely to be Required?

Based on the results of this assessment, the issues where potentially material remediation, management or further assessment on a per source basis may be required relate to the metals in groundwater in the vicinity of the Ash Dam. The elevated metal concentrations in the vicinity of the Ash Dam toe drain have also already been identified by the NSW EPA in the form of a PRP and investigations into this issue in the vicinity of the Ash Dam toe drain were ongoing at the time of the current assessment.

Elevated metal concentrations were identified in groundwater samples collected around the entire perimeter of the Ash Dam, with the highest concentrations generally located in the vicinity of the toe drain, along the north western boundary of the Ash Dam and directly to the east of the Ash Dam. With the exception of selenium, the sediment and surface water results do not suggest that discharges from the Power Station have resulted in widespread significant risks to the marine environment or recreational users of the adjacent waterways.

The metal impacts in the vicinity of the Ash Dam are currently managed by Delta. This is an ongoing issue which could, under a realistic worst case scenario, be material. Estimates for ongoing costs have not been made, as these costs will be dependent on outcome of the relevant PRP and ongoing discussions with NSW EPA. It is also noted that elevated background metal concentrations are present in the area and the potential exists for inputs from historic mining activities to be material.

Further assessment and remediation or management may be required to address the asbestos impacts identified in surface soil in the vicinity of the Transformer Area (AEC VC) and Chlorine Plant (AEC VM). It is however considered unlikely that this work would exceed the material threshold.

It is noted that conducting intrusive investigations within the B Station, Transformer Area and Former A Station demolition Area was not possible, due to the potential health and safety issues associated with the presence of underground services in these areas.

The investigation of these AECs was therefore limited to assessment around the boundaries. Further assessment and remediation may be required to address unidentified soil and groundwater impacts within these areas if the landuse of these portions of the Site was to change in the future. It is possible that costs related to this work could exceed the material threshold. A detailed costing for such works has not been prepared since this would be dependent on the nature and layout of the proposed use which cannot be predicted at this point in time.

Fly-tipped waste was identified on the soil surface on the eastern boundary of the Wyee Rail Coal Unloader Area (AEC VN) adjacent to the publically accessible roadway. These impacts will require addressing and action to prevent further waste dumping in the future should also be considered. The costs of these activities are not however anticipated to be material.

The remediation of the selenium impacts in Wyee Creek or Mannering Bay sediments is not considered to be feasible, given the nature of the estuarine environment in these areas; removing impacted sediment from would be highly disruptive to the estuarine environment and is considered likely to result in more adverse effects on the estuarine ecology than leaving the impacts in situ. This is particularly the case due to the presence of seagrass habitats and mangrove areas within Wyee Bay, Mannering Bay and Wyee Creek (Bio-analysis, 2013) (GHD, 2012).

6.4 SUMMARY – IS THE DATA SUITABLE TO PROVIDE A BASELINE OF ENVIRONMENTAL CONDITIONS AT THE SITE AND IMMEDIATE SURROUNDING RECEIVING ENVIRONMENTS

The data presented in the ESA was considered to generally be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site as at or near the time of the transaction.

It is noted that the majority of the locations proposed in the Preliminary ESA were able to be advanced, with the exception of the locations listed in *Section 4.1*. The main constraints on the implementation of the Stage 2 program were the presence of subsurface and overhead utilities and access restrictions within the buffer zone. The proposed Stage 2 program included soil samples from 188 locations and groundwater samples from 133 locations. The completed Stage 2 program included soil samples from 173 locations and groundwater samples from 89 locations. An evaluation of the proposed and completed investigation locations for each AEC is provided in *Table 8 of Annex B* and on this basis it is considered that the number and distribution of completed boreholes and monitoring wells is sufficient for characterising soil and groundwater conditions for the purpose of this baseline assessment.

The results of the assessment do not suggest the presence of widespread asbestos contamination at the Site. It is noted however that as identified in the ASC NEPM (2013) the vertical boring of soils is not a comprehensive method via which to identify asbestos, however given the objectives of this assessment and the operational constraints, the assessment methodology adopted was considered appropriate. The absence of asbestos impacts across the Site cannot however be guaranteed on the basis of the results of this assessment. As with any investigation of this nature, the potential exists for unidentified contamination to exist between the completed sampling locations both within and between AECs. In particular, it is noted that conducting intrusive investigations within the B Station, Transformer Area and Former A Station demolition Area was not possible, due to the health and safety issues associated with the presence of underground services in these areas. The investigation of these AECs was therefore limited to assessment around the boundaries and unidentified soil and groundwater impacts may be present within these areas.

In addition, the installation of boreholes along an approximately 2 km long stretch of the south western boundary of the Ash Dam was not possible, due to the presence of a Jemena high pressure gas pipeline in the subsurface. In the absence of additional contaminant source areas in this area of the AEC, contamination along the south western boundary is likely to be consistent with that identified along other boundaries of the Ash Dam (i.e. limited to exceedances of the adopted human health and ecological screening levels for metals in groundwater and potentially soil).

On the basis of the above discussion, the data collected during this assessment is considered to be suitable to provide a baseline of environmental conditions at the Site as at or near the time of the transaction.

7 CONCLUSIONS

ERM completed a Stage 2 ESA at Vales Point Power Station in order to develop a baseline assessment of environmental conditions at the Site as at or near the time of the transaction. Soil, groundwater, surface water and sediment data were compared against published environmental quality levels to provide a screening level assessment of potential risks to identified human and environmental receptors. The following conclusions were made based on the data collected during the investigation:

- The key impacts identified included benzene in groundwater in the Vehicle Refuelling Area and downgradient of the Asbestos Landfills, PFOS (a chemical associated with firefighting foams) in groundwater around the boundary of the former A Station Demolition Area and the Chlorine Plant and TRH, benzo(a)pyrene, asbestos and metals in individual soil samples across the Site.

- Selenium concentrations above adopted screening values were also identified in sediment samples collected from within Wyee Creek and Mannering Lake. It is considered likely that discharges from the Ash Dam, potentially including licensed discharges, runoff and groundwater flow have partially contributed to these impacts. Other potential sources within the catchment include mines, other power stations and other industries. The selenium concentrations identified in the current assessment were of the same order of magnitude as those identified in historic investigations suggesting that, as a result of changes to the management of discharges from the Ash Dam, the selenium load in Wyee Creek and Mannering Bay sediments has not increased significantly in recent years.

- TRH and chlorinated hydrocarbons were reported in groundwater samples collected around the boundary of former A Station Demolition Area. The former A Station area could not be investigated directly due to ongoing demolition work and thus a potential data gap exists in this area).

- Various metals were identified at concentrations in excess of the adopted screening values across the Site. Where metals were identified above background concentrations, impact generally appears to be localised in distinct areas of the Site. Potential source areas appear to include the Ash Dam and Coal Storage Area, where the creation of ASS conditions through the disturbance of alluvial sediments, historical and current underground coal mining works and/or the long term storage of waste ash materials and coal may have contributed to the observed metal impacts in groundwater. Acidic groundwater conditions in the vicinity of the Vehicle Refuelling Area also appear to have contributed to the presence of elevated metal concentrations in groundwater in that part of the Site.

- Fly-tipped waste was identified on the soil surface on the eastern boundary of the Wyee Rail Coal Unloader Area along the publically accessible roadway.

- With the exception of the selenium impacts identified in sediment (see below), the impacts identified in soil and groundwater at the sites are generally unlikely to represent a significant risk to human health and/or the environment given appropriate ongoing management based on the current and continued use of the Site as a Power Station.

- The selenium concentrations measured in Wyee Creek and Mannering Bay have the potential to adversely affect marine organisms in these areas. ERM understands that elevated selenium concentrations have previously been measured in fish collected from Mannering Bay and that the NSW EPA has previously been made aware of these impacts. Signage has been posted along Rutleys Road warning the public about the potential health risks associated with the consumption of fish from this area.

- Licensed groundwater bores are not present in the immediate vicinity of the Ash Dam, but rural residential and residential communities are located immediately to the north, west and south. If the extraction of groundwater for potable, domestic, stock watering or commercial purposes was to occur in these areas in the future, the elevated metal concentrations in groundwater may be associated with risks to human health or livestock. It is recommended that this issue is raised with the NSW EPA when discussing the next scheduled deliverable associated with PRP being implemented in the Ash Dam area. It is suggested that the NSW EPA should manage ongoing communications on this issue, given the range of potential sources of metals in groundwater in this area.

- Asbestos was detected in individual shallow soil samples collected from bare ground within the Transformer Area, Chlorine Plant and around the boundaries of the Asbestos Landfill at concentrations in excess of the adopted human health screening values. All of these areas of asbestos impact may represent a health risk if Site employees were to come into contact with them. ERM understands that Delta has recorded these sites in its Asbestos Register and that these impacts shall be managed in accordance with Delta's existing asbestos management procedures.

- The metal impacts in the vicinity of the Ash Dam are currently managed by Delta. This is an ongoing issue which could, under a worst case scenario, be material. Estimates for ongoing costs have not been made, as these costs will be dependent on outcome of the relevant PRP and ongoing discussions with NSW EPA. It is also noted that elevated background metal concentrations are present in the area and the potential exists for inputs from historic mining activities to be material.

- It is noted that conducting intrusive investigations within the B Station, Transformer Area and Former A Station demolition Area was not possible, due to the potential health and safety issues associated with the presence of underground services in this areas. Further potentially material assessment and remediation may be required to address unidentified soil and groundwater impacts within these areas if the landuse of the Site was to change in the future.

- ERM considers that NSW EPA would most likely continue to manage the metals in groundwater in the vicinity of the Ash Dam under the POEO Act (1997) via the Site EPL. The Vales Point EPL includes the requirement for monthly groundwater monitoring in the vicinity of the Ash Dam throughout 2014. It is recommended that Delta include groundwater results from within the Ash Dam Area (AEC VO) in the next scheduled report to the NSW EPA.

- It is recommended that the NSW EPA is notified regarding the benzene concentrations measured in excess of the adopted human health (drinking water) screening levels in the Vehicle Refuelling Area (AEC VH) and Asbestos Landfills (AEC VP). On the basis that the identified benzene impacts do not appear to be migrating offsite, it is considered unlikely in ERM's opinion that these impacts would be considered significant enough to warrant regulation by the NSW EPA.

- The data presented in this Stage 2 ESA was generally considered to be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site and immediate surrounding receiving environments.

8 REFERENCES

ANZECC/ARMCANZ. 2000. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* 2000. IBSN 09578245 0 5.

ASC NEPC. 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999.* Canberra : s.n., 2013.

Aurecon. 2010. *Wyee Dam Overflow Water Qual;ity and Trace Element Assessment of Effects on Receiving Waters.* 2010.

Aurecon. 2014. *Letter Re: Groundwater Investigation - Vales Point Power Station Ash Dam .* 2014.

—. 2014. *Report of Vales Point Ash Dam PRP STage 1 Investigation.* 2014.

Australian Standard. 1999. *Guide to sampling and investigation of potentially contaminated soil Part 2: Volatile substances.* s.l. : Standards Australia, 1999. AS 4482.2 - 1999.

—. 2005. *Guide to the investigation and sampling of sites with potentially contaminated soil - Part 1: Non-volatile and semi-volatile compounds.* Second edition. Sydney : Standards Australia, 2005. AS 4482.1-2005.

Bio-analysis. 2013. *Assessment of Seagrass and Macroalgae from Vales Point Power Station (Summer 2013).* 2013.

British Colombia Ministry for Environment. 2001. *Ambient Water Quality Guidelines .* 2001.

Centennial Coal. 2009. *Environmental Assessment for the Mannering Colliery Extension of Mine Project.* 2009.

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

David Lane and Associates. 2010. *Groundwater Monitoring Well Report, Vales Point Power Station, Vales Road, Mannering Park NSW 2259.* 2010.

—. 2013. *Groundwater Monitoring Well Report, Vales Point Power Station, Vales Road, Mannering Park.* 2013.

DEC. 2006. *Guidleines for the NSW Site Auditor Scheme.* 2nd Edition. s.l. : Department of Environment and Conservation NSW, 2006. ISBN: 1 74137 859 1.

Delta Electricity. 2014. Vales Point Power Station Monitoring Data. [Online] 2014. http://www.de.com.au/Environment/Environmental-Licences---Monitoring/Vales-Point-Power-Station-Monitoring-Data/default.aspx?retain=true&pg=3.

DEWHA. 2009. *National Assessment Guidelines for Dredging.* Canberra : Commonwealth of Australia, 2009.

DLA Environmental . 2012. *Groundwater monitoring well installation report.* 2012.

—. 2013. *Underground Petroleum Storage System (UPSS) monitoring works.* 2013.

DLA Environmental. 2012. *Groundwater Monitoring Well Report, Vales Point Power Station, Vales Road, Mannering Park.* 2012.

EPA. 1997. *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites.* s.l. : Office of Environment and Heritage, Sydney, 1997. ISBN: 0 7310 3892 4.

ERM. 2014. *Preliminary Environmental Site Assessment.* 2014. 0207423RP01.

—. 2012. *Standard Operating Procedure Manual.* 2012.

Friebel, E & Nadebaum, P. 2011. *Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater, Summary, CRC CARE Technical Report No. 10.* Adelaide, Australia : CRC for Contamination Assessment and Remediation of the Environment, 2011. ISBN: 978 1 921431 15 9.

Geological Survey of New South Wales. 2003. *Gosford – Lake Macquarie 1:100 000 Provisional Geology Sheet.* 2003.

Geoscience Australia. Australian Stratigraphic Units Database. [Online] http://www.ga.gov.au/products-services/data-applications/reference-databases/stratigraphic-units.html.

GHD. 2012. *Contamination Assessment & Duty to Report Contamination Central Coast Region - Vales Point Power Station, Munmorah Power Station And Colongra Gas Turbine.* 2012.

—. 2012. *Delta Coast Land Management Manual.* 2012.

Delta Electricity. 1998. Letter Re: Placement of signs adjacent to Rutley's Road near Vales Point. 25 May 1998.

MDH. 2011. *Human Health Based Water Guidance Table.* s.l. : Minnesota Deptartment of Health, 2011.

NEPC. 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999.* Canberra : s.n., 2013.

NHMRC and NRMMC. 2013. Australian Drinking Water Guidelines. *Paper 6 National Water Quality Management Strategy.* s.l. : National Health and Medical Research Council, National Resource Management Medical Council, Canberra, 2013. IBSN online: 1864965118.

—. 2008. *Guidelines for Managing Risks in Recreational Waters.* s.l. : National Health and Medical Research Council, 2008. ISBN Inline: 1864962720.

NSW Government. NSW Natural Resource Atlas website. [Online] [Cited: 13 January 2014.] http://www.nratlas.nsw.gov.au.

NSW EPA. 1995. *Contaminated Sites: Sampling Design Guidelines.* Chatswood, NSW : Environment Protection Authority, 1995. ISBN 0731037561.

NSW Government. NSW Natural Resource Atlas online bore register. [Online] [Cited: 17 April 2013.] http://www.nratlas.nsw.gov.au/wmc/custom/homepage/home.html.

RIVM . 2010. *Environmental risk limits for PFOS; A proposal for water quality standards in accordance with the Water.* 2010.

RIVM. 2001. *Ecotoxicological serious risk concentrations for soil, sediment and (ground)water; updated proposals for first series of compounds.* 2001.

Roach, AC. 2005. *Assessment of metals in sediment from Lake Macquarie, NSW, Australia, using normalisation models and sediment quality guidelines.* Marine Environmental Research, Vol. 59, pp. 453-472.

Standards Association of Australia. 1993. *Geotechnical Site Investigations.* 3rd Edition. Homebush : Standards Australia, 1993. ISBN 978 0 7262 7878 5.

UK HPA. 2009. *HPA Compendium of Chemical Hazards - PFOS and PFOA.* s.l. : United Kingdom Health Protection Agency, 2009. Version 1.

US EPA . 2006. *Guidance on Systemic Planning Using the Data Quality Objectives Process.* 2006.

—. 2009. *The toxicity of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS).* 2009.

US EPA. 2014. *Emerging Contaminants – Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA).* 2014.

WA DOH. 2009. *Guidelines for the assessment, remediation and management of asbestos-contaminated sites in Western Australia.* Perth : Western Australia Department of Health, 2009.

DOCUMENT 6c

Vales Point Power Station

A Station, Environmental Site Assessment – Part 1

Environmental Resources Management

September 2014

COMMERCIAL IN CONFIDENCE

Delta Electricity – Project Symphony

A Station - Environmental Site Assessment - Vales Point Power Station, NSW

Ref: 0237747RP02 _Draft

September 2014

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Project Symphony -
Vales Point Power Station
A Station - Environmental Site Assessment

Approved by: Peter Lavelle
Position: *Technical Director*
Signed: ____________________
Date: September, 2014

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EXECUTIVE SUMMARY

Environmental Resources Management Australia Pty Ltd (ERM) was commissioned by Delta Electricity to undertake additional works subsequent to a Stage 2 Environmental Site Assessment (Stage 2 ESA) at Vales Point Power Station (ERM Reference: 0237747RP01). These additional works focused on the former A station area of the Vales Point Power Station (herein referred to as the "Site"), as this area was not accessible during the initial works, due to ongoing demolition activities.

The primary objective for the additional works was to develop a baseline of environmental conditions at the former A Station area, as at or near the time of the sale of the Power Station. Data obtained during completion of these works may also be used to inform future management of potential contamination at the Site. Due to the potential presence of unknown underground services at depth, this scope of works was limited to non-destructive methods and focussed on the collection of soil samples from within the top 1.5 metres below ground level.

Investigation Methodology

To achieve the stated objectives, ERM collected soil samples and submitted the samples to environmental laboratories for analysis of Constituents of Potential Concern (COPCs). The Conceptual Site Model (CSM) developed for the Site during the Stage 2 ESA was further refined and the analytical data was compared against published environmental screening values to assess potential risks to human health and the environment.

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

Investigation Outcomes

- *The key impacts identified included TRH, asbestos and metals in individual soil samples across the A Station area.*

- *The impacts identified in soil within the A Station area are generally unlikely to represent a significant risk to human health and/or the environment, given use of the Site as a Power Station and the implementation of appropriate ongoing management strategies.*

- *Asbestos was detected in individual shallow soil samples collected from the former A Station area at concentrations in excess of the adopted human health screening values. ERM understands that Delta has recorded these areas of asbestos impact in its Asbestos Register and that they will be managed in accordance with Delta's existing asbestos management procedures. These areas of asbestos impact would only represent a risk to the health of Site employees, if they were to come into contact with them.*

- *No impacts that are likely to require material remediation under the ongoing use of the Site as an operational area within a Power Station were identified during this investigation.*

- *No impacts that trigger a duty to report under the Contaminated Land Management (CLM) Act 1997 were identified during the additional works undertaken within the former A Station area. The 2014 draft revision of the Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997 requires the notification of friable asbestos that is present in soils at concentrations in excess of the ASC NEPM (2013) Health Screening Levels and to which a person has been, or foreseeably will be, exposed to the asbestos fibres by breathing them into their lungs. The 'foreseeability' of people being exposed to the identified asbestos will be dependent upon the future use of the Site and the asbestos management practices employed to control potential exposure and these factors should be evaluated by Delta when assessing the requirement to report the identified asbestos contamination to the NSW EPA, upon the finalisation of the revised guidelines.*

1 *INTRODUCTION*

On 24 November 2011, the New South Wales (NSW) Government announced that it would divest certain State-owned electricity generation assets. In order to support the sale of electricity generation assets owned and operated by Delta Electricity (a State Owned Corporation), Environmental Resources Management Australia Pty Ltd (ERM) was commissioned to undertake a Stage 2 Environmental Site Assessment (Stage 2 ESA) at Vales Point Power Station (*ERM Reference: 0237747RP01*). The Stage 2 ESA was completed between March and June 2014 but the demolition of the former A Station during this period prevented the investigation of this area. ERM was therefore commissioned to undertake an additional assessment targeting the former A Station, to supplement the original *Vales Point Power Station Stage 2 ESA*.

This report should be evaluated in conjunction with the *Vales Point Power Station Stage 2 ESA* (ERM, 2014b)

Vales Point Power Station is situated adjacent to the southern shore of Lake Macquarie, near the township of Mannering Park, approximately 35 km south of Newcastle, NSW (*Figure 1* of *Annex A*). The former A Station, herein referred to as "the Site", occupies an area of approximately 15 ha in the central portion of Vales Point Power Station. The general Site layout is presented as *Figure* 2 of *Annex A*.

The works detailed herein were completed in general accordance with the Sampling, Analyses and Quality Plan (SAQP) presented in the *Preliminary Environmental Site Assessment (PESA)* (ERM, 2014a) and Data Quality Objectives (DQO) included within the *Stage 2 ESA* (ERM, 2014b). Due to the potential presence of unknown underground services at depth at the Site, this scope of works was limited to non-destructive methods and focussed on the collection of soil samples from within the top 1.5 metres below ground level (m bgl).

1.1 *OBJECTIVES*

The primary objective of this assessment was to gather shallow soil data to establish a baseline assessment of environmental conditions within the former A Station area, as at or near the time of the proposed sale of the Vales Point Power Station. Data obtained during completion of this assessment may also be used to inform future management of contamination issues within the former A Station area.

1.2 *APPROACH AND SCOPE OF WORK*

The adopted approach and scope of works for the works undertaken within the former A Station area comprised the following general tasks, in accordance with the requirements set out in the Sampling Analysis and Quality Plan (*SAQP)* defined in *Annex G* of the *PESA* (ERM, 2014a):

Preliminaries

- preparation of a site-specific Health and Safety Plan (HASP) and Environmental Management Plan (EMP);
- engagement of subcontractors including underground utility locators, non-destructive vacuum excavation contractors, concrete corers and laboratories;
- scheduling of Site works with Delta Electricity; and
- completion of site-specific inductions and permitting.

Site Works

- ground-truthing of proposed sampling locations;
- identification of above and below ground services in the vicinity of drilling locations by reviewing publically available Dial Before You Dig (DBYD) plans and site engineering drawings, and engaging suitably qualified underground service locators;
- non-destructive vertical boring and environmental soil sampling in accordance with the requirements of the *SAQP* (ERM, 2014a); and
- laboratory analysis of selected soil samples for particular constituents of potential concern (COPC) in accordance with the requirements of the *PESA* (ERM, 2014a) and as outlined in *Section 3.5*.

Reporting

- preparation and submission of this report at the completion of works.

1.3 *MATERIALITY THRESHOLD*

For the purposes of this report, a consistent approach regarding the materiality of a contamination issue has been adopted to that utilised in the *PESA* (ERM, 2014a) and *Vales Point Power Station Stage 2 ESA* (ERM, 2014b) which was as follows:

- ERM adopted a materiality threshold of AUD 0.5 M (+ GST if applicable) per contamination source;
- material costs are the costs for that item to meet the relevant requirements of NSW Environment Protection Authority (EPA) under its current land use to remediate or manage the contamination issue. Remediation or management includes additional assessment, environmental monitoring, management, containment or other remediation measures; and

- 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 has been considered material.

1.4 *REPORT STRUCTURE*

This report has been prepared as a supplement to the broader *Vales Point Power Station Stage 2 ESA* (ERM, 2014b) and in general accordance with the NSW EPA *Guidelines for Consultants Reporting on Contaminated Sites* (EPA, 1997), as follows:

- *Section 1* - Introduction, objectives and scope of works;
- *Section 2* – Background, including a summary of the Site history and Site conditions;
- *Section 3* - Sampling and works methodologies for completing the investigation;
- *Section 4* - Results of the Stage 2 ESA works; and
- *Section 5* – Overall discussion
- *Section 6* - Conclusions.

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

1.5 *LIMITATIONS*

The findings of this report are based on the client-approved *SAQP* within the PESA (ERM, 2014a) and the scope of work summarised in *Section 1.2* of this report. ERM performed the services in a manner consistent with the normal level of care and expertise exercised by members of the environmental assessment profession. No warranties express or implied, are made.

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

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

All conclusions and recommendations made in the report are the professional opinions of the ERM personnel involved with the project and, while normal checking of the accuracy of data has been conducted, ERM assumes no responsibility or liability for errors in data obtained from regulatory agencies or any other external sources, nor from occurrences outside the scope of this project.

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

2 BACKGROUND

2.1 SITE SETTING

2.1.1 Site Identification

The Site location and the Site boundaries are presented in *Figure 1* and *Figure 2* (respectively) of *Annex A*. A summary of site identification information is presented in *Table 2.1*.

Table 2.1 ***Site Identification Details***

Site Detail	Description
Site Name	A Station area
Site Location	Vales Point Power Station, Vales Road, Mannering Park, NSW
Coordinates	N: 364066, E: 6329937.
Area	Total area is approximately 15 hectares (Ha)
Owner	Delta Electricity (State Owned Corporation)
Local Government	Wyong Shire Council
Title Information	The Site falls within Lot 102 of Deposited Plan 1065718
Zoning[1]	Under the Wyong Local Environmental Plan (LEP) 2012, the Site is zoned SP2 - Electricity Generating Works.

1. Detailed zoning plans are presented in *Annex D* of the *PESA* (ERM, 2014a).

2.1.2 Site Features

The Site comprises the former A Station demolition area which incorporates the footprint of former A Station structures and the area surrounding Stack No. 1, adjacent to and south of the former A Station. The Site is one of the 21 individual Areas of Environmental Concern (AECs) defined within the *Vales Point Power Station Stage 2 ESA* (ERM, 2014b). The Site boundaries presented on *Figure 2* of *Annex A* correlate with the boundaries of AEC VB on *Figure 6.5, Annex A* of the *Vales Point Power Station Stage 2 ESA* (ERM, 2014b).

Vales Point A Station was built in the 1960s as a four-unit station. These generating units were decommissioned in 1989 and since then have undergone partial dismantling, with most of the internal plant items removed. During ERMs initial site works (March 2014) the A Station buildings were undergoing demolition and removal offsite. Environmental investigation works in this area were therefore undertaken when the site was cleared in August 2014.

Prior to the decommissioning and demolition of A Station, this facility was comprised of;

- four coal-fired boilers;
- a turbine house incorporating four steam turbines;

- four generator units (units 1 to 4), with a total capacity of 875 MW;
- an auxiliary bay; and
- two chimney stacks (serving four boilers).

ERM understands that, for the foreseeable future, the ground surface will be covered with recycled crushed concrete and left vacant.

The demolition of the former A Station infrastructure was completed in 2013 and early 2014. With the exception of the two stacks located on the south eastern boundary, all surface infrastructure within the former A Station area has been cleared to basement concrete level. The majority of the underground infrastructure has been decommissioned but remains in situ, including the following;

- the former transformer runway, which is comprised of very thick concrete (estimated to continue to approximately 3 m bgl) extends approximately 15 m into the A Station area from the north western boundary;
- the remainder of the A Station area is largely capped with a concrete slab, estimated to be 30 to 40 cm in thickness, but the slab is not continuous;
- the surface above the areas formerly occupied by the pilings and underground cable tunnels are covered with recycled concrete rubble;
- eight Cooling Water Pits are located within the former Turbine area. These are estimated to be approximately 3 m deep and have been filled with recycled concrete rubble; and
- two former ash pits are located within the A Station area, one in the central portion and one on the north eastern corner.

A portion of the Site, extending approximately 50 m into the A Station area from the south eastern boundary, was covered with approximately 50 cm of imported fill material (crushed concrete) in the months prior to the field investigations and compacted. This area formerly housed the precipitators and boiler houses and at the time of the field works was being used by contractors for the refabrication of components of the B Station. This portion of the A Station is approximately 4000 m^2 and was inaccessible during the field works.

2.1.3 *Surrounding Environment*

The Site is surrounded by the Vales Point Power Station in all directions. The Vales Point Power Station B Station operational area is located immediate to the east of the Site and the administrative area is located to the south west. The cooling water canal is located to the north of the A Station area, across which lies the Chlorine Plant and TransGrid Switchyard.

The closest residential areas to the Site include:

- Mannering Park, located approximately 600 m north of the Site; and
- Kingfisher Shores, approximately 1.4 km south east of Site.

Ecologically significant areas or recreational areas of note surrounding the Site include:

- Tom Barney Oval, located approximately 200 m south west of Site. Based on discussions with the Site Environmental Officer, this oval is occasionally booked out for sporting events, and is regularly accessed by the public; and
- recreational fishing and boating activities are also undertaken in Lake Macquarie, including Mannering Bay, Chain Valley Bay and Wyee Bay. These areas are also contain aquatic environments of significance. The Vales Point cooling water canal, located immediately to the north of the Site enters the power station at Chain Valley Bay and drains into Wyee Bay and Mannering Bay to the northwest.

2.2 *ENVIRONMENTAL SETTING*

2.2.1 *Topography*

The Site is located on the shore of Lake Macquarie, in between Wyee Bay and Chain Valley Bay. The Site is generally flat and lies at an average elevation of approximately 3 m Australian Height Datum (AHD).

2.2.2 *Hydrology*

The Site is located in the Lake Macquarie catchment area, with Lake Macquarie identified as the main local hydrological feature. Local waterways can be summarised as follows:

- Chain Valley Bay, located approximately 300 m north east of the Site;
- Mannering Bay with Wyee Bay immediately beyond, located approximately 1km to the north west of the Site;
- the Vales Point cooling water canal, immediately to the north of the Site, which enters the power station at Chain Valley Bay and exits the at Wyee Bay;
- Chain Valley Retention Pond (also known as Lake Rodham), located approximately 300 m north east of the Site, forms a part of the power station contaminated water management system;
- three settling ponds associated with the sewage treatment works on Site, located 500 m north west of Site;

- five settling ponds associated with the coal storage area, approximately 700 m south west of Site; and
- the Vales Point Power Station Ash Dam, located approximately 1.2 km south west of the Site. A large proportion of the ash which is produced from the Power Station is transported by wet sluicing via a pipeline to the Ash Dam under the current Vales Point Power Station Environment Protection Licence (EPL) (Clause P1.3 of EPL 761).

The surface water within the Site is channelled into a stormwater system around that also discharges into Lake Macquarie via Lake Rodham. ERM understands that the stormwater system is largely still active following the demolition works, although the stormwater pipes on the south-eastern boundary of the Site (adjacent to the laydown area) may have been disturbed during demolition works. A number of surface grates were observed on the Site at the time of our works and had been protected with geo-fabric to prevent silting.

The areas of the Site that are filled with crushed concrete could also become potential sumps for surface water.

2.2.3 *Geology*

Based on a review of the *Gosford – Lake Macquarie 1:100 000 Provisional Geology Sheet* (Geological Survey of New South Wales, 2003), the Site is located on the late Permian to early Triassic Munmorah Conglomerate formation of the Clifton Subgroup, Narrabeen Group. The Munmorah Conglomerate formation is comprised of conglomerate and medium to coarse-grained sandstone with minor siltstone and claystone (Geoscience Australia).

Further information on regional geology is presented in the *Vales Point Power Station Stage 2 ESA* (ERM, 2014b).

2.2.4 *Hydrogeology*

Groundwater flow is expected to be towards the cooling water canal, which is located to the north of the Site. Temporal and localised variations in the direction of groundwater flow is considered likely given the low lying nature of the area and potential tidal influences. The pits and sumps that are filled with crushed concrete could also increase the rate of infiltration into the subsurface and become potential sumps for surface water.

Further information on regional hydrogeology is presented in the *Vales Point Power Station Stage 2 ESA* (ERM, 2014b).

2.2.5 *Groundwater Use*

The groundwater beneath the Site is not extracted for use.

The NSW Natural Resource Atlas online bore register (accessed April 2014) (NSW Government) identifies six groundwater bores within a 5 km radius of the Vales Point Power Station, in addition to the groundwater monitoring wells installed during the *Vales Point Power Station Stage 2 ESA* (ERM, 2014b).

One groundwater bore, located approximately 700 m north of the Site in Mannering Park, is reportedly used for domestic purposes. The Standing Water Level (SWL) was recorded in this well at 5.5 m bgl. One groundwater bore, located approximately 1km south west of the Site is reportedly used for stock (poultry) watering purposes. The remaining four groundwater bores were reported to have been installed for test or monitoring purposes, with SWL recorded in three of these bores at 6m bgl.

2.3 *SITE OPERATIONAL HISTORY*

Detailed information regarding the history and operation of the Site, including historical aerial photographs, zoning and environmental approvals, licenses and management is presented in the *PESA* (ERM, 2014a).

The demolition of the former A Station infrastructure was completed in 2013 and early 2014.

2.4 *NSW EPA CONTAMINATED SITE RECORDS*

The *Contaminated Land Management Record of Notices* is a public database of information regarding significantly contaminated land in NSW and is managed by the NSW EPA under the *Contaminated Land Management Act 1997 (CLM Act 1997).*

At the time of this assessment, no areas of the Vales Point Power Station had been notified to the NSW EPA as being potentially contaminated. A number of recommendations for the notification impacts within the Vales Point Power Station are however presented in the *Vales Point Power Station Stage 2 ESA* (ERM, 2014b) and ERM understands that Delta were evaluating these at the time of the current assessment.

2.5 *PREVIOUS ENVIRONMENTAL INVESTIGATIONS*

Intrusive soil and groundwater investigations have not, to ERM's knowledge, previously been undertaken within the Site but during the Vales Point Power Station Stage 2 ESA (ERM, 2014b) impacts were identified in groundwater around the boundary of the A Station area, including:

- PFOS (a chemical associated with firefighting foams) was identified at concentrations in excess of the adopted human health (drinking water) screening levels was identified in VB_MW02, which is located on the south western boundary of the Site. PFOA was not detected. On the basis that groundwater is not extracted for potable use within the vicinity of the operational area of the Power Station, this identified PFOS impact was not considered to represent a significant risk to human health;

- Total Recoverable Hydrocarbons (TRH), chlorinated hydrocarbons and phenol were reported at concentrations above the laboratory LOR in groundwater samples collected along the south western and south eastern boundaries of the Site but the concentrations did not exceed the adopted screening values;

- The adopted ecological screening value for TRH C_{10}-C_{16} (excluding naphthalene) was exceeded in one soil sample collected from VB_MW01, which is located on the south eastern boundary of the Site. The ground surface at VB_MW01 is covered in concrete hardstanding and this area is used for miscellaneous operational activities, including the storage of skip bins and spare parts. On this basis, TRH impact in this area was not considered to represent a significant risk to the terrestrial environment; and

- Benzene was reported at concentrations exceeding the adopted human health (drinking water) screening values in two groundwater monitoring wells (VH_X_MW06 and VH_X_MW08) located within the Vehicle Refuelling Area, approximately 60 m to the south west and up hydraulic gradient from the Site. The adopted human health (recreational) screening value for benzene was also exceeded at VH_X_MW08. Groundwater monitoring has been ongoing within the Vehicle Refuelling Area since 2010 and the hydrocarbon detections in the *Vales Point Power Station Stage 2 ESA* did not suggest the presence of a significant ongoing release. On the basis that groundwater is not extracted for potable use within the vicinity of the operational area of the Power Station these impacts were not considered to represent a significant potential risk to human health under the ongoing use of the Site as a Power Station.

2.6 *POTENTIAL AND KNOWN SOURCES OF CONTAMINATION*

The primary sources of potential contamination identified within the former A Station area are potential leaks or spills of lubricating oil and fuel during the historic operation of the Site, which may have migrated through cracks in concrete or via damaged drains. The network of drains which run beneath the Site may also represent a potential source of impact.

A major fire event fire occurred in the 5A Air Heater, in the northern portion of the Site in 2011 and Aqueous Film Forming Foam (AFFF) constituents (used in firefighting foams) are therefore potential COPCs.

Many of the structures which were formerly housed within the former A Station area contained asbestos material, some of which remains in subsurface following the demolition activities. Areas of know subsurface asbestos impact within the Site including the following;

- a former ash pit is located on the north eastern corner of the Site, as shown in *Figure 6* of *Annex A*. Delta staff indicated that the north eastern ash pit contains asbestos contamination and that works previously undertaken by Delta included removal of approximately 1 m of asbestos impacted material from the top of this ash pit. The remainder of the asbestos containing material was covered with fill and HEPA filters to prevent potential asbestos fibres becoming airborne; and
- asbestos has been identified in some of the infrastructure remaining in the subsurface, including conduits and pipes.

Anecdotal evidence provided by Delta personnel indicated that during the demolition of the A Station surface infrastructure, fragments of galbestos were released from the former A Station structures onto the ground surface. ERM understands that an asbestos contractor was engaged and that the galbestos fragments were removed.

2.7 *SENSITIVE RECEPTORS*

The sensitive receptors identified in association with the Site include:

- human health receptors, in the form of Vales Point Power Station employees working within the former A Station and surrounding areas;
- intrusive workers working within the former A Station and surrounding areas;
- recreational users and ecological receptors within Mannering Bay, Wyee Bay and Chain Valley Bay; and
- aquifers beneath the Site.

3 *INVESTIGATION METHODOLOGY*

3.1 *SAMPLING LOCATIONS*

Based on a review of the available data, the most appropriate sampling design to achieve the stated project objectives was considered to be primarily based on a judgemental (targeted) sampling program.

It is noted that intrusive investigations were limited to areas where access and site activities enabled investigations to occur without unacceptable health and safety risks to personnel and/or unacceptable disruption to site operations. The sampling plan was discussed with site management prior to the commencement of works to assess this risk and was subject to alteration.

The main constraints on the implementation of A Station program were the presence of subsurface utilities and below ground infrastructure which remained following the demolition of the A Station infrastructure, preventing intrusive activities in some areas. Areas of crushed concrete fill are also present in the subsurface within the former CW pits, cable tunnels and pilings (see *Section 2.1.2*). A portion of the Site, extending approximately 50 m into the A Station area from the south eastern boundary, was also being used by contractors for the refabrication of components of the B Station and was inaccessible during the field works.

Due to the potential presence of unknown underground services at depth within the A Station area, the intrusive works were limited to non-destructive methods and focussed on the collection of soil samples from within the top 1.5m bgl.

The proposed A Station program comprised of soil sampling from 23 locations. The completed program comprised of soil samples from 16 locations.

Deviations from the A Station program were tracked during the course of the investigation via daily field sheets. *Table 3.1* below highlights locations proposed but abandoned or relocated due to subsurface constraints.

Table 3.1 ***Vales Point Power Station - Locations Abandoned or Relocated***

Location ID	Location Type	Comments
VB_SB05	Soil Bore	Abandoned due to location within a current workshop area. Delta refused access.
VB_SB06	Soil Bore	Relocated south of the former cooling water pits due to large number of services in the proposed location and inability to physically locate them. Cored concrete to 0.6 m in auxiliary location but discontinued due to the absence of a shallow soil profile and uncertainty attributed to service clearance techniques caused by exceptionally thick concrete.
VB_SB14	Soil Bore	Encountered a subsurface slab 50 mm below surface slab and unable to core through it.
VB_SB15	Soil Bore	Abandoned as the amended VB_SB06 location was very close by and alternate locations were limited by presence of former cooling water pits and underground services.
VB_SB16	Soil Bore	Abandoned due to location within a current workshop area - unable to be accessed.
VB_SB18	Soil Bore	Abandoned as it fell within the outage laydown area - unable to be accessed.
VB_SB23	Soil Bore	Abandoned as it fell within the outage laydown area - unable to be accessed.
VB_SB24	Soil Bore	Abandoned as it fell within the outage laydown area - unable to be accessed.

Final investigation locations and the locations that were abandoned are presented in *Figure 2* of *Annex A*.

3.2 SITE INSPECTION

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

3.3 SOIL INVESTIGATION

3.3.1 *Soil Sampling Procedure*

Soil investigation and sampling works were undertaken in general accordance with ERM's Standard Operating Procedures (SOPs). The location and number of sampling locations are presented within *Figure 2* of *Annex A*. Where practicable, all boreholes were advanced to a depth of 1.5 m bgl using Non-

Destructive Digging (NDD) and/or hand-auger techniques in accordance with ERM's sub-surface clearance procedures. Non-Destructive Drilling was used as the primary method of advancement however at increments of approximately 0.3 m, the borehole was sucked dry using the NDD and hand augered to provide clarity on soil profile and facilitate the collection of appropriate samples.

Field screening was conducted in accordance with ERM's SOPs using a photo-ionisation detector (PID) fitted with a 10.6 eV lamp, calibrated at the beginning of each working day. Calibration certificates are presented in *Annex D*. Where practicable, soil was collected at 0.3 m depth intervals (or where significant changes in lithology were identified) to 1.5 m bgl. Soil samples were placed in a zip lock bag, sealed and screened for the presence of ionisable volatile compounds. Where the presence of volatiles or other impact was suspected, additional samples were collected.

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

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

Soil samples were collected, to the extent practicable, in accordance with techniques described in *Australian Standard AS4482-2005* (Parts 1 and 2) to maintain the representativeness and integrity of the samples. Soil samples for laboratory analysis were collected from the hand auger. The frequency and nature of field QA/QC samples collected during the assessment works are summarised in *Annex E*.

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

Potential asbestos containing material (ACM) was identified at the surface in the form of intact (redundant) power cable conduits. The location of these conduits correlated with asbestos impact on Delta supplied plans and so samples of this material were not collected. Further, no ACM fragments were visibly identified within the fill profile during the investigation works and so there were no ACM fragments submitted for analysis. Discrete samples of soil were collected in 500 mL snap lock bags during NDD for laboratory analysis for asbestos fibres. These samples were submitted to the laboratory for asbestos identification and (where identified) quantification (%w/w analysis) in accordance with the WA DOH guidelines (WA DOH, 2009).

3.3.2 *Decontamination Procedure*

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

3.3.3 *Soil Bore Reinstatement*

Upon completion, soil bores were backfilled and the surface covering reinstated to match existing.

3.3.4 *Management of Waste Materials Generated During Drilling*

Non-liquid waste materials generated during drilling works were stored on-site in stockpiles inside a temporary bund in a designated area near the Vales Point Power Station Ash Dam, prior to disposal by Delta at a later date within the Ash Dam in accordance with relevant EPL conditions.

3.4 *SURVEYING*

All soil bore investigation locations were digitally located by field staff with a handheld Global Positioning System (GPS) unit.

3.5 *LABORATORY ANALYSIS*

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

All samples were analysed for the following COPCs:

- metals and metalloids (arsenic, cadmium, chromium, copper, nickel, lead, mercury, selenium and zinc);
- Polychlorinated Biphenyls (PCBs);
- Total Recoverable Hydrocarbons (TRH); and
- Polycyclic Aromatic Hydrocarbons (PAHs).

Additional contaminants of concern were analysed within individual AECs to target specific sources of contamination or if required based on observations made in the field.

These contaminants include:

- Volatile Organic Compounds (including benzene, toluene, ethylbenzene and xylenes - BTEX); and
- Perfluorooctane sulfonate (PFOS) and Perfluorooctanoic acid (PFOA) – to target areas where fire retardants may have been used or stored;
- Asbestos.

3.6 *QUALITY ASSURANCE/QUALITY CONTROL*

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

In summary, the QA/QC data reported by ALS for soil samples and field duplicate results were generally free of systematic and method biases and were assessed to be of sufficient quality for the purposes of this investigation.

3.7 *DATA SCREENING*

Individual soil, groundwater, sediment and surface water data, along with the maximum, minimum, mean, standard deviation and 95% upper confidence limit (UCL) of the mean concentration (if required) were compared to adopted screening values.

The screening values adopted for the Site are designed to provide a screening value assessment of potential risks that may be associated with the SPR linkages that have been identified for this Site. The specific assessment levels adopted are presented alongside the analytical data in the summary tables presented in *Annex B*. The approach to the screening of the data gathered in this assessment has generally been to initially adopt conservative assessment values. Any exceedances of these values have then been evaluated on a case by case basis, in light of the specific characteristics of the individual sample and the area of the Site from which the sample was collected.

The adopted screening values have generally been sourced from guidelines made or approved under the *CLM Act 1997*, which includes the *ASC NEPM* (ASC NEPC, 2013). Where alternative sources have been utilised, appropriate justification has been provided.

3.7.1 *Soil Screening Values*

Soil data was assessed against investigation criteria published in the NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Measure 1999,* Schedule B1 - Guideline on Investigation Levels for Soil and Groundwater (ASC NEPC, 2013), including;

- Health Investigation Level (HIL) – 'D' Commercial/Industrial;
- Health Screening values (HSLs) for Vapour Intrusion and Direct Soil - 'D' Commercial/Industrial;
- Ecological Investigation/Screening values (EILs/ESLs) – for commercial industrial areas (as applicable); and
- The Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE, 2011) *Technical Report No. 10* HSLs for Vapour Intrusion and Direct Contact - Intrusive Maintenance Workers (labouring within shallow trenches).

The EILs/ESLs for commercial/industrial areas have been adopted across the Site.

Laboratory analysis for pH and CEC is required to establish site specific EILs/ESLs, and an assessment of background conditions is necessary. The EILs/ESLs established during the *Vales Point Power Station Stage 2 ESA* (ERM, 2014b) using the analytical data collected from buffer/boundary locations were utilised in this assessment establishing background conditions. The details of the calculations used to establish Site specific EILs/ESLs are provided in *Annex I* of the *Vales Point Power Station Stage 2 ESA* report.

The ASC NEPM (2013) also provides EILs for aged and fresh contamination for the metal constituents Ni, Cr III, Cu, Zn and Pb. For the purposes of EIL derivation, a constituent incorporated in soil for at least two years was considered to be aged. Given that the Site has been operational since the 1960s and no significant individual release events of these metals have been recorded, any identified impacts are likely to primarily represent aged contamination. The EILs for aged contamination have been adopted.

The ASC NEPM (2013) and CRC CARE (2011) *Health screening values for petroleum hydrocarbons in soil and groundwater* provide Health Screening values (HSLs) for soil and groundwater impacts located at depths from 0 to 4+ m bgl in soil types ranging from sand to clay and Health Investigation Levels (HILs) for shallow soil impacts. The screening values for sandy soils have been adopted across the Site, as a conservative approach. The significance of any exceedances of the HILs/HSLs have been evaluated on a case by case basis, with reference to the use of the area of identified potential concern.

3.7.2 *Screening values for Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA)*

No authoritative screening criteria have been published within Australia for assessing chronic risks to human health from either perfluorooctane sulfonate (PFOS) or Perfluorooctanoic acid (PFOA) in soils. As such, a literature review and web-based research were conducted to identify conservative screening values for these COPCs.

Values of 6 mg/kg and 16 mg/kg were adopted for PFOS and PFOA in soil respectively, based on recently published US EPA Region 4 guidance *Emerging Contaminants Fact Sheet -PFOS and PFOA, May 2012* (US EPA, 2009c) for residential land-use settings. Whilst these criteria are acknowledged to be designed for application to a more sensitive land-use, they are considered appropriate to inform requirements for more detailed, or site-specific, risk characterisation.

It is noted that these guideline values have no regulatory standing in NSW and hence these values have been adopted to provide a high level evaluation of potential ecological risk and have not been used to assess the duty to report requirements under the CLM Act (1997).

4 INVESTIGATION RESULTS

This section discusses the results associated with the soil samples collected from within the Site. It is noted that due to uncertainties regarding sub surface infrastructure, further groundwater investigation works were not undertaken in the operational area of the former A Station.

4.1 SITE GEOLOGY OBSERVATIONS

A generalised description of the lithology and geology encountered in the Site is presented *in Table 4.1*.

Due to uncertainties regarding sub surface services, the maximum depth to which locations were advanced was 1.5 m bgs. Twelve of the 16 locations were advanced in an area where there was a concrete slab present. Fill present directly below the slab varied between sandy clay and sand with some gravels. Beyond this initial fill was re worked clay fill with highly weathered sandstone encountered towards the bottom of the hole in some locations.

Table 4.1 ***Generalised Field Lithology Descriptions***

Lithological Unit	Description	Depth[1] (m bgl)
Hardstanding	Concrete and asphalt generally in good condition (present in some locations within the operational area).	0 – up to 0.3
Fill	Fill material of variable composition, varying from sandy gravel to re-worked gravelly sandy clay (present in some locations within the Site).	0 – up to 1.5

1. Depths and lithologies varied across the site.

Detailed descriptions of the Site lithology and geology as observed at each location during the investigation are presented in the borehole logs in *Annex C*.

4.2 FIELD OBSERVATIONS

During the sampling process, indicators of contamination such as black staining and hydrocarbon odours were noted in several bore holes within this AEC. Measured concentrations of ionisable volatile compounds via headspace analysis were noted not to exceed 0.3 ppm v (isobutylene equivalent) in any soil sample collected from this AEC.

A summary of the field observations from the drilling works are presented within *Table* 4.2 and also on the borehole logs included within *Annex C*.

Table 4.2 *Field Observations Summary*

Borehole ID	Depth (m bgl)	Visual or Olfactory Evidence	PID Range (ppm v - isobutylene equivalents)
VB_SB07	4	None	0
VB_SB07	1.5	None	0
VB_SB08	0.8	Hydrocarbon odour/black staining	0-0.3
VB_SB09	1.5	None	0-0.1
VB_SB10	1.5	None	0
VB_SB11	1.3	Black Staining	0
VB_SB12	0.8	None	0
VB_SB13	1.5	None	0
VB_SB17	1.5	None	0
VB_SB19	1.5	None	0-0.1
VB_SB20	1.5	None	0
VB_SB21	1.5	Black staining	0
VB_SB22	1.5	None	0
VB_SB25	0.7	None	0-0.1
VB_SB26	0.4	None	0
VB_SB27	1.5	None	0

4.3 SOIL ANALYTICAL RESULTS

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

4.3.1 *Hydrocarbons*

Concentrations of TRH were reported above the laboratory LOR in the following soil samples;

- VB_SB08 at a depth of 0.2 and 0.7 m bgl;
- VB_SB10 at a depth of 0.3 m bgl;
- VB_SB11 at a depth of 0.7 m bgl;
- VB_SB19 at a depth of 0.3 m bgl;
- VB_SB20 at a depth of 0.4 m bgl;
- VB_SB25 at a depth of 0.6 m bgl; and
- VB_SB26 at a depth of 0.2m bgl.

All concentrations were however below the adopted human health screening values.

The adopted ecological screening value for TRH C_{10}-C_{16} (excluding naphthalene) was exceeded in one soil sample collected from VB_SB08 and the adopted ecological screening value for TRH C_{16}-C_{34} was exceeded in three soil samples collected from within the top 1 m bgl at VB_SB08, VB_SB10 and VB_SB11. The ground surface at VB_SB08,VB_SB10 and VB_SB11 is covered in concrete hardstanding and this area is currently used for miscellaneous operational activities, including as a lay down area during outages at the operational B Station. On this basis, TRH impact in this area is not considered to represent a significant risk to potential terrestrial ecological receptors.

It is noted that the deeper soil sample collected at all three locations, also reported TRH concentrations either below or only marginally above the laboratory LoR. This provides some evidence that indicates that the vertical migration of these impacts may be limited.

Measurable concentrations of PAHs (benzo(a)pyrene, benzo(a)anthracene, benzo(b)fluoranthene, chrysene and fluoranthene) were detected in one sample collected from VB_SB25 at a depth of 0.6 m bgl but the concentration did not exceed the adopted screening criteria.

4.3.2 *PFOS/PFOA*

Concentrations of PFOS were reported above the laboratory LOR in the soil sample collected from VB_SB09, VB_SB10, VB_SB11, VB_SB25 and VB_SB25 at 0.5m bgl however the detected concentrations were below the adopted screening value.

4.3.3 *Metals*

Measurable concentrations of metals were detected in 30 of the 32 samples analysed however only the adopted ecological screening levels for zinc were exceeded in two samples; VB_SB19 at 0.3m bgl and VB_SB26 at 0.2m bgl. The ground surface at VB_SB19 is covered in concrete hardstanding and this area is currently used for miscellaneous operational activities, including as a lay down area during outages at the operational B Station. VB_SB26 is located within an unsealed roadway area.

Given the these detections were only noted in two shallow samples, and that all deeper samples across the AEC returned measured concentrations below the adopted ecological screening criteria, significant vertical migration from surface soils does not appear to be occurring. Further to this, the fact that only two samples from thirty two exceeded the ecological screening criteria suggests that these are localised elevated concentrations, not likely to be representative of gross zinc impacts across the area. The 95% UCL was calculated for zinc in all samples across this area (*Annex H*) and found to be less than the adopted screening level. The concentrations which exceeded the screening level detected are also less than 2 x the adopted screening level and as such are not considered to represent a significant risk to the terrestrial environment.

4.3.4 *Asbestos*

Asbestos was detected in three samples collected within this AEC; VB_SB07 at 0.3m bgl, VB_SB13 at 0.2m bgl and VB_SB19 at 0.3m bgl.

At VB_SB07_0.3 the measured concentrations of amosite asbestos fines and fibrous asbestos (%w/w) did not exceed the adopted human health screening value. The laboratory described this detection as "one small friable asbestos fibre bundle (approximately 2 x 0.5 x 0.5mm)".

At VB_SB13_0.2 and VB_SB19_0.3, the fibrous asbestos concentrations exceeded the adopted human health screening levels. At VB_SB13, the laboratory report identified "one small fragment of degraded and friable asbestos fibre board (approximately 3 x 3 x 2mm) and several small friable asbestos fibre bundles (approximately 2 x 0.5 x 0.5mm)". At VB_SB19, fibrous chrysotile and amosite asbestos were detected and the laboratory report identified "several small friable asbestos fibre bundles (approximately 3 x 1 x 0.5mm)".

All three locations, at which asbestos was detected, are covered in concrete hardstand. These areas of asbestos impact would only represent a risk to the health of Site employees, if they were to come into contact with them during intrusive works requiring the removal of the concrete. ERM understands that Delta has recorded these areas of asbestos impact in its Asbestos Register and that they will be managed in accordance with Delta's existing asbestos management procedures to reduce the potential for exposure to occur.

It is noted that this asbestos assessment is considered indicative in nature, and additional analysis, in accordance with ASC NEPM (2013) would need to be undertaken to comprehensively delineate asbestos impacts associated with this area. The asbestos assessment is however considered sufficient for the purpose of this baseline assessment and that a more detailed assessment would not be required unless the future use of the areas was to change.

4.4 *DATA QUALITY*

The data presented in the ESA was considered to generally be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site. Whilst some minor non-conformances have been identified in relation to field and laboratory QA/QC, these are not considered to have a material impact on the outcomes of this assessment. A detailed review of the Data Quality of this assessment is provided in *Annex E*.

Comparison of the LOR to the screening values has been undertaken, confirming that the screening values are less than the laboratory LOR for all compounds analysed.

5 OVERALL DISCUSSION

The primary objective of these additional works was to develop a baseline assessment of environmental conditions in the footprint of the former A Station which was not accessible during the completion of the *Vales Point Power Station Stage 2 ESA* (ERM, 2014b). The results of the assessment have also been used to assess:

- the nature and extent of soil impact on / beneath the Site and in relation to neighbouring sensitive receptors;
- whether the impacts at the Site represent a risk to human health and/or the environment, based on the continuation of the current use;
- whether the impact at the Site is likely to warrant notification /regulation under the *CLM Act 1997*;
- whether material remediation is considered likely to be required; and
- whether the data collected during the assessment was of a suitable quality and completeness to provide a baseline of environmental conditions at the Site.

The overall results of the assessment are discussed herein, with reference to these objectives.

5.1 *SUMMARY - THE NATURE AND EXTENT OF SOIL IMPACTS AND ASSOCIATED HEALTH AND ENVIRONMENTAL RISKS*

A CSM was developed and refined, which identified the following ecological and human receptors:

- human health receptors, in the form of Vales Point Power Station employees working within the former A Station and surrounding areas;
- intrusive workers working within the former A Station and surrounding areas;
- recreational users and ecological receptors within Mannering Bay, Wyee Bay and Chain Valley Bay; and
- aquifers beneath the Site;

Soil data was compared against published environmental quality levels to provide a screening level assessment of potential risks to these identified receptors. The findings of the screening process indicated that concentrations in soil generally complied with the adopted screening values, with some exceptions, as outlined in *Section 4.3*.

The soil results do not suggest the presence of contamination in the subsurface at the Site that may represent a significant risk to human health of the terrestrial environment. As with any investigation of this nature, the potential exists for unidentified contamination to exist between the completed sampling locations or in areas not sampled. In particular, samples were not collected from within the transformer runway on the north western portion of the Site or within the south eastern portion of the Site that was inaccessible during the field works.

The soil results also do not suggest the migration of the identified soil impacts into Site groundwater. It is noted however that the presence of groundwater contamination within the Site cannot be discounted in the absence of groundwater analytical data.

The results of the assessment identified some areas of asbestos impact in fill material. It is noted however that as identified in the ASC NEPM (2013) the vertical boring of soils is not a comprehensive method via which to identify asbestos, however given the objectives of this assessment and the operational constraints, the assessment methodology adopted was considered appropriate. The absence of asbestos impacts across the areas of the Site that were not sampled cannot however be guaranteed on the basis of the results of this assessment.

5.2 *SUMMARY – DOES THE IMPACT WARRANT NOTIFICATION UNDER THE CONTAMINATED LAND MANAGEMENT ACT 1997?*

Under Section 60 of the *CLM Act (1997)*, a person whose activities have contaminated land or a landowner whose land has been contaminated is required to notify NSW EPA when they become aware (or ought reasonably have been aware) of the contamination. The DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*, state that a landowner or a person whose activities have contaminated land is required to notify NSW EPA that the land is contaminated if:

- the level of the contaminant exceeds the appropriate published screening level with respect to a current or approved use of the land, **and** people have been, or foreseeably will be, exposed to the contaminant; or
- the contamination meets a specific criterion prescribed by the regulations; or
- the contaminant has entered, or will foreseeably enter, neighbouring land, the atmosphere, groundwater or surface water, **and** the contamination exceeds, or will foreseeably exceed, an appropriate published screening value and will foreseeably continue to remain above that level.

The soil results obtained in this assessment have been compared against the screening values specified in NSW DECC (2009) *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* and a number of exceedances have been identified. It is also noted that a draft revision of this document was published in 2014 and that the guidance provided in this document has also been considered.

Every exceedance of these screening values is not, however, required to be reported to the NSW EPA. In the case of onsite soil contamination, if no plausible exposure pathway to people or the environment is present, reporting is not required.

On the basis of the discussions outlined in *Section 4.3*, the constituents that have been identified in soil collected within the Site are not considered likely to represent a significant risk to human health or the environment, due to the absence of a plausible exposure pathway. Consequently, the reporting of these impacts to the NSW EPA under the current guidelines is not considered likely to be required.

The 2014 draft revision of the *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* requires the notification of friable asbestos that is present in soils at concentrations in excess of the *ASC NEPM* (2013) Health Screening Levels **and** to which a person has been, or foreseeably will be, exposed to the asbestos fibres by breathing them into their lungs. The 'foreseeability' of people being exposed to the identified asbestos will be dependent upon the future use of the Site and the asbestos management practices employed to control potential exposure. These factors should be evaluated by Delta when assessing the requirement to report the identified asbestos contamination to the NSW EPA, upon the finalisation of the revised guidelines.

5.3 *SUMMARY – IS MATERIAL REMEDIATION OR MANAGEMENT LIKELY TO BE REQUIRED?*

The material remediation or management of the zinc, TRH and PFOS impacts identified in soil collected from within the Site is considered unlikely to be required under the ongoing use of the Site for general maintenance activities associated with the operation of the Power Station.

Further assessment and remediation may be required to address unidentified deeper soil and groundwater impacts within the Site if the landuse was to change in the future. A detailed costing for such works has not been prepared since this would be dependent on the nature and layout of the proposed use which cannot be predicted at this point in time.

Asbestos contamination has previously been identified by Delta within the former A Station area and during this investigation additional asbestos impacts were identified in surface soil. ERM understands that Delta has recorded these areas of asbestos impact in its Asbestos Register. The further assessment and remediation of these impacts may be required in the event that the use of the Site was to change but under the current use of the area ERM understands that these impacts will be appropriately managed in accordance with Delta's existing asbestos management procedures.

5.4 *SUMMARY - IS THE DATA SUITABLE TO PROVIDE A BASELINE OF ENVIRONMENTAL CONDITIONS AT THE SITE AND IMMEDIATE SURROUNDING RECEIVING ENVIRONMENTS*

The data presented in the ESA was considered to generally be of a suitable quality and completeness to provide a baseline of environmental conditions at the Site as at or near the time of the transaction, given the constraints that are associated with intrusive works in this area, including the presence of potential subsurface and overhead utilities, areas of thick hardstanding and concrete rubble fill and access restrictions.

The majority of the locations proposed were able to be advanced, with the exception of the locations listed in *Section 3.1*. In conjunction with the data collected around the boundaries of the Site during the *Vales Point Power Station Stage 2 ESA* (ERM, 2014b), the locations completed are considered adequate to provide a general indication of potential shallow soil contamination within the former A Station Area.

The installation of groundwater wells within the Former A Station demolition Area was not considered feasible, due to the health and safety issues associated with the presence of potential unknown underground services in this area. The investigation of this AEC was therefore limited to assessment of shallow soils (to a maximum depth of 1.5 m bgl). Unidentified soil and groundwater impacts may be present at depth within the Site, but the results of the current assessment do not provide evidence that the historic operation of the former A Station area was associated with potentially significant contamination.

On the basis of the above discussion, the data collected during this assessment is considered to be suitable to provide a baseline of soil conditions in the area of the former A station, at or near the time of the transaction.

6 CONCLUSIONS

ERM completed additional works within the former A Station area, subsequent to completion of the *Vales Point Power Station Stage 2 ESA,* in order to further develop a baseline assessment of environmental conditions within the former A Station area as at or near the time of the sale of the Power Station. Soil data were compared against published environmental quality levels to provide a screening level assessment of potential risks to identified human and environmental receptors. The following conclusions were made based on the data collected during the investigation:

- the key impacts identified included TRH, asbestos and metals in individual soil samples across the A Station area;
- the impacts identified in soil within the A Station area are generally unlikely to represent a significant risk to human health and/or the environment, given use of the Site as a Power Station and the implementation of appropriate ongoing management strategies;
- asbestos was detected in individual shallow soil samples collected from the former A Station area at concentrations in excess of the adopted human health screening values. ERM understands that Delta has recorded these areas of asbestos impact in its Asbestos Register and that they will be managed in accordance with Delta's existing asbestos management procedures. These areas of asbestos impact would only represent a risk to the health of Site employees, if they were to disregard the implemented management controls and to come into contact with them;
- no impacts that are likely to require material remediation under the ongoing use of the Site for general maintenance activities associated with the operation of the Power Station were identified during this investigation;
- no impacts that trigger a duty to report under the Contaminated Land Management (CLM) Act 1997 were identified during the additional works undertaken within the former A Station area. The 2014 draft revision of the *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* requires the notification of friable asbestos that is present in soils at concentrations in excess of the *ASC NEPM* (2013) Health Screening Levels and to which a person has been, or foreseeably will be, exposed to the asbestos fibres by breathing them into their lungs. The 'foreseeability' of people being exposed to the identified asbestos will be dependent upon the future use of the Site and the asbestos management practices employed to control potential exposure and these factors should be evaluated by Delta when assessing the requirement to report the identified asbestos contamination to the NSW EPA, upon the finalisation of the revised guidelines.

7 *REFERENCES*

ASC NEPC. 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999.* Canberra : s.n., 2013.

Australian Standard. 1999. *Guide to sampling and investigation of potentially contaminated soil Part 2: Volatile substances.* s.l. : Standards Australia, 1999. AS 4482.2 - 1999.

Australian Standard. 2005. *Guide to the investigation and sampling of sites with potentially contaminated soil - Part 1: Non-volatile and semi-volatile compounds.* Second edition. Sydney : Standards Australia, 2005. AS 4482.1-2005.

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

DEC. 2006. *Guidleines for the NSW Site Auditor Scheme.* 2nd Edition. s.l. : Department of Environment and Conservation NSW, 2006. ISBN: 1 74137 859 1.

EPA. 1997. *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites.* s.l. : Office of Environment and Heritage, Sydney, 1997. ISBN: 0 7310 3892 4.

ERM. 2014. *Preliminary Environmental Site Assessment.* 2014. 0207423RP01.

ERM. 2014. *Stage 2 Environmental Site Assessment.* 2014. 027747RP01.

ERM. 2012. *Standard Operating Procedure Manual.* 2012.

Friebel, E & Nadebaum, P. 2011. *Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater, Summary, CRC CARE Technical Report No. 10.* Adelaide, Australia : CRC for Contamination Assessment and Remediation of the Environment, 2011. ISBN: 978 1 921431 15 9.

Geological Survey of New South Wales. 2003. *Gosford – Lake Macquarie 1:100 000 Provisional Geology Sheet.* 2003.

MDH. 2011. *Human Health Based Water Guidance Table.* s.l. : Minnesota Deptartment of Health, 2011.

NEPC. 2013. *National Environment Protection (Assessment of Site Contamination) Measure 1999.* Canberra : s.n., 2013.

NSW Government. NSW Natural Resource Atlas website. [Online] [Accessed April 2014] http://www.nratlas.nsw.gov.au.

NSW EPA. 1995. *Contaminated Sites: Sampling Design Guidelines.* Chatswood, NSW : Environment Protection Authority, 1995. ISBN 0731037561.

UK HPA. 2009. *HPA Compendium of Chemical Hazards - PFOS and PFOA.* s.l. : United Kingdom Health Protection Agency, 2009. Version 1.

US EPA. 2006. *Guidance on Systemic Planning Using the Data Quality Objectives Process.* 2006.

US EPA. 2009. *The toxicity of perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS).* 2009.

US EPA. 2014. *Emerging Contaminants – Perfluorooctane Sulfonate (PFOS) and Perfluorooctanoic Acid (PFOA).* 2014.

WA DOH. 2009. *Guidelines for the assessment, remediation and management of asbestos-contaminated sites in Western Australia.* Perth : Western Australia Department of Health, 2009.

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Vales Point Power Station

Additional Baseline Contamination Assessment – Part 1

Jacobs

July 2017

JACOBS

Vales Point Additional Baseline Contamination Assessment

Delta

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Environment Service Contract H54487

Vales Point Additional Baseline Contamination Assessment

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Contents

Executive Summary

Introduction

Jacobs Group (Australia) Pty Ltd (Jacobs) was commissioned by Sunset Power International Pty Ltd t/as Delta Electricity (Delta) to undertake an Additional Baseline Study at the Vales Point Power Station (referred to hereinafter as the site) to support the agreement with the NSW Government to indemnify Delta against certain losses suffered or incurred in connection with "Pre-Existing Contamination", "Legacy Contamination" and "Ash Dam Contamination" on site.

Objectives and Scope of Works

The objective of the baseline contamination investigation was to assess the existing contamination (if identified) at the site which may have occurred as a result of activities undertaken by Delta associated with the Vales Point Power Station.

Specific objectives also included:

- The vertical extent of potential contamination associated with the historical and current use of the site and adjoining areas as a power station, specifically within the ash dams and sediments of Wyee Bay.
- Identify a baseline for contamination (if present) to specify 'pre-existing' and 'legacy' contamination at the site.

The scope of works included test pitting and sample collection within the ash dam capping material and the investigation and sediment sampling and analysis in Wyee Bay.

Results

Capping material:

The capping investigation results identified the following:

- The sub-surface material encountered in the test pits (TP01 to TP46) generally consisted of sandy clays and clayey sand fill materials. Depths of fill materials ranged from a minimum depth of 0.05 m bgl (TP06, TP11, TP18) to a maximum depth of 2.0 m bgl at TP43. The average depth of fill material across each of the ponds was 0.145 m bgl in Pond 1, 0.227 m bgl in Pond 2 and 0.56 m bgl in Pond 3. These materials were underlain by deposited waste fly ash from the Ash dam. No natural material was encountered during the investigation.

- Soil samples from test pits were selected for analysis based generally on providing vertical and lateral coverage of potential contaminant extents within the capping material and on visual observations. All soil samples recorded contaminant concentrations below the adopted Site Assessment Criteria (SAC).

- No asbestos was detected within samples analysed or observed within soil samples or within capping material and was not observed on the surface with the exception of one fragment located 20 m north of TP01.

- Preliminary waste classification of the samples analysed indicated that the material sampled during the investigation would be classified as General Solid Waste (non-putrescible).

Sediment results:

The sediment investigation results identified the following:

- Sediment textures vary greatly in the southern section of Lake Macquarie from muds, to gravels composed of shells and lithic fragments.
- Coal is present in sediment to the west and northwest of Vales Point Power Station. The distribution of coal in sediment west and northwest of the Vales Point Power Station is not clearly defined by the current sampling locations.
- The highest concentrations of PAHs and higher TOC content in sediment were consistent with coal particles observed in sediment.
- Concentrations of total, normalised PAHs in sediment did not exceed relevant sediment quality guideline values.
- Trace metal concentrations in sediment are generally below the SAC with the exception of mercury and cadmium which marginally exceeded the relevant sediment quality guidelines values at two locations (J5 and J8).
- Selenium concentrations in sediment exceeded the adopted screening value at six of the eight sample locations and in twelve of the sixteen primary sediment samples analysed.
- All eight sediment sample locations returned analytical results for per- and poly-fluoroalkyl substances (PFAS) below the limits of reporting for all the compounds tested.

Conclusions

Based on the field and analytical result, Jacobs concludes the following:

- Contamination above the SAC was not identified within Pond 1, 2 and 3 for the applied analytical regime at the locations tested. Pre-existing or legacy contamination within the sampled capping material was not present within the pond capping material at the locations tested. Contamination exposure risks associated with current use for the currently industrial site usage and risks to site users in the form of workers and to ecological receptors is considered to be low.
- Elevated selenium concentrations above the adopted guideline value were reported in samples from six of the eight sediment sample locations in Wyee Bay. Based on the results from Jacobs investigations and comparison to ERM's 2014 ESA, there is evidence to suggest inputs from the ash dam and operation of the power station in the form of licenced discharges and run-off, along with other land uses in the area such as mines and industry may have contributed to the selenium concentrations in sediments within Wyee Bay. Comparisons between the results reported in ERM 2014 to results from this investigation indicate similar concentrations between the two. Furthermore there does not appear to have been an increase in concentrations since ERM completed their investigation in 2014. The selenium concentrations reported in the sediments of Wyee Bay have potential to have adverse impacts on marine organisms within Wyee Bay and surrounding water bodies. Subsequently there is an additional health risk to consumers of fish taken from the bay, as elevated concentrations may be present within the fish.

- Coal is present in sediment to the west and northwest of Vales Point Power Station. The distribution of coal in sediment west and northwest of the Vales Point Power Station is not clearly defined by the current sampling locations.

1. Introduction

Jacobs Group (Australia) Pty Ltd (Jacobs) was commissioned by Sunset Power International Pty Ltd t/as Delta Electricity (Delta) to undertake an Additional Baseline Study at the Vales Point Power Station (referred to hereinafter as the site) to support the agreement with the NSW Government to indemnify Delta against certain losses suffered or incurred in connection with "Pre-Existing Contamination", "Legacy Contamination" and "Ash Dam Contamination" on site.

The location of the site is presented as **Figure 1** and **Figure 2**.

This report details the works undertaken during the contamination investigation, field observations and the results of sampling and analysis in comparison to the applicable guidelines detailed within the National Environment Protection Council *National Environment Protection (Assessment of Site Contamination) Measure 1999* as revised in 2013 (NEPC, 2013) as endorsed by the NSW Environmental Protection Authority (NSW EPA) and other relevant guidelines. The report has been prepared in general accordance with the NSW EPA Guidelines, the National Environment Protection (Assessment of Site Contamination) Measure 1999 as amended 2013 (ASC NEPM) and relevant Australian Standards.

The investigation was undertaken in general accordance with the Jacobs *Sampling, Analysis and Quality Plan (SAQP): Vales Point Power Station – Additional Baseline* dated 20 February 2017.

1.1 Project background

Delta acquired the Vales Point Power Station from the NSW Government in December, 2015. As part of the transaction, the NSW Government agreed to indemnify Delta against certain losses suffered or incurred by Delta in connection with "Pre-Existing Contamination", "Legacy Contamination" and "Ash Dam Contamination". Delta also agreed to indemnify the NSW Government against certain losses suffered or incurred by the NSW Government in connection with "Operating Period Contamination." The terms of these indemnities are set out in the "Vales Point Closure and Put and Call Option Deed" (the Handback Deed).

The Handback Deed defined Pre-Existing Contamination as contamination identified in the "Baseline Study" as well as a relatively new category of contaminants referred to as Per- and Polyfluoroalkyl Substances (PFAS), regardless of when the presence of the PFAS contamination is identified. The Baseline Study included several investigations undertaken by Environmental Resource Management Australia (ERM). The Handback Deed also provided Delta with an option to undertake an Additional Baseline Study to further define Pre-Existing Contamination.

The Additional Baseline Study needs to be notified to the NSW Government within 12 months of the Completion Date (understood by Jacobs to be 17 December, 2015). The draft Additional Baseline Study report must then be submitted to the NSW Government within 6 months of the notice date.

At any time during Delta's operation of the Vales Point Power Station or at the end of the "Operating Period", the NSW Government may choose to undertake an "Operating Period Contamination Study". Delta can potentially be held liable for costs to remedy contamination that is identified to have occurred during the Operating Period.

Delta has reviewed the Baseline Study reports prepared by ERM and has found two areas requiring additional investigation:

- Capping material used for ash ponds 1, 2 and 3; and
- Sediments in Wyee Bay.

These two aforementioned areas form the basis for the following baseline contamination investigation.

1.1.1 Ash pond capping material

In relation to the capping material for the ash ponds, ash from the power station was transported to the ash ponds as a slurry and allowed to settle. As the ponds reach their capacity, the ash was allowed to dry out and was then capped with capping material of approximately 0.5 metre thickness, with some variation. A topsoil layer was then applied and the area was vegetated.

In recent years, Virgin Excavated Natural Material (VENM) as defined in the Protection of the Environment Operations Act 1997 or Excavated Natural Material (ENM) as defined in the Excavated Natural Material Order under Part 9, Clause 93 of the Protection of the Environment Operations (Waste) Regulation 2014 has been specified for the capping material. Delta currently has procedures in place requiring suppliers of material to provide certification that the material is VENM or ENM and visual inspections of the material are performed on all trucks entering the site.

However, there have been numerous examples in industry where material certified as VENM or ENM has contained contaminants or other materials which do not meet the requirements of the respective legislation. The procedures currently employed to check the material by Delta may not have been employed as rigorously in the past as they are now. Furthermore, Jacobs understands that capping of the ponds commenced in the 1990's before the VENM and ENM framework was introduced.

The capping material was not investigated by ERM as part of the existing Baseline Studies and therefore Delta proposed an investigation of this material as part of the Additional Baseline Study. The primary objective of this investigation was to determine if the capping material contains contaminants at selected locations across the capped areas, in order to identify this contamination as "Pre-Existing Contamination".

1.1.2 Sediments in Wyee Bay

The ERM Stage 2 Environmental Site Assessment (ERM, 2014a) included sampling of sediment from Wyee Bay, Chain Valley Bay, Wyee Creek and the Wyee Creek diversion, and Mannering Bay. Concentrations of cadmium, copper, selenium and Polycyclic Aromatic Hydrocarbons (PAH) in certain sediment samples exceeded ERM's adopted screening values. The most significant exceedance appears to be in relation to selenium with a maximum concentration of 26 mg/kg in one sample versus a screening value of 2 mg/kg.

ERM noted that elevated selenium concentrations in sediment throughout Lake Macquarie are well documented and the concentrations identified by ERM were of the same order of magnitude as those identified in previous investigations. ERM noted that the sources of the elevated selenium concentrations are likely to be discharges from the Vales Point Ash Dam and potentially other sources in the catchment such as mines, other power stations and other industries. Delta proposed the collection of sediment samples at a minimum of eight locations including seven locations previously sampled by ERM and one additional background location. The purpose of this investigation was to collect additional data to better understand the existing sediment impacts identified by ERM.

2. Objectives and Scope of Works

The objective of the baseline contamination investigation was to assess the existing contamination (if identified) at the site which may have occurred as a result of activities undertaken during the Vales Point Power Station's operation prior to sale to Delta (Sunset Power International) in 2015

Specific objectives also included:

- The vertical extent of potential contamination associated with the historical and current use of the site and adjoining areas as a power station, specifically within the ash dams and sediments of Wyee Bay.
- Provide additional data to the ERM 2014 ESA baseline for contamination that will augment and support a broader understanding of 'pre-existing' and 'legacy' contamination at the site.

The scope of works undertaken to address the objectives are detailed below. Sampling locations for the ash pond capping investigation and sediment investigation are presented on **Figure 1** and **Figure 2** respectively.

2.1 Ash dam investigation

Investigation works included, in order of occurrence:

- Dial Before You Dig Search and completion of an 'Authority To Dig Form'.
- Mobilisation to sampling locations using a non-differential GPS.
- Scraping of vegetation and top soil layer using excavator.
- Test pit excavation and sample collection.
- Logging of test pit and physical characteristics, including photograph log.
- Test pit reinstatement - Excavated material was placed back in the test pit in the approximate order in which it was excavated. The excavator will then be used to compact the material (bucket compaction and / or track or wheel rolling).
- Samples placed in an esky with cooling media for transport to the laboratory.

2.2 Sediment investigation

Investigation works included, in order of occurrence:

- Sampling locations were located using non-differential GPS.
- A piston corer was used to collect sediment cores. The acceptability of the core following collection and the criteria for acceptance of the core included:

  i. No obvious loss of surficial sediment.

  ii. The core must have entered the profile vertically.

  iii. There must be no gaps in the stratigraphy.

  iv. There must be no disturbance of the sediment stratigraphy.

  v. The core would ideally penetrate the entire thickness of unconsolidated material and reach refusal at rock, densely packed sand or clay.

d) The collected samples were placed on clean trays, logged, photographed and subsampled as appropriate. Rigorous decontamination procedures were followed to minimize sample contamination.

2.3 Reporting

Preparation of a report incorporating the results of the fieldwork and laboratory analysis and an assessment as to the suitability of the site for commercial/industrial land use (considered to be the most appropriate land use setting based on current/former activities) and potential impacts to environmental receptors.

Specific information includes:

- An account of the investigation methodology, of soil and sediment conditions including the accurate locations of the investigation points and detailed results of laboratory and field assessment.
- Identification of potentially significant contamination issues at the site (where applicable).
- The lateral and vertical extent of any fill material identified.
- The risk posed by the determined contaminant concentrations within soils and sediment against relevant human health and ecological investigation levels.
- A conceptual site model which clearly identifies any unresolved issues, potential contaminant pathways and data gaps which may require action.
- A section outlining the appropriate quality control measures adopted throughout the investigation and assessment against the relevant data quality objectives and indicators.
- Conclusions and recommendations.

3. Previous Site Investigations

Prior to 2014, Vales Point Power Station had undergone limited investigations, with works generally complete to meet compliance requirements with site Environmental Protection Licence (EPL). A summary of the investigations undertaken included:

- Groundwater monitoring including well installation undertaken by Aurecon in 2013 to assist with compliance to the Pollution Reduction Programme notice on the EPL
- Surface water monitoring as part of licensed discharged under the site EPL
- Investigations associated with the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008.
- A preliminary phase 1 contamination assessment by GHD in 2012 to assess contaminations issues associated with the site operations and recommendations relating to need for further investigations, remediation and/or management.

3.1 Project Symphony – Vales Point Power Station: *Stage 2 Environmental Site Assessment*, ERM 2014.

In 2014, ERM was commissioned by Delta Electricity to undertake a 'Preliminary and Stage 2 Environmental Site Assessment (ESA)' (ERM,2014a) at the Vales Point Power Station.

The objective of the ESA was to establish the baseline environmental conditions at the site as part of the proposed sale of the site.

To achieve the objective, ERM undertook a regime of soil, sediment, surface water and groundwater sample collection and environmental laboratory analysis of samples for contaminates of concern identified in a conceptual site model (CSM) developed during the Preliminary ESA. Following the completion of the site investigation and following receipt of laboratory analytical, the CSM was revised and analytical data was screened against adopted screening criteria.

The ERM (2014a) included sampling of sediment from Wyee Bay, Chain Valley Bay, Wyee Creek, Wyee Creek diversions and Mannering Bay. A summary of the key outcomes and results relevant to this investigation is provided below.

- Concentrations of cadmium, copper, selenium and PAH in certain sediment samples exceeded ERM's adopted screening criteria.
- The most significant of these exceedances was selenium which had a highest concentration of 26 mg/kg.
- It was reported that concentrations of selenium were potentially the result of inputs from the power stations and ash dam.
- It was noted that selenium concentrations had the potential to have significant adverse impacts on marine organisms in these waters and that uptake of selenium in these marine organism could represent a subsequent health risks to consumers of fish taken from the Bay.

Following a review of the Baseline Study reports prepared by ERM (2014a), Delta identified two areas which required additional investigation:

- Capping material used for ash ponds 1, 2 and 3.
- Sediments in Wyee Bay.

In relation to capping material used in ash ponds 1, 2 and 3, it was identified that the capping material was not investigated as part of ERM's investigations.

With regards to sediments in Wyee Bay, it was found that concentrations of cadmium, copper, selenium and Polycyclic Aromatic Hydrocarbons (PAH), in certain sediment samples, exceeded ERM's adopted screening values. The most significant exceedance appeared to be in relation to selenium, with a maximum concentration of 26 mg/kg in one sample compared the screening value of 2 mg/kg.

4. Data Quality Objectives

Jacobs has followed the Data Quality Objective (DQO) process presented in the National Environmental Protection Measure (NEPM 2013), which in turn references relevant guidelines published by the NSW EPA, Australia and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ) and the National Environmental Protection Council (NEPC).

The DQO process is recommended when site contamination data is being relied on to make a risk-based decision as part of a detailed site investigation, although a simplified planning process may be appropriate for straight forward screening assessments.

At the investigation level, DQOs are qualitative and quantitative statements, developed in the first six steps of the DQO process that define the purpose of the site assessment to be undertaken and the type, quantity and quality of data needed to inform decisions relating to the assessment of site contamination. In the seventh step of the DQO process, the SAQP is developed to generate data to meet the DQOs. Specific to this Data Gap Study, Delta has added an eighth step to the DQO Process; Risk Characterisation and evaluation of possible future works and obligations. This eighth step is included to assist in the planning process for immediate and subsequent actions in the short term and long term for environmental management under the existing site operations.

The SAQP should document the criteria that a sample design should satisfy, including when, where and how to collect samples or measurements and the relevant acceptance (performance) criteria.

The preferred approach for sampling is that it be conducted within the general framework of a human health and environmental risk assessment. This process is consistent with guidance published jointly by ANZECC and the National Medical Health Research Council (NHMRC, 1992) *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*, and guidance published by the NEPC for assessment of contaminated land.

The advantages in using the DQO approach for site assessment include:

- Data collection activities are designed to acquire the information needed to make, or assist in making decisions
- Resources are used effectively
- It provides a framework that is transparent and readily defensible

The investigation and sampling methodology presented in this investigation has been designed to identify and assess the presence, level and extent of potential contamination associated with pre-existing conditions at the Site.

The steps in the DQO process are outlined in the following **Sections 4.1** to **4.7**.

4.1 Step 1 - State the Problem

Table 4.1 summarises the problem, develops the conceptual site model and identifies the project team.

Table 4.1 : Step 1 - State the Problem

Project Drivers	Delta acquired the Vales Point Power Station from the NSW Government in December, 2015. As part of the transaction, the NSW Government agreed to indemnify Delta against certain losses suffered or incurred by Delta in connection with "Pre-Existing Contamination", "Legacy Contamination" and "Ash Dam Contamination". Delta also agreed to indemnify the NSW Government against certain losses suffered or incurred by the NSW Government in connection with "Operating Period Contamination." The terms of these indemnities are set out in the "Vales Point Closure and Put and Call Option Deed" (the Handback Deed). Jacobs understands that Delta has reviewed the Baseline Study reports prepared by ERM and has found two areas requiring additional investigation: **1) Capping material used for ash ponds 1, 2 and 3; and,** **2) Sediments in Wyee Bay.**	
Objectives	The overall goal for the site investigation was to collect sufficient data to identify and assess the presence, level and extent of potential contamination associated with pre-existing conditions at the Site, in accordance with the requirements of the "Vales Point Closure and Put and Call Option Deed" (the Handback Deed).	
Project team	Jacobs Project Director:	Matt Davies
	Jacobs Project Manager	Robert Gauthier
	Jacobs Fieldwork Lead	Kyle McLean
	Sub-contractors	
	Excavation Contractor:	Ken Coles
	Sediment Contractor:	Geochemical Assessments
	Analytical Laboratories:	Primary – ALS, Secondary - Envirolab
Conceptual Site Model	The conceptual model for the Vales Point site is provided within the ERM (January 2014), *Stage 2 ESA*.	

4.2 Step 2 - Identify the Decision Statement

The decisions that will address the problem as noted in **Step 1** are summarised in **Table 4.2**.

Table 4.2: Step 2 - Identify the decision

Schedule 9 Contamination Provisions	Decisions on the presence, extent and significance of Pre-Existing Contamination require additional Pre-Existing Contamination Studies, including more data relating to soil and sediment contamination distribution and behaviour.
Site history	The site history of the separate Areas of Environmental Concern (AEC's) at the Vales Point Power Station are discussed within the ERM (January 2014).
Media of Concern	Based on the previous investigations undertaken by ERM, the additional investigation targeted the shallow soils with the cap areas for pond 1, 2 and 3, and the near-surface sediment samples within Wyee Bay (alluvial sediments) typically to a depth <.5m depth.
Transport and Migration	The potential migration pathways at the Vales Point site include: • Overland runoff.

	• Surface water drainage lines. • Underground trenches/pipelines. • Regional groundwater flow. • Sediment suspension and dispersion. • Sediment pore water.
Contaminants of Concern	The contaminants of concern are listed for each study area under Section 10 and 11 of this report.
Receptors	The potential sensitive receptors of contaminants at the Site include: • Workers undertaking excavation works at the site. • Wyee Bay • Mannering Bay. • Flora and Fauna within the surrounding area.
Guideline criteria	The guideline criteria are listed in Section 14 – Site Assessment Criteria. Contamination at the site which would pose an unacceptable risk to current and future land use and on-site and off-site environmental and human health receptors as defined by the following guidelines: • National Environment Protection Council (NEPC) *National Environment Protection (Assessment of Site Contamination) Measure 1999* as revised 2013 (NEPM, 2013). • Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC Care), *Technical Report No. 10 – Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater,* September 2011 (Friebel and Nadebaum 2011) • Government of Western Australia Department of Environmental Regulation, *Assessment and management of contaminated sites, Contaminated sites guidelines*, December 2014 (WADOH, 2014). • Australia and New Zealand Environment and Conservation Council (2000) *Australian and New Zealand guidelines for fresh and marine water quality guidelines* (ANZECC 2000).
Decision statements	• Are there unidentified or unquantified contamination issues at the two site areas? • What is the nature and extent of soil and sediment contamination at the site areas, in relation to trigger levels? • What is the nature and extent of sediment movement at the Wyee Bay locations? Is it likely to cause contamination to migrate? • Is contamination present at the site areas that require remediation and/or management in order to bring the site areas to a condition suitable for its current land use? • Is contamination present at the two site areas that can trigger an Authority or Court Order?

4.3 Step 3 - Identify inputs to the decision

The main types of information needed to resolve the decision statements (as presented in Step 2) are provided in **Table 4.3.**

Table 4.3: Step 3 – Identify the inputs

Site condition	• Previous environmental assessments and investigation data for the site. • Use of field investigation techniques to identify previously undocumented areas of potential contamination

	(e.g. environmental sampling and analysis). • Visual observations of condition of soils and sediment. • Screening with a photo-ionisation detector (PID) to assess potential presence of volatile contaminants. • Visual observations of local flora and evidence of stress.
Target media	Observations, descriptions, photographs, logging and sample data to describe the type, extent and distribution of contaminated soils and groundwater at the locations tested at the site
Assessment criteria	Contamination investigation level criteria as outlined in **Step 2** and **Section 14**
Field work	A PID was used to screen soil samples in the field. The results of the PID screening assisted the field team to select which samples within the soil profile are most likely to be contaminated; and thus determine which samples should be analysed. Site observations recorded during the fieldwork was also used to determine which samples should be analysed.
Laboratory analytical method	Laboratory analytical methods will be undertaken in accordance with National Association of Testing Authorities (NATA) certification requirements, where possible.

4.4 Step 4 - Define the Boundaries of the Study

The geographic and temporal boundaries are identified together with any economic and practical constraints are described in **Table 4.4**.

Table 4.4: Step 4 - Define the boundaries of the study

Geographical limit	The study boundary of the ash pond investigation is illustrated in **Figure 1**. The sediment sample locations are presented in **Figure 2**. The geographical limits of Ponds 1, 2 and 3 are defined by the topographical features and assumed limits of ash deposition within each pond, and this is approximately illustrated by the blue outline surrounding each pond on **Figure 1**. The sediment sampling locations were defined by Delta as part of the study boundary locations for sediments, and were based on the approximate previous sample locations established by ERM (2014). Sediment sample locations are not within the property boundaries of the Vales Point Power Station land holdings.
Investigation limits	• The depth of potential soil contamination will be related to the maximum depth achievable by the excavation equipment, and/or when the extent of capping material is established. • Environmental media of concern: soils and sediment. • Qualitative measurements for soil vapour and odour.
Constraints	Access to some areas of capping samples was restricted due to overgrown or unstable areas and the presence of site infrastructure including utilities and services. Sediment sample locations had potential to be constrained by depths and weather conditions during sampling.

4.5 Step 5 - Develop a Decision Rule

This Step involves the defining the parameters of interest and integrating the information from **Steps 1** to **4** into statements that give a logical basis for choosing between alternative actions. The decision rules that were imposed on the investigations analytical results are detailed in **Table 4.5**.

Table 4.5: Step 5 – Develop a decision rule

Decision rule	• If the maximum observed contaminant concentration exceeds the adopted assessment criteria, then the results will trigger further investigation of the accuracy of the result. • The field and laboratory quality control procedures and limits that are discussed in Section 3 will be imposed on the analytical data. If the results are outside the specified limits, then the results will be reviewed to determine whether there is a significant impact on the acceptability of the results. Further investigation may be required if the results are not considered to be acceptable. • The results will be assessed against the Precision, Accuracy, Representativeness, Completeness and Comparability (PARCC) parameters to determine their acceptability for use in the investigation. A discussion of the PARCC parameters assessment is included in Section 3. • An assessment of the appropriate laboratory detection limits required to compare against the adopted assessment criteria (listed in Section 3) has been completed.

4.6 Step 6 - Specify Acceptable Limits on Decision Errors

The performance criteria for the sampling design is as follows:

- **Precision** - Precision refers to the degree of mutual agreement between duplicate measurements and provides an estimate of random error. Precision was assessed through the calculation of relative percentage differences (RPD's) between primary and duplicate (or triplicate samples) to provide an estimate of random error. The acceptable RPD limits are summarised in Section 12.
- **Accuracy** – Accuracy refers to the difference between a samples analytical result and the true value of the sample. Accuracy was assessed for the primary and secondary laboratories by evaluating reagent blank results, laboratory duplicates, and the percent recoveries of matrix spike samples, surrogate spikes and laboratory control samples. A description of these procedures is included in Section 12.
- **Representativeness** - Representativeness refers to the degree to which data accurately and precisely measures the conditions and characteristics of the parameter of interest. Representativeness was ensured by executing consistent sample collection procedures, storage, shipping, equipment decontamination and proper laboratory sample handling procedures (eg Chain of Custody procedures). Representativeness was be assessed by evaluating calibration standards, rinsate blank samples, method blank samples, duplicate samples and compliance with the sampling methodology (described in Section 10 and 11) and the field QA/QC procedures (described in Section 12).
- **Completeness** - Completeness refers to the amount of actual data collected throughout the sampling event compared to the amount expected in the SAQP scope.
- **Comparability** - Comparability refers to the confidence with which one data set can be compared to another. Comparability for the sampling results was achieved through the use of the Standard Operating Procedures, published guidance for sampling and investigation methodologies, comparison of QC sample results including duplicate samples, triplicate samples, reagent blank samples, matrix spike samples, surrogate spikes and laboratory control samples.
- **Sample design** - The sampling design strategy is based on a targeted inspection, field screening, logging and sampling approach. The extent of environmental sampling was based on field observations and judgement by field personnel with experience in contaminated site investigations and assessments.

4.7 Step 7 - Optimising the Design for Obtaining Data

Table 4.6 optimises the design implemented throughout the investigation.

Table 4.6: Step 7 - Optimise the design for obtaining data

Review of DQO outputs	The inputs and assessments of the previous investigations have allowed for the determination of an effective sampling and analysis design. The sampling scope and methodology have been outlined within **Section 9, 10** and **11.**
Consideration of SAQP results with Baseline results	The results of the assessment program to form the basis for the Additional Baseline Assessment Study, in accordance with the Handback agreement. Specifically, the optimization of the study outcomes will address the following data gaps: 1. Spatial Studies – The Delta review of the ERM Report identified areas where analytical data was lacking and more locations were required to define the extent and significance of pre-existing contamination at the capped pond areas; 2. Characterisation Studies – The Delta Review of the ERM report identified additional works to further characterize the sediment analytical results reported in the ERM Study. This includes completion of an additional round of sediment sample capture, analysis and reporting for compounds that were previously and also not previously tested during the ERM study, and testing samples at a lower detection level for selected analytes. If additional studies do not identify new areas of soil and sediment contamination, then no further soil and sediment contamination assessment works will be recommended.

4.8 Step 8 - Risk Characterisation and Evaluation of possible future steps and obligations

Step 8 sets out the platform to interrogate 'where to from here' after the data has been gathered, reduced and considered. Essentially, this Step is used to address the decision statements in Step 2, in comparison with the obligations and requirements under the Handback Deed, NSW EPA Triggers, and the ongoing operational use of the site as approved under the planning regime.

- **Risk Criteria** - Guideline criteria under Step 2 and CLM Act established a process to determine whether a site is contaminated and whether that contamination is significant enough to warrant regulation. The Act does not define the nature or level of contamination that requires regulation, as this is determined on a case-by-case basis. Risk Characterisation included: the type, nature, quantity and concentration of contaminants, how they manifest themselves, the characteristics they display, and the nature of their impacts in a particular medium. This includes the current use of the site, who might be exposed to the contaminants, and the exposure scenario.
- **Future Steps** - Exposure risk scenario considerations were applied to any soil and sediment contamination issues to determine if formalised management processes (remediation, removal, treatment) are required. Additional environmental monitoring and reporting are often needed to assess whether management actions are achieving goals that are protective of human health and the environment. The processes for reviewing monitoring data and ways in which the data will feed into decisions about the contamination and management strategy were articulated. The length of time for which monitoring is expected to continue and the regulatory reporting to authorities and management inputs were defined. Qualitative and if necessary Quantitative health risk assessment works are likely future steps to allow consideration of management options under the CLM Act, or, if necessary for groundwater pollution, under the POEO Act.

5. Site description

5.1 General

Vales Point power station is located on the NSW Central Coast and operated by Delta. The station currently comprises two 660 MW units, fired with black coal from surrounding mines. To cover any shortfall, limited supplies of black coal are sourced from outside the area and delivered to site by rail. The combustion of coal produces around 21% ash of which about 10% is furnace ash and 90% is fly ash. At present the power station is producing around 650,000 tonnes of ash per year.

5.2 Site history

The construction of Vales Point Power Station began in 1963. Initially commissioned as a 875 megawatt (MW) 4 unit station, known as A Station, in 1978 and additional two units of 660 MW each, known as Station B were added, making the combined capacity of 2195 Megawatts which at the time made it the largest power station in Australia. In 1989, Station A was decommissioned reducing the capacity to 1320 MW. Since 1989, the stations has undergone various phases of decommissioning with the Station A turbines removed in 1997 and boilers and buildings of Station A removed over 2011 to 2014. In December 2015 the NSW Government sold Vales Point Power Station to Sunset Power International who currently trade as Delta Electricity.

5.3 Site identification

The site is divided between two local government areas (LGA) with Wyee Bay, the entirety of Pond 2, the majority on Pond 1 and the western portion of Pond 3 located in LGA of the Lake Macquarie and the majority of Pond 3 and the eastern portion of Pond 1 located in the LGA of the Shire of Wyong.

The legal description of the portions of the site subject to the contamination investigations were:

- Lot 1 in Deposited Plan (DP) 1166358
- Lot 7497 in DP 1165634
- Lot 4 in DP 911564
- Lot 1 in DP 28898
- Lot 7 in DP 15257
- Lot 102 in DP 1196330
- Lot 29A in DP 755242
- Lot 22 in DP 755242
- Lot 7077 in DP 1056107
- Lot 1 in DP 1195160
- Lot 102 in DP 1170291
- Lot 12 in DP 1091396

- Lot 150 in DP 755266

Note, no lot or deposited plan identifiers exist for the Wyee Bay site and as such the Lot and DP numbers listed above are for land based portions (Ash Dam, Ponds 1,2 and 3) of the site that were subject to investigation.

5.4 Site zoning and land use

The current zoning of the site with respect to the Ash Dam storage ponds (Ponds 1,2 and 3) was Electricity Generating Works (SP2) under the Lake Macquarie Local Environmental Plan (LEP) (2014) and the Wyong Local Environmental Plan (2013). The current zoning of Wyee Bay was Natural Waterways (W1) under the Lake Macquarie LEP (2014).

5.5 Geology

A review of the Gosford – Lake Macquarie 1:100 000 Provisional Geology Sheet (Geological Survey of New South Wales 2003) indicates the Ash Dam storage Ponds 1,2 and 3 is comprised of 'man-made fill' (mf) overlaying the late Permian to early Triassic, Munmorah Conglomerate formation (Rnm). The Munmorah Conglomerate formation is made up of conglomerate, pebbly sandstone and grey to green shale. The geology underlying Wyee Bay is identified as mud, sandy mud (Qm) overlying the Munmorah Conglomerate formation.

5.6 Regional hydrogeology and hydrology

The site is located in the Lake Macquarie catchment. The primary regional hydrological feature within the catchment is Lake Macquarie. Local water bodies in the area and surrounding the site (Wyee Bay and Vales Point Ash Dam) include:

- Mannering Bay immediately to the north of Pond 1 and immediately south of Wyee Bay
- Vales Point Ash Dam reservoir immediately to the south and south of the Vales Point Ash Dam (part of the Ash Dam)
- Wyee Bay approximately 900 m north of Pond 1.
- Wyee Creek approximately 900 m north west of Pond 2
- Lake Munmorah Ash Dam reservoir and Lake Munmorah approximately 1300 m to the south east of Vales Point Ash Dam
- Chain Valley Bay approximately 2000 m to the north east of Pond 1 and Pond

With respect to surface flows within the Ash Dam, site drainage which includes an unnamed constructed creek intersecting Pond 2 and the Ash Dam overflow system, generally flows in a north and north east direction towards Mannering Bay which subsequently filters into Wyee Bay.

In terms of surface flows into Wyee Bay, Wyee Bay is noted to receive water from the Vales Point Ash Dam at the licenced discharge point 2 (LDP 2) into the outlet canal and via the overflow system via Mannering Bay and Wyee Creek after extreme weather events. Other sources include Coral Creek (north east of Wyee Creek) and storm water flows from surrounding land uses including residential and industrial.

Regional groundwater flow is expected to flow towards Lake Macquarie to the north / north east. Given the low lying nature of the area, a tidal influence of the surrounding waterbodies localised variates is expected. Based on site observations groundwater is expected to flow in a north / north west directions towards Mannering and Wyee Bay.

5.7 Acid sulfate soils

Acid sulfate soils (ASS) are the common name given to naturally occurring sediments and soils containing iron sulfides (principally iron sulfide or iron disulfide or their precursors). The exposure of the sulfide in these soils to oxygen by drainage or excavation leads to the generation of sulfuric acid. Areas of ASS can typically be found in low lying and flat locations which are often swampy or prone to flooding.

ASS Risk Maps from the CSIRO Australian Soil Resource Information System (ASRIS) database were reviewed to ascertain the probability of ASS being present across the proposal area. Based on this information, the site is assessed as having a high probability of ASS occurrence to the north of the site between Pond 1 and Mannering Bay and a low probability to extremely low probability of ASS presence surrounding the remainder of the site.

No suspected ASS was observed in the material excavated during the capping investigation because fill and natural soil did not exhibit the following characteristics (as defined in the ASS Management Advisory Committee 1998):

- Fill and soils did not exhibit a sulphurous smell.
- There was no evidence of shell.
- No jarositic horizons or substantial iron oxide mottling was observed.
- Fill and soils were not classified as unripe muds (soft, buttery, blue grey or dark greenish grey) or estuarine silty sands or sands (mid to dark grey) or bottom sediments of estuaries or tidal lakes (dark grey to black).

6. Conceptual Site Model

The following Conceptual Site Model (CSM) is based on the risk items detailed in the ERM (January 2014) Project Symphony- Vales Point Power Station: Stage 2 Environmental Assessment and potential risks associated with potential contaminants associated with fill material used for capping the deposited ash in Ponds 1, 2 and 3 of the Ash Dam which was not part of ERM's investigations.

Based on site information and an understanding of potential areas of interest, the following conceptual site model (CSM) was developed identifying source-pathway-receptor linkages which were to be tested during the investigation to assess the risk of contamination (if present) impacting upon human health and environmental receptors in the context of the current and future land uses.

The CSM for the site is presented as **Table 6.1**.

Table 6.1 : Conceptual site model

Source	Pathway	Receptor	ERM (2014) Risk Ranking	Jacobs Risk Ranking
Vales Point Ash Dam – Ponds 1,2,3 Imported capping material	Infiltration & leaching	Groundwater beneath the site	Not assessed as part of investigation	Low to moderate
	Dermal absorption	Human receptors (site workers) .	Not assessed as part of investigation.	Low to moderate
	Inhalation of asbestos fibres	Human receptors (site workers) .	Not assessed as part of investigation.	Moderate to high
	Ingestion (direct contact)	Human receptors (site workers)	Not assessed as part of investigation.	Low to moderate
	Inhalation of vapours (on-site)	Human receptors (on-site users / workers)	Not assessed as part of investigation.	Low
	Ecological Exposure	Terrestrial fauna	Not assessed as part of investigation.	Low
Sediments in Wyee Bay: Discharges from Vales Point Ash Dam and/or Vales Point Power Station Discharged from off-site 3rd party land uses,	Dermal absorption	Human receptors (recreation users)	Potential source pathway linkages discounted based on data collected.	Low
	Ingestion (direct contact)	Human receptors (recreation users)	Potential source pathway linkages for human health receptors discounted based on data collected.	Low
	Ecological Exposure	Aquatic fauna / benthic organisms	Potential source pathway linkages not able to be discounted on collected data.	Moderate to High
	Seafood consumption	Human receptors (fishers and consumers)	Potential source pathway linkages for human health receptors discounted based on data collected.	Low

7. Fieldwork

Jacobs undertook the contamination investigation works at the site between the following dates:

- 27 to 28 February 2017 (capping investigations in Ponds 1. 2 and 3).
- 3 March 2017 (sediment sampling in Wyee Bay).

The capping investigation and sediment sampling was undertaken in general accordance with the SAQP (Jacobs, February 2017). Departures from the SAQP and justification for the departures are detailed in **Table 7.1**. All works were supervised by an experienced Jacobs environmental scientist.

Table 7.1: Departures from the SAQP

SAQP	Departure	Justification
Sediment sampling: We will also collect one field duplicate, one triplicate sample and one rinsate samples for QA/QC purposes.	Two intra-lab duplicates were collected and analysed as part of the sediment investigation however no inter-lab triplicate or rinsate sample was collected.	A second intra-lab duplicated was collected from a second sample location and submitted for analysis. This was considered sufficient for QA/QC purposes and the assessment data usability and the representativeness of sampling techniques employed during sampling. Thorough cleaning and decontaminating of sampling equipment was undertaken between each sample location with Decon 90 solution and as such a rinsate sample was considered unnecessary.

8. Ash Dam Capping Investigation

8.1 Soil sampling program

The soil sampling program undertaken for the contamination investigation is detailed in **Table 8.1**.

Table 8.1: Sampling program

Contamination item	Investigation strategy	Investigation depth	Investigation type	Comments
Soil investigation	46 test pits	Vertical extent of capping material	General contamination	Pond 1 – 6 test pits (TP01 to TP06) Pond 2 – 14 test pits (TP07 to TP20) Pond 3 – 16 test pits (TP21 to TP46)

Sampling locations are presented on **Figure 1**.

8.2 Depth intervals of sampling

For the ash dam capping investigation, soil samples were collected as grab samples from excavated material taken from the capping material overlying deposited ash or at other discrete locations where there was evidence of potential contamination (odorous or discoloured soils, erroneous waste or fill) within the capping material. Sample depths varied based on the vertical extent of capping material encountered.

8.3 Method of sample collection

All soil samples at depth were collected as grab samples excavated from the capping material. Samples were transferred to sample containers by Jacobs field staff by hand using disposable nitrile gloves.

Care was taken to ensure that representative samples were obtained from the depth required and that the integrity was maintained, particularly when dealing with potentially volatile and semi-volatile components.

Where there was sufficient sample volume, part of the sample was placed in a re-sealable polyethylene bag for measurement of volatile soil gases using the closed headspace Photoionisation Detector (PID) method. The procedure for soil screening using a PID is summarised as follows:

1. A corresponding sample to that selected for possible laboratory analysis is placed into a "snap-lock" or re-sealable plastic bag until half filled, then sealed.
2. The bag is then hand warmed (or left in sunlight) for ten minutes with occasional agitation to maximise the release of Volatile Organic Compounds (VOC) into the bag.
3. Measure background VOC concentrations in ambient air prior to each reading in order to account for sensor drift. Record on a field data sheet along with date, location details, depth and method (HS for headspace method).
4. Use the point of the PID or a knife to punch a small hole in the top the plastic bag. Place the tip of the PID in the bag and monitor the readout and note the maximum and minimum concentration during the recording period.
5. Note the concentrations in field data sheets.

6. Repeat process outlined above for each sample (i.e., background reading followed by sample reading).
7. Check that samples with high concentrations of VOCs in headspace gases have been included for VOC testing at the laboratory.

The PID is a non-specific detector, as such, the instrument provides a measure of concentrations of total combustible and ionisable compounds reported as equivalents of a calibration span gas. Therefore, the data are used to compare Volatile Organic Compounds (VOC) concentrations between samples without an understanding of the specific compounds present.

VOC concentrations detected by PIDs are dependent on a number of factors including:

- The concentration and type of VOCs present in soil samples;
- Soil texture and compaction largely influence the potential for VOCs to be released from samples;
- Time since sample collection; and
- Temperature. These strongly affect the level of volatilisation of VOCs from soil and fill samples. In fact, temperature changes may result in differences of up to one order of magnitude in levels of VOCs detected using PIDs. Consequently, field screening for VOCs should be undertaken at the same time for all samples in order to produce representative results. Generally, it is recommended that samples be stored on ice and returned to base. Screening should be carried out after allowing samples to equilibrate to ambient air temperatures.

8.4 Sample containers, method of sample storage and handling

All soil samples for the soil investigation were placed in jars provided by the primary laboratory Australian Laboratory Service (ALS). All sample jars were fitted with Teflon lined lids. The jars were completely filled with soil, labelled with the date, unique sampling point identification and sampler information.

For asbestos identification additional sample was collected and placed into a laboratory supplied 500ml zip log bag. The zip lock bags were labelled with the date, unique sampling point identification and sampler information.

The soil jars and zip lock bags once filled with sample and sealed, were immediately placed in an esky/cool box in which a cooling medium had been added to keep the samples below a temperature of approximately 4 °C. At the end of the sampling program the samples in the cool box were transported to the laboratory. Custody seals were placed on the esky / cool box for delivery to the laboratory.

8.5 Decontamination procedures

Samples from test pits and surface samples were collected as grab samples from material at the centre of the excavator bucket or directly from the surface of the site using new disposable nitrile gloves, changed between sample locations. As such, decontamination measures were not required based on the sampling methods adopted for the soil investigation.

8.6 Sample logging and documentation

Experienced Jacobs field staff completed soil logs during the field investigation. The logs recorded the following data:

- Sample number
- Soil classification, colour, consistency or density, moisture content and obvious indications of contamination.
- Depth of excavation.
- Excavation refusal (if encountered)
- Method of excavation

In addition, the physical attributes of samples such as soil/fill characteristics, obvious signs of contamination such as discolouration and/or odour were noted on the logs.

All samples, including quality assurance (QA) samples, were transported to the primary laboratory under Chain of Custody (CoC) procedures and maintained in an ice-filled cool box. The CoC detailed the following information:

- Site identification.
- The sampler.
- Nature of the sample.
- Collection time and date.
- Analyses to be performed.
- Sample preservation method.

8.7 Reinstatement

Test pits location were reinstated with excavated material and compacted using the excavator bucket and tracks. Excavated material was reinstated into the excavations in the order in which they were excavated (i.e. deep materials to the base of the excavation and shallow materials to the surface).

8.8 Laboratory analysis

Soil samples were selected for analysis based generally on providing vertical and lateral coverage of the site and on visual observations. Samples were dispatched to a laboratory accredited by the National Association of Testing Authorities (NATA).

The analytical schedule for the capping investigation included submission of 46 primary and 3 blind / split QC samples for the following parameters:

- Metals and metalloids (arsenic, cadmium, chromium, copper, nickel, lead, mercury and zinc);
- pH and electrical conductivity (EC);
- Total Petroleum Hydrocarbons and Total Recoverable Hydrocarbons;
- Polycyclic Aromatic Hydrocarbons (PAHs), including benzo(a)pyrene;
- Benzene, Toluene, Ethylbenzene and Xylenes (BTEX);
- Polychlorinated Biphenyls (PCBs); and
- Asbestos (absence / presence)

In addition to the primary and duplicate/replicate QC samples, 1 laboratory trip blank and 1 trip spike sample was also submitted and analysed for BTEX as part of field QA/QC

Analysis of 10 samples was also undertaken for %clay, pH and Cation Exchange Capacity in order to assess contaminant concentrations against ecological investigation levels in accordance with the ASC NEPM.

Note that the asbestos analysis undertaken was to confirm the presence or absence of ACM and asbestos fibres only. If present, quantification of the concentration of ACM, fibrous asbestos and asbestos fibres was to be undertaken.

8.9 Analytical parameters and methods

Jacobs commissioned ALS as the primary laboratory and Envirolab as the secondary laboratory. MPL and Eurofins are NATA accredited for the testing undertaken.

Where appropriate, the soil samples were analysed in accordance with NEPC *National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013* (NEPC, 2013) guidelines using methods based on US Environment Protection Agency (US EPA) and American Public Health Association (APHA) approved analytical methods.

9. Sediments in Wyee Bay Investigation

9.1 Sediment sampling program

The sediment sampling program undertaken for the contamination investigation is detailed in **Table 9.1**.

Table 9.1: Sampling program

Contamination item	Investigation strategy	Investigation depth	Investigation type	Comments
Sediment investigation	8 sample locations	2m	General contamination	Two samples per sample location at two intervals for primary potential contaminants of concern. One sample per sample location at the upper interval for secondary contaminants of concern.

Sampling locations are presented on **Figure 2**.

9.2 Depth intervals of sampling

For the sediment investigation, 2 samples were collected per sample location generally at 0.5 metre intervals. For cores at Locations J2, J3, J5, J7 and J8 the 2 intervals were 0.0-0.5 m and 0.5 to 1.0 m. At location J6, closest to the Vales Point Power Station, the core was sampled in three intervals to a depth of 1.5 m (i.e. 0.0-0.5 m, 0.5 to 1.0 m and 1.0 to 1.5 m). The core at location J4 terminated with hard refusal at 0.4 m and was subsampled in a single interval (0.0-0.4 m). At location J1, the core met refusal at 0.8 m and was subsampled from 0.0 to 0.4 m and 0.4 to 0.8 m..

9.3 Method of sample collection

Sediment samples were collected using Geochemical Assessments custom built 5 m sampling vessel. A piston corer containing a 50.8 mm diameter stainless steel core barrel was used to collect core samples from unconsolidated sediments. Samples were collected by lowering and recovering the piston corer using aluminium rods. As the barrel was pushed into the sediment a partial vacuum was created to reduce core compaction and enable good core recovery. The collected core samples were extruded onto clean trays, accessed for acceptability, logged, photographed, subsampled and transferred directly to sample containers by Jacobs field staff using disposable nitrile gloves.

The acceptance criteria to determine each sediment cores' acceptability was as follows:

- No obvious loss of surficial sediment;
- The core must have entered the profile vertically;
- There must be no gaps in the stratigraphy;
- There must be no disturbance of the sediment stratigraphy
- The core would ideally penetrate the entire thickness of unconsolidated material and reach refusal at rock, densely packed sand or clay.

Care was taken to ensure that representative samples were obtained from required depths and that the integrity was maintained, particularly when dealing with potentially volatile and semi-volatile components.

9.4 Sample containers, method of sample storage and handling

All sediment samples for the soil investigation were placed in jars provided by the primary laboratory ALS. All sample jars were fitted with Teflon lined lids. The jars were completely filled with soil, labelled with the date, unique sampling point identification and sampler information.

The sediment jars, once filled with sample and sealed, were immediately placed in an esky/cool box in which a cooling medium had been added to keep the samples below a temperature of approximately 4 °C. At the end of the sampling program the samples in the cool box were transported to the laboratory. Custody seals were placed on the esky / cool box for delivery to the laboratory.

9.5 Decontamination procedures

Sediment samples were extracted from a decontaminated piston corer and taking care to keep the core intact placed on decontaminated trays prior to being placed into laboratory sample containers. The piston corer and sample trays were decontaminated using a phosphate free decontaminating liquid between each sampling depth. New disposable nitrile gloves were used between sample depths.

9.6 Sample logging and documentation

Experienced Jacobs field staff completed logs during the field investigation. The logs recorded the following data:

- Sample number and depth.
- Soil classification, colour, consistency or density, moisture content and obvious indications of contamination.
- Depth of coring
- Core refusal.
- Method of coring.

In addition, the physical attributes of samples such as sediment characteristics, obvious signs of contamination such as discolouration and/or odour were noted on the logs.

All samples, including quality assurance (QA) samples, were transported to the primary laboratory under Chain of Custody (CoC) procedures and maintained in an ice-filled cool box. The CoC detailed the following information:

- Site identification.
- The sampler.
- Nature of the sample.
- Collection time and date.
- Analyses to be performed.
- Sample preservation method.

9.7 Laboratory analysis

Sediment samples were selected for analysis based generally on providing vertical and lateral coverage of the site and on visual observations.

9.7.1 Primary chemical analysis

Sediment samples were selected for analysis based generally on providing vertical and lateral coverage of the site. Samples were dispatched to a laboratory accredited by the National Association of Testing Authorities (NATA).

The analytical schedule for the sediment investigation included submission of 16 primary and 2 blind / QC samples for the following parameters:

- PAH (ultra-low trace)
- Trace metals (arsenic, cadmium, cobalt, chromium, copper, nickel, lead, zinc, mercury and selenium);
- Total Organic Carbon (TOC)

As cobalt is a common contaminant in sediment, cobalt has been added to the analysis. TOC was also added in order to provide an indication of the presence of coal sediments and to provide a comparison of contaminant concentrations to screening values.

9.7.2 Secondary chemical analysis

A total of eight shallow sediment samples (existing sediment bed down to 0.5m below bed sediment surface) were collected and analysed for:

- 15 samples (13 primary + 2 QA/QC) for PFAS

9.7.3 Sediment particle size determination

In addition to chemical analysis subsamples were also subject to sediment particle size distribution analysis in which sediment subsamples were wet and dry sieved (<63 μm; 63-125 μm; 125-250 μm; 250-500 μm; 500-1,000 μm; 1,000-2,000 μm, 2,000-4,000 μm and >4,000 μm fractions) in Geochemical Assessments' dedicated grainsize laboratory. Laboratory QAQC included analysis of two duplicate samples.

9.7.4 Microscopic examination of coarse sediment fraction

The presence of coal particles in the sediment samples was semi-quantitatively assessed, by examination of the coarse fractions of sediment in which the >63 μm fraction of sediment was dried at 60°C and examined under a digital stereoscopic microscope (magnification 7.5x to 40x).

9.8 Analytical parameters and methods

Jacobs commissioned ALS as the primary laboratory for chemical analysis. ALS is a NATA accredited for the testing undertaken. Geochemical Assessment was commissioned to undertake particle size distribution analysis and microscopic examination of sediment subsamples.

Where appropriate, the soil samples were analysed in accordance with NEPC *National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended 2013* (NEPC, 2013) guidelines using methods based on US Environment Protection Agency (US EPA) and American Public Health Association (APHA) approved analytical methods.

10. Quality Control Plan

Field and laboratory QA/QC requirements compliant with NEPC (2013) requirements (where applicable) were undertaken as part of the field work program as outlined below.

10.1 Field QA/QC program

Field QA/QC for this project consisted of the collection of blind replicate, split replicate, trip blank and trip spike samples.

10.1.1 Environmental samples

Environmental samples or field samples were the representative soil and sediment samples collected for analysis to determine aspects of their chemical composition.

10.1.2 Blind replicate samples

Blind replicate samples were provided by the collection of two environmental samples from the same location. These samples were preserved, stored, transported, prepared and analysed in an identical manner. As a minimum, the results of analyses on the blind replicate sample pair were assessed by calculating the Relative Percentage Differences (RPDs) between the results. The RPD was calculated as the difference between the results divided by their mean value and expressed as a percentage. If the RPD exceeded the value adopted for any analytes, additional investigation would be required, or justification provided for not conducting additional investigation.

Blind replicate samples were generally collected at a rate of one duplicate for every 20 environmental samples in accordance with AS 4482.1-2005.

10.1.3 Split replicate samples

Split samples provided a check on the analytical proficiency of the laboratories. Split samples were provided by the collection of two environmental samples from the same location. These samples were preserved, stored and transported in an identical manner. The split samples were analysed by the secondary laboratory. As a minimum, the results of analyses on the split replicate sample pair were assessed by calculating the RPDs between the results. The RPD was calculated as the difference between the results divided by their mean value and expressed as a percentage. If the RPD exceeded the value adopted for any analytes, additional investigation would be required, or justification provided for not conducting additional investigation.

Split replicate samples were generally collected at a rate of one duplicate for every 20 environmental samples in accordance with AS 4482.1-2005.

10.1.4 Trip blanks

The trip blank consisted of laboratory-supplied clean sand (for soil samples). The purpose of trip blanks was to detect potential contamination during sample transport. These samples were kept within eskies during sampling activities and were not opened in the field. Trip blanks were analysed at the laboratory as regular samples for BTEX compounds only.

The trip blank was submitted with the batch of soil samples delivered to the respective primary laboratory. No trip blank was submitted with the batch of sediment samples submitted to the primary laboratory.

10.1.5 Laboratory-prepared trip spike

The laboratory-prepared trip spike consisted of sand (for soil samples) spiked with known concentrations of BTEX. The trip spike was submitted for BTEX analysis with the results compared with the known additions. Generally, samples were spiked with concentrations of 15, 15, 15 and 30 ppm of benzene, toluene, ethylbenzene and total xylenes respectively. The purpose of these samples was to monitor VOC losses during transit.

A trip spike was submitted with the batch of soil samples delivered to the respective primary laboratory. No trip spike was submitted with the batch of sediment samples submitted to the primary laboratory.

10.2 Laboratory QA/QC program

The reliability of test results from the analytical laboratories was monitored according to the QA/QC procedures used by the NATA accredited laboratory. The QA/QC programme employed by ALS (the primary laboratory) specified holding times, extraction dates, method descriptions, Chain of Custody (COC) requirements, analysis, LORs and acceptance criteria for the results. Laboratory QA/QC requirements undertaken by ALS and Eurofins are based on NEPM requirements and are outlined below (NEPC, 2013).

10.2.1 Laboratory duplicate samples

Laboratory duplicates provided data on analytical precision for each batch of samples.

Laboratory duplicates were performed at a rate of one duplicate for batches of 8-10 samples with an additional duplicate for each subsequent ten samples.

10.2.2 Laboratory control samples

Laboratory control samples consisted of a clean matrix (de-ionised water or clean sand) spiked with a known concentration of the analyte being measured. These samples monitored method recovery in clean samples and were used (where required) to evaluate matrix interference by comparison with matrix spikes.

10.2.3 Surrogates

For organic analyses, a surrogate was added at the extraction stage in order to verify method effectiveness. The surrogate was then analysed with the batch of samples and percentage recovery calculated.

10.2.4 Matrix spike

Matrix spikes consisted of samples spiked with a known concentration of the analyte being measured, in order to identify properties of the matrix that may hinder method effectiveness. Samples were spiked with concentrations equivalent to 5 to 10 times the LOR and percentage recovery calculated.

10.2.5 Method blanks

Method blanks (de-ionised water or clean sand) were carried through all stages of sample preparation and analysis at a rate of approximately 10%. Analyte concentrations in blanks should be less than the stated LOR. Reagent blanks were run if the method blank exceeded the LOR. The purpose of method blanks was to detect laboratory contamination.

10.3 Data Acceptance Criteria

The QA/QC Data will be assessed against the Data Acceptance Criteria (DAC) provided in **Table 10.1**.

Table 10.1 QA/QC Compliance Assessment

QA/QC Sample Type	Method of Assessment	Acceptable Range
Field QA/QC		
Blind Replicates and Split Samples	The assessment of split replicate is undertaken by calculating the Relative Percent Difference (RPD) of the replicate concentration compared with the original sample concentration. The RPD is defined as: $$\text{RPD} = 100 \times \frac{\lvert X1 - X2 \rvert}{\text{Average}}$$ Where: X1 and X2 are the concentration of the original and replicate samples.	The acceptable range depends upon the levels detected: • 0 – 100% RPD (When the average concentration is < 5 times the LOR) • 0 – 75% RPD (When the average concentration is 5 to 10 times the LOR) • 0 – 50% RPD (When the average concentration is > 10 times the LOR)
Blanks (Rinsate and Trip Blanks)	Each blank is analysed as per the original samples.	Analytical Result < LOR
Laboratory-prepared Trip Spike	The trip spike is analysed after returning from the field and the % recovery of the known spike is calculated.	70% - 130%
Laboratory QA/QC		
Laboratory Duplicates	Assessment as per Blind Replicates and Split Samples.	The acceptable range depends upon the levels detected: • 0 – 100% RPD (When the average concentration is < 4 times the LOR) • 0 – 50% RPD (When the average concentration is 4 to 10 times the LOR) • 0 – 30% RPD (When the average concentration is > 10 times the LOR)
Surrogates Matrix Spikes Laboratory Control Samples	Assessment is undertaken by determining the percent recovery of the known spike or addition to the sample. $$\% \text{ Recovery} = 100 \times \frac{C - A}{B}$$ Where: A = Concentration of analyte determined in the original sample; B = Added Concentration; C = Calculated Concentration.	• 70% - 130% (General Analytes) • 50% - 130% (Phenols) • 60% - 130% (OP Pesticides)
Method Blanks	Each blank is analysed as per the original samples.	Analytical Result < LOR

Note: LOR = Laboratory Level of Reporting (LOR) or the minimum detection limit for a particular analyte.

11. Quality Assurance and Quality Control

For the purpose of assessing the quality of data presented in this report, Jacobs collected and analysed various Quality Control (QC) samples (blind duplicate and blind triplicate sample), trip spike and trip blank samples, while the laboratory completed their own internal QC. The current section of this report is focused on the presentation of the results of these QC samples, adherence to Quality Assurance (QA) systems and discussion of deviations, if any from the DAC.

11.1 Field quality assurance

All samples were collected by experienced Jacobs environmental scientists, under established Jacobs protocols and in general accordance with the SAQP (January 2017). Adherence to Jacobs protocols by experienced field staff trained in sample collection and handling techniques ensures the quality and representativeness of the samples collected.

11.2 Field quality control

The following QC samples were collected for laboratory analysis:

- Blind duplicate (soil): DUP-A (duplicate of soil sample TP04).
- Blind duplicate (soil): DUP-B (duplicate of soil sample TP31)
- Blind duplicate (soil): DUP-C (duplicate of soil sample TP44)
- Split replicate (soil): TRIP-A (duplicate of soil sample TP04)
- Split replicate (soil): TRIP-B (duplicate of soil sample TP31).
- Split replicate (soil): TRIP-C (duplicate of soil sample TP44).
- Blind duplicate (sediment): J3_Dup 0.5 (duplicate of water sample J3-0.5).
- Blind duplicate (sediment): J5-0.5_Dup (duplicate of water sample J5-0.5).
- Trip Blank sample for soil investigation: TRIP BLANK (soil).
- Trip Spike sample for soil investigation: TRIP SPIKE (soil).

11.2.1 Blind duplicate samples

Five blind duplicate samples (three soil sample and two sediment samples) were analysed to assess the quality control during the field sampling program. This equates to 6.5% blind duplicate soil analysis and 12.5% blind duplicate sediment analysis. This blind duplicate analysis exceeds and therefore conforms to the Australian Standard (AS 4482.1 - 2005) *Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds* requirement of 5%.

The Relative Percentage Differences (RPDs) for all analytes for the blind duplicates taken during the soil and sediment sampling program confomed to the DAC with the exception of:

- Cadmium (59% RPD) between the primary sediment sample J5-0.5 (1.8 mg/kg) and the blind duplicate J5-0.5 DUP (3.3 mg/kg).

- Chrysene (51% RPD) between the primary sediment sample J5-0.5 (204 mg/kg) and the blind duplicate J5-0.5 DUP (344 mg/kg).

RPDs calculate the difference in magnitude between the two samples and do not take into account the minor differences in actual concentrations.

The cadmium RPD returned a slight exceedance of the guideline of 50% RPD. With respect to cadmium concentrations reported in samples J5-0.5 and J5-0.5 DUP, the concentrations reported values with minor exceedances of the SAC (SQG-low). For cadmium concentrations reported between the primary and duplicate, the difference in the concentration of cadmium is not understood. However based on sediment results from the sediment investigation as well as ERM's Stage 2 ESA, cadmium is known to be present in the sediment of Wyee Bay. Considering this the slight exceedance of the RPD for cadmium is not expected to affect the overall usability of the data set.

With respect to the chrysene RPD between J5-0.5 and J5-0.5 DUP, a slight exceedance of 51% above the guideline of 50% RPD was reported. Considering the RPD between the primary and duplicate samples only exceeded the RPD guideline by 1% and no SAC is available for Chrysene, the slight exceedance of the RPD for Chrysene is not expected to affect the overall usability of the data set.

RPD results for the soil and sediment investigations are presented in **Table C** and **Table D** respectively.

11.2.2 Split replicate samples

Three split replicate samples (three soil sample sample) were analysed to assess the quality control during the field sampling program. This equates to 4.8% split replicate soil and sediment analysis. This split replicate analysis is marginally less than the Australian Standard (AS 4482.1 - 2005) *Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds* requirement of 5%.

The RPDs for all analytes for the split replicates taken during the soil sampling program conformed to the DAC with the exception of:

- Electrical conductivity (53% RPD) between primary soil sample TP31 (29 µg/L) and split replicate TRIP B (50 µg/L).

- Lead (67% RPD) between primary soil sample TP31 (15 mg/L) and split replicate TRIP B (30 mg/L).

RPDs calculate the difference in magnitude between two samples and do not take into account the minor differences in actual concentrations.

The electrical conductivity RPD returned a slight exceedance of 53% above the guideline of 50%. Considering that electrical conductivity is not considered a contaminant but a parameter for the measuring the saline nature of water, soil and sediment and is often naturally variable, the slight exceedance of the RPD between TP31 and TRIP-A, is not expected to affect the overall usability of the data set.

With respect to lead concentrations reported in samples TP31 and TRIP-B, the concentrations reported represent values lower than the SAC. Considering lead concentrations in all samples are below the SAC and heavy metals are known to occur in the sediments, the RPD exceedance of 67% above the RPD guideline of 50% is not likely to affect the overall usability of the data set.

RPD results for the soil and sediment investigations are presented in **Table C** and **Table D** respectively.

11.2.3 Trip blanks

One trip blank was submitted with samples delivered to the laboratory for analysis. The trip blank sample was analysed for BTEX only. The concentrations of BTEX compounds in the trip blank were below the respective laboratory LOR demonstrating that no cross contamination occurred during sample handling and therefore conformed to the DAC.

Trip blank results are presented in **Table E**.

11.2.1 Trip spikes

One trip spike was submitted with samples delivered to the laboratory for analysis. The trip spike sample was analysed for BTEX only. The concentrations of BTEX compounds were within the acceptable ranges (70% - 130%) for the percentage recoveries as outlined in the DAC.

Trip spike results are presented in **Table F**.

11.3 Laboratory QA

All analysis was undertaken by a NATA accredited laboratory using NATA accredited analytical methods.

11.4 Laboratory QC

Laboratory QC data is presented in full in the laboratory certificates in **Appendix B.**

11.4.1 Laboratory duplicates

RPDs for all laboratory duplicates for soil and sediment samples conformed to the DAC.

11.4.2 Laboratory control samples

Recoveries for all laboratory control samples for soil and sediment conformed to the DAC.

11.4.3 Surrogates

Recoveries for all laboratory surrogate samples for soil and sediment conformed to the DAC.

11.4.4 Matrix spikes

Recoveries for all matrix spike control samples for soil and sediment conformed to the DAC.

11.4.5 Method blanks

All method blanks for soil and sediment reported analyte concentrations below the laboratory LOR and therefore conformed to the DAC.

11.4.6 Sample holding times

All soil and sediment samples were extracted and analysed within the specified holding times with the exception of TP01, TP05, TP08 and TP15 for pH. Although the samples were submitted within holding times and the samples were due for extraction (6 March 2017) within holding times, extraction did not occur until the 7 March 2017 (the day after). It is unknown why extractions occurred after the due date, however as the analysis occurred within the holding times following extraction and considering the samples were of soil, it is unlikely that exceedance of the holding times for pH in TP01, TP05, TP08 and TP15 will affect the useability of the results.

11.4.7 Sample condition

All samples were received by the analytical laboratories in correctly preserved and chilled containers with no reported breakages. The individual sample receipts are presented with the laboratory reports in **Appendix B.**

11.5 Data Quality Indicators (DQI)

11.5.1 Precision

For all field and laboratory duplicates, the nominated QA/QC acceptance criteria was generally met with the exception of recoveries in two analytes in one blind duplicate and two analytes in one split replicate sample which were outside the DAC. The variations are not considered to affect the precision of the data for reasons discussed in **Section 13.2** and therefore analytical precision provided confidence of limited variability and high reproducibility of the data set.

11.5.2 Accuracy

Laboratory accuracy was assessed by the analysis of laboratory control samples and method blanks and percent recoveries of matrix spikes and surrogates.

The assessment of the results of these laboratory control samples indicated the accuracy of the analytical results were acceptable and represent an accurate measure of the reported data.

11.5.3 Representativeness

Jacobs consider the samples collected from the site to be representative of the materials being targeted as part of this monitoring program. Jacobs staff ensured that samples collected were representative of the material observed in each groundwater well and surface water location.

11.5.4 Completeness

All samples were collected and analysed in accordance with the Jacobs work instructions. All other required QA/QC data, including both field and laboratory data, as outlined in the sampling and analysis program, is also provided and complete.

11.5.5 Comparability

Samples were collected by experienced Jacobs environmental scientists in accordance with the sampling and analysis program using appropriate Jacobs protocols and analysed in accordance with NATA accredited laboratory methods. The comparability of the data should be consistent as sampling protocols were employed throughout the duration of the fieldwork and analysis was undertaken by NATA registered laboratories using accredited analytical methods.

11.6 Assessment

Despite some minor non-conformances within the ratio of split replicate analysis to primary analysis, split replicate RPDs and holding times for one sample, it is concluded that laboratory data are of acceptable quality and are considered useable in making conclusions and recommendations regarding the site.

12. Site Assessment Criteria

To address potential health and environmental impacts within the site, Jacobs compared the analytical test results against a set of health and ecological based soil and sediment investigation levels to be referred to as Site Assessment Criteria (SAC) considered to be appropriate for the current land use and main potential receptors of concern (i.e. commercial/industrial guidelines, given the current and future land use and that any potential exposure times to possible contaminants during construction activities or disturbance have been considered as short term).

That is, the SAC have been set at levels that provide confidence that contaminant concentrations below the SAC will not adversely affect human health or terrestrial/aquatic ecosystems.

The SAC developed for the investigation was derived (where applicable) from the following guidelines:

- National Environment Protection Council (NEPC) *National Environment Protection (Assessment of Site Contamination) Measure 1999* as revised 2013 (NEPM, 2013).
- Australia and New Zealand Environment and Conservation Council (2000) *Australian and New Zealand guidelines for fresh and marine water quality guidelines* (ANZECC 2000).
- enHealth (June 2016) *Guidance Statements on Perfluorinated Chemicals – Interim Values* (enHealth, 2016)
- CRC Care (January 2017) *Technical Report No.38 – Assessment, management and remediation for PFOS and PFOA* (CRC Care, 2017)
- Australian Government Department of Health (3 April 2017) *Australian guidance values for assessing exposure to perfluorooctane sulfonate (PFOS) and perfluorooctane acid (PFOA)* (DoH, 2017)

12.1 Aesthetics

Aesthetics on sites relates to the presence of observable odours, discoloration and erroneous wastes materials in soil which could possibly indicate contamination. Such olfactory evidence can point to how receptors can be impacted by vapours on and migrating from the site. Odour threshold for organic substances can be exceeded in off-site settings (through groundwater transmission of hydrocarbons) and whilst may not represent a direct health risk, could possibly prompt civil action. Aesthetics was continually assessed during the investigation and reported on the field logs (where present).

12.2 Ecological Investigation Levels

Based on the current and future land use for commercial/industrial purposes and given potential exposure times to possible contaminants during disturbance have been considered to be short term, ecological investigation levels (EILs) were considered for a commercial/industrial land use as part of the capping investigation.

EILs were generated using the NEPC (2013) – Volume 2 – Table 1B (1-7). For the Project, it has been assessed that the EILs will apply to contaminants within the top 2 metres of soil at the surface / ground level which corresponds to the root zone and habitation zone of many species. Additionally, typical background concentrations were required to be calculated in order to derive selected EILs. To generate the EILs for the investigation, Jacobs have used the methodology as summarised below.

EILs were generated for heavy metals and naphthalene. 10 samples were selected to determine the 'background concentrations' for soils within the site. As the investigation was limited to site capping material, did not extend into natural soils and the depth of sample was typically less than 0.5 m bgl, an average of the 10 samples has been applied to calculate the EILs. The EILs were calculated (where appropriate) using the NEPC (2013) equation:

EIL = ABC[1] + ACL[2]

A summary of the adopted EILs is presented as **Table 12.1**

Table 12.1: Ecological Investigation Levels (expressed as mg/kg).

Substance	Ecological Investigation Levels
Arsenic	160 [1]
Cadmium	3 [2]
Chromium	430 [3]
Copper	190 [3]
Lead	1,800 [3]
Mercury	1 [2]
Nickel	100 [3]
Zinc	510 [3]
Naphthalene	370 [1]

[1] Generic EILs for aged arsenic/Naphthalene from **Table 1B (5).**
[2] EILs from NEPM 1999 (no EILs specified for contaminants in NEPM 2013).
[3] EILs derived from NEPM 2013 equation ABC+ACL.

12.3 Ecological screening levels

Ecological Screening Levels (ESLs) are focused on petroleum hydrocarbon and total recoverable hydrocarbon (TRH) compounds and are compared against actual site conditions (sub-surface materials and depth) to assess the potential risk to terrestrial ecosystems. For the purposes of calculating the ESLs, the generic soil type (i.e. three broad classes of sands, silts or clays) and land use need to be defined.

For the purposes of this assessment Jacobs, as a conservative measure and considering the variable nature of encountered material from clayey sands to sandy clays, have adopted sands as the most representative for the soil profile at the site.

Given the proposed land use of commercial/industrial, the corresponding land use and associated ESL were used to determine the assessment criteria.

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[1] ABC is ambient background concentration (the soil concentration in a specified locality that is the sum of the naturally occurring background level and the contaminant levels that have been introduced from diffuse or non-point sources by general anthropogenic activity).

[2] ACL is added contaminant limit (the added concentration (above the ABC) of a contaminant above which further appropriate investigation and valuation of the impact on ecological values is required).

Table 12.2 summarises the ESL criteria for soils that have been adopted.

Table 12.2: ESLs for Petroleum Based Fractions (expressed as mg/kg)

Compound / Fraction	Ecological Screening Level
F1 (C6 – C10)	215
F2 (>C10 – C16)	170
F3 (>C16 – C34)	1700
F4 (>C34 – C40)	3300
Benzene	75
Toluene	135
Ethylbenzene	165
Xylenes	180
Benzo(a)pyrene	0.7

[1] Table 1B(6) ESLs for TPH fractions F1 – F4, BTEX and Benzo(a)pyrene in soils - NEPM (2013).

12.4 Health investigation levels

To address potential health impacts at the site, Jacobs compared the analytical testing results for the capping investigation against a set of health based Soil Investigation Levels (SILs) appropriate for commercial/industrial land use in context of the current and future land use of the site and in consideration of the potential for contamination in soil to impact upon human receptors. The health based SILs have been derived from the NEPC (2013) guidelines. The adopted SILs are summarised in **Table 12.3**

Health Investigation Levels (HILs) have been developed for a broad range of metals and organic substances. The HILs are applicable for assessing human health risk via all relevant pathways of exposure. The HILs are generic to all soil types and apply generally to a depth of three metres below the surface for residential use.

Health Screening Levels (HSLs) have been developed for selected petroleum compounds and fractions and are applicable to assessing human health risk via the inhalation and direct contact pathways. The HSLs depend on specific soil physio-chemical properties, land use scenarios, and the characteristics of building structures. They apply to different soil types, and depths below surface to >4 metres. Further details on their use are provided in Friebel and Nadebaum (2011a, 2011b & 2011c).

The HSLs defined within the NEPC (2013) relate only to the volatile fractions of the petroleum hydrocarbons range i.e. BTEX, naphthalene and TRH C6 – C10, TRH C10 – C16.

Jacobs has adopted the lower value from the following criteria given that exposure times to contamination (if present) during any disturbance and/or construction activities are expected to be short term:

- NEPC (2013) Health Investigation Level recommended from exposure setting 'D' which includes premises such as shops, offices, factories and industrial sites (i.e. sites with minimal exposure opportunities).
- Friebel, E & Nadebaum, P (September 2011) Technical Report No.10, Health screening levels for petroleum hydrocarbons in soil and groundwater. Part 1: Technical development document - HSL-D Commercial / Industrial Criteria and Intrusive Maintenance Worker (Table A4).

Table 12.3 Soil Investigation Levels (expressed mg/kg)

Substance	Soil Investigation Levels			
Metals / Metalloids				
Arsenic (total)	3,000 [1]			
Cadmium	900 [1]			
Chromium (VI)	3,600 [1]			
Copper	240,000 [1]			
Lead	1,500 [1]			
Mercury (inorganic)	730[1]			
Nickel	6,000 [1]			
Zinc	400,000 [1]			
Polychlorinated Biphenyls (PCB)				
PCBs	7 [1]			
Polycyclic Aromatic Hydrocarbons (PAH)				
Naphthalene	NL [2]			
BaP TEQ	40 [1]			
Total PAH	4,000 [1]			
Asbestos				
Fibrous asbestos and asbestos fibres	No detectable asbestos			
Organochlorine Pesticides[1]				
DDT+DDE+DDD	3,600			
Aldrin and dieldrin	45			
Chlordane	530			
Endosulfan	2,000			
Endrin	100			
Heptachlor	50			
HCB	80			
Methoxychlor	2,500			
Mirex	100			
Toxaphene	160			
F1, F2 and BTEX *(based on sand soil type)* #				
Depth (m)	***0 – <1***	***1 – <2***	***2 – <4***	***>4***
F1 (C_6-C_{10} minus sum of BTEX concentrations)	260 [2]	370 [2]	630 [2]	NL [2]
F2 (>C_{10}-C_{16} minus napthalene)	NL [2]	NL [2]	NL [2]	NL [2]
Benzene	3 [2]	3 [2]	3 [2]	3 [2]
Toluene	99,000 [3]			
Ethylbenzene	NL	N	NL	NL

Substance	Soil Investigation Levels			
Xylenes	230[2]	81,000[3]		
Naphthalene	11,000[3]			

[1] NEPC (2013) Table 1 A(1) Health investigations levels for soil contaminants – Commercial / Industrial D.

[2] NEPC (2013) Table 1 A(3) Soil HSLs for vapour intrusion – commercial/industrial, 0 to <1, 1 - <2, 2 - <4, >4 m Sand.

[3] HSL-D Commercial / Industrial Criteria and Intrusive Maintenance Workers detailed within Table A4, Friebel, E & Nadebaum, P 2011, Soil Health screening levels for direct contact, Technical Report 10.

NL – NL indicates the HSL is not limiting (see Footnote 5, Table 1A(3)).

TEQ – Toxic Equivalent.

Soil Vapour as the primary Exposure Pathway to impact potential receptors.

12.5 Asbestos

NEPM (2013) provides health based screening levels for different forms of asbestos contamination in soil. To apply these screening levels, significant investigations, excavation and sample volumes are required to assess the volume of asbestos relative to soil. Jacobs have adopted a high level criterion to assess the presence / absence of asbestos in soil samples and to determine whether additional investigations are required to assess the risk to site users. The high level criterion adopted by Jacobs is no asbestos in any form present in soil samples or observed on surface soils and in excavated materials.

12.6 ANZECC Sediment Guidelines

The sediment screening values adopted for the project to assess the presence of contaminants in sediments have been adopted from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ (2000)). The purpose of these guidelines in relation to sediments in aquatic environments are:

- to identify sediments where contaminant concentrations are likely to result in adverse effects on sediment ecological health;
- to facilitate decisions about the potential remobilisation of contaminants into the water column and/or into aquatic food chains;
- to identify and enable protection of uncontaminated sediments.

The ANZECC/ARMCANZ (2000) guidelines provided sediment quality guideline (SQG) values (a Trigger/Screening value and a High value) for a range of common contaminants. These SQG values were intended for use in the screening level assessment and to assist decisions when accompanied by additional lines of evidence, e.g. bioavailability and ecotoxicology data.

The ANZECC/ARMCANZ (2000) SQG values are based on the effects of sediment contaminants on benthic organisms. The interim SQG trigger value (TV or ISQG-Low) is based on the lower 10th percentile of an effects database (ANZECC/ARMCANZ, 2000). The application of sediment guidelines involves a tiered, decision-tree approach in which the total concentrations of contaminants are compared to SQG values. The initial comparison is usually made with the ISQG-Low values. If the contaminant concentrations exceed the TVs, further investigations should be initiated to determine whether there is indeed an environmental risk associated with the exceedance. Importantly the TVs were not intended for use as a pass/fail basis, but as a means of identifying contaminants of potential concern (COPCs). A second upper guideline value, the ISQG-high, was also derived from the median of the effects data. This value has no particular significance except as being indicative of a value above which there is a high probability of toxicity to benthic organisms. In 2013 the interim ANZECC (2000) guidelines for sediment quality were finalised.

The sediment quality investigation included sampling of surficial sediment; and comparison of analytical results to the Agriculture and Resources Management Council of Australia and New Zealand (ARMCANZ) and the Australian and New Zealand Environment and Conservation Council (ANZECC) (2013) sediment quality guideline values (SQGV).

Table 12.4 summarised assessment criteria for sediments that have been adopted from the ANZECC (2013) SQGV:

Table 12.4 : Adopted SQG - Low and SQG – High guideline values

Contaminant	SQG – Low (mg/kg)	SQG – High (mg/kg)
Arsenic (As)	20	70
Cadmium (Cd)	1.5	10
Chromium (Cr)	80	370
Copper (Cu)	65	270
Lead (Pb)	50	220
Nickel (Ni)	21	52
Mercury	0.15	1
Zinc (Zn)	200	410
Total PAHs	10	50

12.7 Selenium in sediments

No ANZECC screening criteria exists for selenium in sediments. In the absence of ANZECC screening criteria for selenium in sediment and in order to provide a comparison between the results of this investigation with that undertaken by ERM in 2014, the marine sediment screening value of 2 mg/kg, from the British Columbia Ministry of Environment (2001) *Ambient Water Quality Guideline,* for selenium has been adopted for the purposes of the investigation. As the guideline value has no regulatory standing in NSW, this value has been adopted for the sole purpose of providing a guideline for assessment of potential ecological risk, bioaccumulation in the food chain and selenium direct toxicity, and considered protective of selenium bioaccumulation into the food chain and its direct toxicity.

12.8 PFAS in sediments

The NSW EPA have advised the there are no suitable values for sediments for either human health or ecological protection at the time of issuing this report. EPA have taken advice from The Office of Environment and Heritage (OEH), specifically that OEH do not support the use of soil values for sediments. Consideration of PFAS concentrations sediments is important and useful to understand if there may be closed pathways to humans or ecological receptors. Accordingly, in the absence of specific sediment criteria, all screening values should only be used in conjunction with other investigations (soil, water, sediment) to account for potential leaching, off-site transport and bioaccumulation/secondary exposure.

Jacobs has referenced the most recent draft guidance from EPA and OEH for soil, water and biota for comparison purposes:

- PFAS Screening Criteria (May 2017) *Prepared by Contaminants and Risk, Environment Protection Science Branch, OEH Science DOC17/239693*

13. Results

13.1 Ash pond capping investigation

13.1.1 Site stratigraphy

The sub-surface material encountered in the test pits (TP01 to TP46) generally consisted of sandy clays and clayey sand fill materials. Depths of fill materials ranged from a minimum depth of 0.05 m bgl (TP06, TP11, TP18) to a maximum depth of 2.0 m bgl at TP43. The average depth of fill material across each of the ponds was 0.145 m bgl in Pond 1, 0.227 m bgl in Pond 2 and 0.56 m bgl in Pond 3. These materials were underlain by deposited waste fly ash from the Ash dam. No natural material was encountered during the investigation.

A summary of the nature and depth of capping material encountered during the excavation of each test pit, along with details of each test pit location is detailed in **Table 13.1**. A photo log showing the depth to ash is presented as **Appendix B**

Table 13.1: Test pit capping material descriptions

Test pit ID	Pond	Coordinates		Capping material description
		eastings	northings	
TP01	Pond 1	363068	6329013	Depth – 0.15 m bgl (PID 2.6ppm) Surface description - Gravels and shale . ACM observed on surface approximately 20 metres north of TP01 Fill - 0.15 m bgl – Gravelly clay, cream and orange with red mottling, overlying ash.
TP02	Pond 1	362953	6329001	Depth – 0.2 m bgl m bgl (PID 2.7ppm) Surface description – Gravels and shell Fill - 0.0 to 0.2 m bgl – Sandy gravelly clay with rock, overlying ash.
TP03	Pond 1	362829	6328988	Depth – 0.10 m bgl (PID 2.6ppm) Surface description – Gravel with shale, cement / concrete and fabric Fill – 0.0 to 0.1 m bgl – Gravelly clayey sand some clays and tile piece present, overlying ash.
TP04	Pond 1	362728	6328977	Depth –0.12 m bgl (PID 2.4ppm) Surface description – Clayey silt with gravel and rock fragments Fill – 0.0 to 12 m bgl – Silty sandy clay with occasional gravel and pebbles, overlying ash.
TP05	Pond 1	362554	6328929	Depth – 0.25 m bgl (PID 2.2ppm) Surface description – Grass Fill – 0.0 to 0.25 m bgl – Gravelly sandy clay with shells and pieces of concrete, overly ash.
TP06	Pond 1	362399	6328877	Depth – 0.05 m bgl (PID 1.2ppm) Surface description – Grass Fill – 0 to 0.05 m bgl – Gravelly clayey sands and sandy clays with fine gravels and occasional coarse gravels present, overly ash.
TP07	Pond 2	362241	6328770	Depth – 0.15 m bgl (PID 1.7ppm) Surface description – Grass

Test pit ID	Pond	Coordinates		Capping material description
		eastings	northings	
				Fill -0 to 0.15 m bgl – Clayey sand with occasional medium coarse gravel. Clay/sandy clay from 0.05. Plastic pipe and wood observed. Ash from 0.15 m bgl.
TP08	Pond 2	362307	6328639	Depth – 0.5 m bgl (PID 2.2ppm) Surface description – Grass Fill –0.0 to 0.5 m bgl - Clayey sands with fine gravels and occasional ferruginous rock (pebbles), overlying ash.
TP09	Pond 2	362140	6328643	Depth – 0.1 m bgl (PID 2.8ppm) Surface description – Grass Fill –0.0 to 0.1 m bgl - Clayey sand with occasional fine gravel and rock fragments, overlying ash.
TP10	Pond 2	362117	6328713	Depth – 0.0 to 0.15 m bgl (PID 2.0ppm) Surface description – Grass Fill – Clay.0 to 0.15 m bgl - Clayey sand / sandy clay, overlying ash
TP11	Pond 2	361816	6328509	Depth – 0.05 m bgl (PID 3.6ppm) Surface description – Silty clay with sparse marsh Fill – 0.0 to 0.05 m bgl – Silty Clay with occasional fine to coarse gravel, overlying ash.
TP12	Pond 2	361974	6328472	Depth – 0.15 m bgl (PID 2.5ppm) Surface description – Gravelly sand Fill – 0.0 to 0.15 – Clayey sands with some variable gravels (becoming sandy clay at 0.10 m bgl), overly ash.
TP13	Pond 2	362131	6328493	Depth – 0.2 m bgl (PID 3.0ppm) Surface description – Gravelly clayey sand Fill – 0.0 to 0.1 m bgl – Clayey sand with gravels / 0.1 to 0.2 – Clay /clayey sand, overly ash.
TP14	Pond 2	362250	6328475	Depth – 0.6 m.bgl (PID 1.3ppm) Surface description – grass/plant Fill – 0.0 to 0.4 m bgl; – Gravelly clayey sand, medium coarse with gravels (variable) and decaying wood present / 0.4 to 0.6 m bgl – Sandy clay, firm, medium dense, overlying ash.
TP15	Pond 2	362139	6328318	Depth – 0.45 m bgl (PID 2.5ppm) Surface description – Grass / Marsh Fill – 0.0 to 0.45 m bgl Sandy clay with rare coarse gravels/pebble, overlying ash.
TP16	Pond 2	361979	6328358	Depth – 0.4 m bgl (PID 1.5ppm) Surface description – Silt Fill – 0.0 to 0.4 m bgl – Heterogeneous material (clay, sandy clay, clayey sands and rock), variable colours, overlying ash.
TP17	Pond 2	361829	6328340	Depth – 0.08 m bgl (1.7ppm) Surface description – Sand Fill – 0.0 to 0.08 – Clayey sand, brown with light pale brown, medium coarse, medium dense, overlying ash.

Test pit ID	Pond	Coordinates		Capping material description
		eastings	northings	
TP18	Pond 2	361676	6328336	Depth –0.05 m bgl (PID 2.2ppm) Surface description – Grass Fill – 0.0 to 0.05 m bgl – Clayey sand, brown, medium coarse, medium dense overlying ash.
TP19	Pond 2	361668	6328164	Depth – 0.15 m bgl (PID 2.1ppm) Surface description – Grass Fill – 0.0 to 0.15 m bgl – Clayey sand, brown, medium coarse, soft, loose, overlying ash.
TP20	Pond 2	361836	6328181	Depth – 0.15 m bgl (PID 1.8ppm) Surface description – Clayey sand Fill – 0.0 to 0.15 mbgl – Clayey sands to sandy clays, heterogeneous, brown, grey, white, orange, red, soft to firm with some weathered rock, overlying ash.
TP21	Pond 3	362414	6328673	Depth -0.5 m bgl (PID 3.2ppm) Surface conditions – Grass / sandy clay Fill – 0.0 to 0.1 m bgl – Sandy clay with some gravels (fine), brown, dense, soft. 0.1 to 0.5 m bgl – Clayey sands / sandy clays / clay, brown with some light grey, medium dense, soft with gravels, overlying ash.
TP22	Pond 3	362440	6328787	Depth –0.45 m bgl (PID 1.3ppm) Surface description – Rock, moss, grass Fill – 0.0 to 0.45 m bgl – Clayey gravelly sand to 0.1 m bgl with clay with rock and sandy clay, brown, dense from 0.1 m bgl, overlying ash.
TP23	Pond 3	362629	6328789	Depth – 0.45 m bgl (PID 1.4ppm) Surface description – Grass / swamp Fill – 0.0 to 0.1 m bgl – Clayey sands, brown with occasional gravel, soft. 0.1 to 0.45 m bgl – Clay, heterogeneous, grey, brown, red, orange, very dense, stiff with sandstone rubble, overlying ash.
TP24	Pond 3	362654	6328650	Depth –0.4 m bgl (PID 1.7ppm) Surface conditions – Grass Fill – Gravelly sandy clay / clayey gravels, brown, soft. Gravels variable, overlying ash.
TP25	Pond 3	362761	6328762	Depth – 0.5 m bgl (PID 0.8ppm) Surface conditions – Grass, clayey sands, bricks and rubble. Fill – 0.0 to 0.15 m bgl – Clayey sand with coarse gravel, brown, fine grained, soft. Some brick fragments 0.15 to 0.5 m bgl – Sandy clay, cream with some grey, light brown, yellow and orange, very dense, stiff, overlying ash.
TP26	Pond 3	362776	6328661	Depth - 0.5 m bgl (PID1.4ppm) Surface conditions – Grass Fill – 0.0 to 0.5 m bgl – Gravelly sandy clay, very dense, soft, fine grained, overlying ash.
TP27	Pond 3	362765	6328500	Depth – 0.6 m bgl (PID 1.4ppm) Surface conditions – Grass

Test pit ID	Pond	Coordinates		Capping material description
		eastings	northings	
				Fill – 0.0 to 0.2 m bgl – Gravelly clayey sands, brown, medium coarse. 0.2 to 0.6 m bgl – Gravelly clayey sands / sandy clay, brown, medium coarse, dense to very dense. Brick, wood and bitumen present. Ash from 0.6 m bgl.
TP28	Pond 3	362941	6328469	Depth – 0.55 m bgl (PID 1.7ppm) Surface conditions – Grass Fill – 0.0 to 0.55 m bgl - Clayey sand with occasional gravel and rock (50mm), light brown / grey with some pale lime green inclusions, hard. Occasional clay. Ash from 0.55 m bgl.
TP29	Pond 3	362195	6328643	Depth – 0.5 m bgl (PID 3.1ppm) Surface conditions – Grass Fill – 0.0 to 0.25 m bgl - Clayey sand with occasional gravel, brown, fine to medium coarse, soft. 0.25 to 0.5 m bgl – Clay, heterogeneous, brown, light brown, orange, light grey, red, dense to very dense, overlying ash.
TP30	Pond 3	362940	6328799	Depth – 0.9 m bgl (PID 4.2ppm) Surface conditions – Grass Fill – 0.0 to 0.1 m bgl - Sandy / silty clay, brown soft, medium dense, fine grained sands. 0.1 to 0.9 m bgl – Sandy clay with weathered sandstone, medium coarse to coarse, light brown, yellow, orange and red with occasional light grey and black (weathered rock), overlying ash.
TP31	Pond 3	363080	6328795	Depth – 0.4 m bgl (PID 4.7ppm) Surface conditions – Grass Fill – 0.0 to 0.25 m bgl – Clayey sand with occasional brick, brown, soft. 0.25 to 0.4 m bgl – Clayey sand, brown, soft with 70% weathered sandstone, medium coarse, overlying ash.
TP32	Pond 3	363088	6328643	Depth – 0.45 m bgl (PID 4.7ppm) Surface conditions – Grass Fill – 0.0 to 0.25 m bgl - Clayey sand to sandy clay, brown, medium dense to dense, soft. 0.25 to 0.45 m bgl – Weathered coal / coal ash, black, overlying ash.
TP33	Pond 3	363097	6328468	Depth – 0.5 m bgl (PID 2.7ppm) Surface conditions – Grass Fill – 0.0 to 0.1 m bgl – Clay sand, silt, brown, fine, very soft. 0.1 to 0.5 m bgl – Weathered sandstone / sandy clay, light grey with pale orange, medium coarse, soft to firm, overlying ash.
TP34	Pond 3	363108	6328327	Depth – 0.45 m bgl (PID 2.7ppm) Surface conditions – Grass Fill – 0.0 to 0.45 m bgl – Silty clay to clay with rare gravel, fine to medium coarse, dense to very dense, overlying ash.
TP35	Pond 3	363248	6328160	Depth – 0.45 m bgl (PID 2.4ppm) Surface conditions – Grass Fill – 0.0 to 0.45 m bgl - Sandy gravelly clay, brown, soft, medium dense.

Test pit ID	Pond	Coordinates		Capping material description
		eastings	northings	
				Concrete and brick present. Ash from 0.45 m bgl.
TP36	Pond 3	363248	6328346	Depth – 0.55 m bgl (PID 3.3ppm) Surface conditions – Grass Fill – 0.0 to 0.55 m bgl - Clay, heterogeneous, brown, grey, white, yellow, orange, red, medium dense to dense, soft. Crushed rock, gravel and sandy clay present, overlying ash.
TP37	Pond 3	363264	6328475	Depth – 0.6 m bgl (PID 2.9ppm) Surface conditions – Grass / gravelly silt Fill – 0.0 to 0.15 m bgl – Clayey sand, brown, fine to medium coarse with occasional gravel (fine). 0.15 to 0.6 m bgl – Sandy clay with some gravel and crushed weathered sandstone, soft to firm, dense. Decaying timber present. Ash from 0.6 m bgl.
TP38	Pond 3	363282	6328659	Depth – 0.3 m bgl (PID 4.1ppm) Surface conditions – Grass / moss / gravel Fill – 0.0 to 0.3 m bgl – Sandy clay with weathered sandstone, brown with orange and yellow bands (sandstone), medium dense to very dense, fine to medium coarse, overlying ash.
TP39	Pond 3	363275	6328805	Depth – 0.75 m bgl (PID 0.9ppm) Surface conditions – Grass Fill – 0.0 to 0.1 m bgl – Clayey sand to sandy clay, brown, medium dense to dense, soft, medium coarse. 0.1 to 0.75 m bgl – Sandy clay with highly weathered ferruginous rock (turned clay), brown and grey, very dense and soft, overlying ash.
TP40	Pond 3	363413	6328600	Depth – 0.65 m bgl (PID 1.5ppm) Surface conditions – Grass Fill – 0.0 to 0.1m bgl – Silty clay, dark grey, soft. 0.1 to 0.65 m bgl – Clay with fine gravels, heterogeneous, brown with light grey, red, orange, very dense to compact, soft, overlying ash.
TP41	Pond 3	363418	6328461	Depth – 0.6 m bgl (PID 2.7ppm) Surface conditions – Grass / plants Fill – 0.0 to 0.15 m bgl – Clayey sand, brown, very soft. 0.15 to 0.6 m bgl – Sandy clay with weathered sandstone and sands, light grey with cream and orange, red, medium coarse, dense, soft, overlying ash.
TP42	Pond 3	363391	6328337	Depth – 0.4 m bgl (PID 2.4ppm) Surface conditions – Rocky sand Fill – 0.0 to 0.4 m bgl – Heterogeneous (sandy clay with rock rumble (various) and sandstone), grey, red, orange, light brown, soft, dense, overlying ash.
TP43	Pond 3	363381	6328141	Depth – 2.0 m bgl (PID 1.9ppm) Surface conditions – Gravel Fill – 0.0 to 0.15 m bgl – Gravelly sand with crushed sandstone, medium coarse to coarse, soft. Gravel variable. 0.15 to 2.0 m bgl – Clay, heterogeneous, white, orange, red, light brown, very dense, soft to stiff. Brick present within 0.0 to 1.0 m bgl. Test pit terminated at

Test pit ID	Pond	Coordinates		Capping material description
		eastings	northings	
				2.0 m bgl.
TP44	Pond 3	363532	6328152	Depth – 0.45 m bgl (PID 2.1ppm) Surface condition– Grass Fill – 0.0 to 0.05 – Clayey sand, brown with gravels, coarse, soft, loose. 0.05 to 0.45 m bgl – Heterogeneous (clay, sandy clay, rock), brown, grey, light brown, orange, red, medium dense, soft, overly ash.
TP45	Pond 3	363583	6328328	Depth – 0.0 to 0.1 m bgl (PID 2.3ppm) Surface condition – Grass Fill – 0.0 to 0.1 m bgl – Sandy clay, white, cream, medium dense, soft. Gravels present. 0.1 to 0.65 m bgl – Clayey sand with crushed weathered rock rubble, brown, coarse grained, medium dense, soft, overlying ash.
TP46	Pond 3	363577	6328479	Depth – 0.5 m bgl (PID 2.4ppm) Surface condition - Grass Fill – 0.0 to 0.15 m bgl – Clayey sand, brown, fine grained, soft, loose to medium dense. 0.15 to 0.5 m bgl – Clay with sandy clay, rock and gravel, heterogeneous, brown, orange, red, light brown and light grey, dense to very dense, overlying ash.

13.1.2 Aesthetics

A number of aesthetic issues (i.e. presence of erroneous wastes) were observed during the capping investigation at the Ash Ponds, as detailed in **Table 13.2**.

Table 13.2 Aesthetic issues

Investigation Location	Depth (m bgl)	Aesthetic Issues
TP01	Surface	ACM located approximately 20m north of sample location
TP03	0.0 to 0.15	Tile fragment observed within fill material
TP05	0.0 to 0.1	Concrete observed within fill material
TP07	0.0 to 0.15	Plastic pipe and wood/timber observed in fill material
TP14	0.0 to 0.4	Decaying wood/timber observed in fill material
TP27	0.0 to 0.6	Brick, wood/timber and bitumen observed in fill material
TP32	0.25 to 0.45	Weathered coal / ash observed in fill material
TP35	0.0 to 0.45	Concrete and brick observed within fill material
TP37	0.15 to 0.6	Decaying wood/timber observed within fill material
TP43	0.15 to 2.0	Brick observed within fill material.

In addition to the aesthetic issues summarised in **Table 13.2**, heterogeneous material was noted in a number of test pits. These test pits included TP16, TP20, TP29, TP42, TP43, TP44 and TP46.

In conjunction with visual observations, observable odours and VOC concentrations were monitored at all locations during the investigation. No notable foreign odours were observed at any of the locations and VOC concentrations measured using a PID were low.

No evidence of stress was noted in the observed flora within the Ponds. Vegetation where present appeared in good health.

13.2 Soil analytical results

Soil analytical results from samples collected from boreholes (TP01 to TP46) are presented below and in **Table A.** Laboratory certificates of analysis are presented in **Appendix D.**

13.2.1 Heavy metals

Concentrations of all heavy metals in all soil samples analysed were below the adopted SAC.

13.2.2 Total recoverable hydrocarbons (TRH)

The concentrations of TRH compounds in all soil samples analysed were below the LOR and SAC.

13.2.3 Benzene Toluene Ethylbenzene Xylenes (BTEX)

The concentrations of BTEX compounds in all soil samples analysed were below the LOR and below the SAC.

13.2.4 Polycyclic aromatic hydrocarbons (PAH)

The concentrations of all PAH compounds in all soil samples were below the SAC.

13.2.5 Polychlorinated biphenyls (PCB)

The concentrations of PCB compounds in all soil samples analysed were below the LOR and the SAC.

13.2.6 Asbestos

A visual inspection of surface soils for potential ACM fragments was undertaken at each of the test pit locations (where possible) prior to the commencement of drilling. Where the surface of the site and surface soils were visible, no potential ACM fragments were observed at or in the near vicinity of the sampling locations.

Asbestos was not detected in any of the samples submitted for analysis.

13.2.7 pH

The lowest reported pH was 4.6 and the maximum reported pH was 8.5. Comparison with the discharge limits for discharge to waters prescribed in the site's environment protection license (EPL 761) for Point 18 (Overboarding of Ash Dam) indicated 26 samples which reported pH levels outside of the discharge limit of 6.5 to 9.0. Of the samples with pH levels outside of the discharge limits, all were below 6.5 units indicating soils were slightly to moderately acidic in nature.

13.2.8 Electrical conductivity

The lowest recorded electrical conductivity was 19 µs/cm and the highest reported electrical conductivity was 5450 µs/cm. Only one location, TP11 (5450 µs/cm) had a concentration indicative of saline soil. No SAC has been identified for electrical conductivity.

13.3 Sediment investigation

13.3.1 Stratigraphy and sediment particle size determinations

Sediments were cored and sampled at 8 sample locations as part of the sediment investigation. Sediment at location J1 was gravelly silty sand with bivalve shells. Sediments from locations J2 and J4 was typically gravelly silts which included bivalve shells (approximately 47.9% gravel. At locations J3 and J5 sediments were composed of sandy silts with a gravel component and at locations J6, J7 and J8 sediment cores presented cores composed of sandy silts with a maximum gravel component of 9.3%.

The maximum depth of sediments sampled was 1.5 m in 3 intervals (0.0 to 0.5 m, 0.5 to 1.0 m and 1.0 to 1.5 m) at J6. Sediment cores from locations J2, J3, J5, J7 and J8 were sample to a maximum depth of 1m at two intervals (0.0-0.5 m to 0.5 to 1.0 m). Refusal of the piston corer was encountered at two locations, J1 at 0.8 m and J4 at 0.4 m. From J1 samples were collected in two intervals (0.0 to 0.4 m and 0.4 to 0.8 m) and from J4 a sample was collected at one interval (0.0 to 0.4 m).

Results of the sediment particle size determinations are detailed in Geochemical Assessments', Vales Point Sediment Assessment Report provided in **Appendix A**. A photo log of sub-samples collected from the sediment sample locations is presented in **Appendix C.**

13.3.2 Microscopic examination of sediment coarse fractions

Microscopic examination undertaken by Geochemical Assessment of sediment samples indicated the coarse fraction of most samples was comprised of abundant quartz, quartzite and shells/shell fragments. Many samples also contained black, carbonaceous material, or aggregates of brown, organic material.

Coal was observed in sediments from locations J5, J6 and J8. The highest percentage of coal was observed in the surficial (0.0-0.5 m) samples at locations J5 (up to 40%) and J8 (~20%). Note that coal particles may be present in the fine (<63 µm) fraction of sediment, but this fraction was not examined as the particles would be too small to be positively identified.

Coke was observed only in sample, J7 0.5-1.0 and charcoal common in sample J7 0.0-0.5, but not observed in other samples.

Results of the sediment particle size determinations are detailed in Geochemical Assessments', Vales Point Sediment Assessment Report provided in **Appendix A**

13.3.3 Sediment analytical results

Sediment analytical results from samples collected from sample locations (J1 to J8) are presented below and in **Table B.** Laboratory certificates of analysis are presented in **Appendix B.**

13.3.4 PAH (ultra low trace)

The concentrations of all PAH (ultra low trace) compounds in all sediment samples were below the SAC.

13.3.5 Trace heavy metals (As, Cd, Co, Cr, Cu, Ni, Pb, Zn, Hg and Se)

The concentrations of all heavy metals in all sediment samples analysed were below the adopted SAC with the exception of:

- Cadmium concentrations detected in samples J5-0.5 (1.8 mg/kg), J5.0.5_DUP (3.3 mg/kg) and J8_0.8 (2.3 mg/kg) which exceeds the SQG-Low guideline value of 1.5 mg/kg)

- Mercury concentrations detected in sample J5-0.5 (0.16 mg/kg) and in sample J5.0.5_DUP (0.21 mg/kg) which exceeds the SQG-Low guideline value of 1.5 mg/kg)
- Selenium concentrations detected in twelve of sixteen samples which exceeds the adopted screening value of 2 mg/kg. Samples were:
  - J2-0.5 (3.3 mg/kg)
  - J2-1.0 (3.2 mg/kg)
  - J3-0.5 (5.3 mg/kg) / J3-DUP 0.5 (3.5 mg/kg)
  - J3-1.0 (3.2 mg/kg)
  - J5-0.5 (2.8 mg/kg) / J5-0.5 DUP (3.9 mg/kg)
  - J5-1.0 (2.9 mg/kg)
  - J6-0.5 (2.5 mg/kg)
  - J6-1.0 (2.6 mg/kg)
  - J6-1.5 (2.7 mg/kg)
  - J7-1.0 (2.7 mg/kg)
  - J8-0.8 (5.9 mg/kg)
  - J8-1.0 (2.7 mg/kg)

For samples where a primary and duplicate sample was taken, the sample with the highest recorded concentration of specific contaminants has been adopted for the consideration of chemical analysis results.

13.3.6 Total Organic Carbon (TOC)

The total organic carbon contents of sediment subsamples varied from 0.3% to 6.05%.

13.3.7 PFAS

The concentrations of PFAS compounds in all sediment samples analysed were below the laboratory limits of reporting.

13.4 Preliminary waste classification

To assess the waste classification of the material encountered during the investigations into the capping material in ponds 1, 2 and, a review of the laboratory analytical results was undertaken in accordance with the appropriate specific contaminant concentrations (SCC) detailed in the NSW EPA (November 2014) Waste Classification Guidelines – Part 1: Classification of wastes (NSW EPA, 2014). Based on the review, no exceedances of the CT1 criteria detailed in Table 1 of the NSW EPA (2014) guidelines for general solid waste.

14. Discussion

14.1 Capping material

Samples of soil / capping material collected from the test pits were analysed for contaminants of concern which may be present within the capping material used in Pond 1, Pond 2 and Pond 3 and which indicate general contamination.

No natural materials were observed within test pit locations. With the exception of TP43, ash was found underlying the capping layer at all locations. The depth and vertical extent of the capping layer varied vertically and laterally across the site with capping material generally less than the 0.5m in thickness. The shallowest ash was encountered was at 0.05 m bgl (TP06, TP11 and TP18) with the deepest at 0.9 m bgl (TP30).

The following aesthetic issues were identified at the site:

- ACM located on the surface approximately 20 north of sample location, TP01.
- Deleterious materials (brick, concrete, plastic pipe etc.) observed within TP03, TP05, TP07, TP14, TP27, TP32, TP35, TP37, TP43.
- Heterogeneous material observed within TP16, TP20, TP29, TP42, TP43, TP44 and TP46.

Soil samples from test pits were selected for analysis based generally on providing vertical and lateral coverage of potential contaminant extents within the capping material and on visual observations. All soil samples recorded contaminant concentrations below the adopted SAC.

Although the analytical results indicate a lack of pre-existing contamination, the presence of deleterious material as well as heterogeneous material within select test pits locations indicates that capping material at these locations was likely either not sourced from a VENM or ENM source or has experienced disturbance and / or undergone mixing with non VENM or ENM material during or following placement of capping material.

No asbestos was detected within samples analysed or observed within soil samples or within capping material and was not observed on the surface with the exception of one fragment located 20 m north of TP01.

Preliminary waste classification of the samples analysed indicated that the material sampled during the investigation would be classified as General Solid (non-putrescible)

Based on comparison with discharge limits (pH 6.5 to 9.0) identified in the site's EPL, 26 sample locations which had pH levels outside (below pH 6.5) the discharge limits. The pH levels at these locations indicated soils were slightly to moderately acidic in nature. Electrical conductivity results indicated soils for the majority were not saline in nature, with the exception of one location, TP11 which had an electrical conductivity of 5450 µS/cm. Based on the electrical conductivity concentrations and pH levels, risk of acid sulphate soils being present within the capping material is low.

14.2 Sediment

Sediment samples collected from the sediments cores taken from Wyee Bay were analysed to determine the presence and extent of contaminants of concern which may be present within sediments and to provide a better understanding of existing impacts which had previously identified by ERM in 2014 as part of a Stage 2 ESA.

Sediment samples from the sediment cores were selected for analysis based generally on providing vertical coverage of contamination and potential contaminant extents. The majority of sediment samples recorded contaminant concentrations below the adopted SAC with a small of samples reporting concentrations of contaminant compounds above the SAC for cadmium, mercury and selenium.

The results of laboratory analysis indicated elevated concentrations above the ANZECC SQG-low criteria for cadmium concentrations at J5 and J8 sample locations and mercury concentrations at J5 sample location. Selenium concentrations were reported above the adopted guideline value at six of the eight sample locations (J2, J3, J5, J6, J7 and J8).

The SQG-Low values which were exceeded for cadmium and mercury represent concentrations where the likelihood of adverse biological impacts are expected to be very low, whereas the SQG-High value represents concentrations where the likelihood of adverse impacts are more likely to occur. In consideration of this if exceedance of the SQG values occurs it does not necessarily indicate adverse biological impact are likely to occur but rather, indicates that additional investigations/assessment may be required to determine if there is indeed a risk to posed by the exceedance. With this in mind, based on the location of both sample locations, the exceedance of cadmium at J5 and J8 and the marginal exceedance of mercury at J5 are unlikely to indicate the impacts are the result of inputs from the Vales Point Power Station or Ash Dam.

Exceedances of the adopted selenium screening criteria were identified at the majority of sediment sample locations, the highest of which was at J5 with 3.9 mg/kg in J5-0.5 DUP. Based on the exceedances and comparisons to results reported by ERM in 2014, the concentrations of selenium may be the result of inputs from the operation of the power station as well as from the Ash Dam, urban run-off and other land uses. Comparison between the locations sampled as part of this investigation to the corresponding locations sampled as part of ERM (2014) indicates similar concentrations between the two. Although Mannering Creek and Mannering Bay, in which the highest concentrations were previously reported by ERM in 2014,were not sampled as part of this investigation, there is a potential that the selenium concentrations reported in sample locations in Wyee Bay, especially J6 to J8 can be attributed to inputs from the ash dam as both Mannering Creek and Mannering Bay feed into Wyee Bay.

An assessment of the distribution of coal in Wyee Bay was undertaken by Geochemical Assessments (2017) as part of the sediment investigation undertaken by Jacobs. The results of that assessment identified coal in the coarse fraction of sediment subsamples at locations J5, J6 and J8 situated west of the Vales Point Power Station.

TOC contents over 5% are uncommon in sediment samples. TOC contents (>6%) in subsamples J5 0.0-0.5 and J8 0.0-0.5 correlated with the highest observed contents of coal particles in sediment subsamples and suggests a significant contribution to TOC values from coal.

Concentrations of total PAH which were normalised to 1% TOC in sediments, did not exceed the SQG – Low values (4 mg/kg). The highest concentration of total PAHs was 3.19 mg/kg.

Comparison between PAH concentrations reported in the Jacobs additional baseline investigation (Jacobs 2017) with PAH concentrations reported in ERM (2014), indicate concentrations reported in Jacobs additional baseline investigation were typically lower than concentrations reported in ERM 2014. A correlation does appear to exist when concentrations of individual PAHs have been reported above the LOR in comparable sample locations. For example, comparisons between sample locations, J5 (Jacobs 2017) to VR_W_SS04 (ERM 2014) and J8 (Jacobs 2017) to VR_W_SS03 (ERM 2014) all report concentration above the LOR for Acenaphthylene, Naphthalene, Fluroene and Phenanthrene.

Although there were no exceedances of the applied SQG guideline (5 mg/kg) for Total PAHs in Jacobs (2017) additional baseline investigation and there were two exceedances of the ISQG-Low (4 mg/kg) for Total PAHs reported at two sample locations in ERM (2014), it should be noted the sediment quality guidelines applied in ERM (2014) are different to guidelines applied by Jacobs for the additional baseline investigation. Where ERM in 2014 applied the ANZECC (2000) interim sediment quality guidelines (ISQG), Jacobs has applied the ANZECC (2000) sediment quality guidelines (SQG) which were revised in Simpson SL, Batley GB and Chariton AA (2013), *Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines.* As such there is a limited comparability between the two data sets for PAHs when considering the adopted guideline values in ERM (2014) and Jacobs (2017)

Concentrations of total PAHs exceeded 0.25 mg/kg in sediment at locations J3 0.0-0.5 and J6 0.5 -1.0, however coal was not observed in the coarse fraction of sediment. This suggested that coal particles may be present in the fine fraction of sediment.

The percentage of coal estimated (semi-quantitatively) by microscopic examination (see **Appendix A – Vales Point Sediment Assessment (Geochemical Assessments, 2017) – Table 4** for details) refers to the proportion of coal in the coarse (>63 µm) fraction of sediment. The proportion of coal in whole sediment calculated assuming nil coal in the fine sediment fraction (J5 0.0-0.5, 3.8%; J6-0.5, 0.4%; J8 0.0-0.5, 2.6% and J8 0.5-1.0, 1.7%) would likely underestimate the actual percentage of coal in sediment.

The highest concentrations of PAHs in sediment were consistent with the presence of coal fragments in the coarse fraction of sediment subsamples. Concentrations of PAHs in surficial subsamples J5 0.0-0.5 and J8 0.0-0.5 (2.86 and 3.19 mg/kg, respectively) correlated with the highest observed content of coal particles in sediment and suggests a significant contribution by coal to these PAH concentrations.

Concentrations of inorganic contaminants are generally low in comparison to relevant sediment quality guideline values, and waterways in other urbanised and industrial areas in NSW.

14.3 Revised conceptual site model

Based on the results of the capping investigation undertaken in Ponds 1,2 and 3 of the Vales Point Ash Dam and sediment investigation in Wyee Bay the following revised CSM was developed identifying source-pathway-receptor linkages which were tested during the investigation to assess the risk of contamination (if present) impacting upon human health and environmental receptors in the context of the proposed road construction works and current status of the site (site occupied but not an operational service station).

The revised CSM for the site is presented as **Table 14.1.**

Table 14.1: Revised conceptual site model

Source	Pathway	Receptor	Contamination Investigation results	Jacobs Risk Ranking
Vales Point Ash Dam – Ponds 1,2,3 Imported capping material	Infiltration & leaching	Groundwater beneath the site	Groundwater was not encountered. Results were either below the SAC and/or the LOR. Infiltration of potential contaminants through underlying ash unlikely.	Very Low
	Dermal absorption	Terrestrial fauna Human receptors (site	Results were either below the SAC and/or the LOR. The concentrations of contaminant compounds detected in samples are unlikely to significantly impact upon terrestrial	Very Low

Source	Pathway	Receptor	Contamination Investigation results	Jacobs Risk Ranking
		workers)	fauna or on-site workers at the site.	
	Inhalation of asbestos fibres	Human receptors (site workers).	No asbestos fibres were identified in the samples analysed. Asbestos (as ACM) was not encountered within test pits during sampling or analysis. Known asbestos dump present in the south east of Pond 3. Area demarcated. If disturbed risks associated with exposure would increase.	Low
	Ingestion (direct contact)	Terrestrial fauna Human receptors (site workers)	Results for heavy metals, hydrocarbons (TRH, BTEX, PAH), OCP, PCBs were either below the SAC and/or the LOR with the exception of a localised exceedance of the zinc EIL reported within the surface fill at one location in the vicinity of the fertiliser storage sheds. The concentrations of contaminant compounds detected in samples are unlikely to significantly impact upon terrestrial fauna at the site.	Low
	Inhalation of vapours (on-site)	Human receptors (on-site users / workers)	Results were either below the SAC and/or the LOR. The concentrations of contaminant compounds detected in samples are unlikely to significantly impact upon terrestrial fauna or on-site workers at the site.	Very Low
Sediments in Wyee Bay - Discharges from Vales Point Ash Dam and/or Vales Point Power Stations	Dermal absorption	Human receptors (recreation users)	Results indicated heavy metal exceedance above the SAC of cadmium, mercury and selenium in sediments samples. The concentrations of contaminant compounds detected in samples are unlikely to represent a significant risk to human health via dermal contact.	Low
	Ingestion (direct contact)	Human receptors (recreation users)	Results indicated heavy metal exceedance above the SAC of cadmium, mercury and selenium in sediments samples. The concentrations of contaminant compounds detected in samples are unlikely to represent a significant risk to human health via ingestion.	Low
	Ecological Exposure	Aquatic fauna / benthic organisms	Results indicated heavy metal exceedance above the SAC of cadmium, mercury and selenium in sediments samples. The concentrations of contaminant compounds detected in samples have the potential to adversely impact marine organisms exposed to the sediments.	Moderate
	Seafood consumption	Human receptors (fishers and consumers)	Results indicated heavy metal exceedance above the SAC of cadmium, mercury and selenium in sediments samples. Considering the potential of impacts to marine organisms which may come into contact with sediments, there is a potential for fish to have elevated concentrations of contaminants such as selenium. Subsequently consumption of fish taken from Wyee Bay and surrounding water bodies may increase the risk of human health impacts.	Moderate

15. Conclusions and Recommendations

Jacobs have undertaken the baseline contamination assessment of the capping material in Pond 1, 2 and 3 of the Vales Point Ash Dam and sediments in Wyee Bay surrounding the Vales Point Power Stations located in Mannering Park, NSW. Conclusions and recommendations following the investigation are detailed in the following sub-sections.

15.1 Conclusions

15.1.1 Capping Investigation

Based the results of the laboratory analysis, contamination above the SAC was not identified within Pond 1, 2 and 3. Thus, pre-existing or legacy contamination within the sampled capping material was not present within the pond capping material. Risks associated with current and future uses and risks to site users in the form of constructions workers and to ecological receptors is considered low.

In consideration of the presence of heterogeneous and deleterious material within capping materials at select locations in each of the ponds, as well as the uncertainties around the source of capping materials and that capping of ponds commenced in 1990's prior to the introduction of the VENM framework, the capping material is not considered suitable for classification as VENM or ENM. Although the capping material cannot be classified as VENM or ENM, preliminary waste classification indicates the material is suitable for classification as general solid waste (non-putrescible).

15.1.2 Sediment Investigation

Based on the field and analytical result, Jacobs concludes the following:

- Sediment textures vary greatly in the southern section of Lake Macquarie from muds, to gravels composed of shells and lithic fragments.
- Coal is present in sediment to the west and northwest of Vales Point Power Station. The distribution of coal in sediment west and northwest of the Vales Point Power Station is not clearly defined by the current sampling locations.
- The highest concentrations of PAHs and higher TOC content in sediment were consistent with coal particles observed in sediment.
- Concentrations of total, normalised PAHs in sediment did not exceed relevant sediment quality guideline values.
- Trace metal concentrations in sediment are generally below the SAC with the exception of mercury and cadmium which marginally exceeded the relevant sediment quality guidelines values at two locations (J5 and J8).
- PFAS compounds were reported as below the limits of reporting at all eight sediment sample locations.

Elevated selenium concentrations above the adopted guideline value were reported in samples from six of the eight sample locations. Based on the results from Jacobs investigations and comparison to ERM (2014) there is evidence to suggest inputs from the ash dam and operation of the power station in the form of licenced discharges and run-off, along with other land uses in the area such as mines and industry may have contributed to the selenium concentrations in sediments within Wyee Bay.

Comparisons between the results reported in ERM 2014 to results from this investigation indicate similar concentrations between the two. Furthermore there does not appear to have been an increase in concentrations since ERM completed their investigation in 2014. The selenium concentrations reported in the sediments of Wyee Bay have potential to have adverse impacts on marine organisms within Wyee Bay and surrounding water bodies. Subsequently there is an additional health risk to consumers of fish taken from the bay, as elevated concentrations may be present within the fish.

16. References

Australian Government Department of Health (3 April 2017) *Australian guidance values for assessing exposure to perfluorooctane sulfonbate (PFOS) and perfluorooctane acid (PFOA)*

Australia and New Zealand Environment and Conservation Council (2000) *Australian and New Zealand guidelines for fresh and marine water quality guidelines: Volume 1*

Australian Standard AS 4482.1-2005 Guide to the investigation and sampling of sites with potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds (AS 4482.1-2005).

Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC Care), *Technical Report No. 10 – Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater,* September 2011 (Friebel and Nadebaum 2011)

CRC Care (January 2017) *Technical Report No.38 – Assessment, management and remediation for PFOS and PFOA*

CSIRO Australia (2014), *Australian Soil Resource Information System ASRIS*, accessed 17 April 2017, http://www.asris.csiro.au/mapping/viewer.htm

enHealth (2016) *Guidance Statements on Pefluorinated Chemicals – Interim Values*

ERM (2014a) Project Symphony – Vales Point Power Station: *Stage 2 Environmental Site Assessment*, July 2014.

Gosford – Lake Macquarie 1:100 000 Provisional Geology Sheet (Geological Survey of New South Wales 2003)

Jacobs (2017) *Sampling, Analysis and Quality Plan (SAQP): Vales Point Power Station – Additional Baseline*

Lake Macquarie City Council (2014) Lake Macquarie Local Environmental Plan, Lake Macquarie City Council, NSW.

National Environmental Protection Council, National Environment Protection Measure (Assessment of Site Contamination) Measure 1999 (as amended 2013) (NEPC, 2013).

PFAS Screening Criteria (May 2017) *Prepared by Contaminants and Risk, Environment Protection Science Branch, OEH Science DOC17/239693*

Simpson SL, Batley GB and Chariton AA (2013) Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO Land and Water Science Report 08/07. CSIRO Land and Water

Western Australia Department of Health – Department of Environment and Conservation (2009), Guidelines *for the Assessment, Remediation and management of Asbestos-Contaminated Sites in Western Australia* (WA DOH, 2009)

Wyong Shire Council (2013) Wyong Local Environmental Plan, Wyong Shire Council, NSW.

Limitations

The sole purpose of this report and the associated services performed by Jacobs is to assess the condition of the site (with respect to soil and groundwater contamination) in accordance with the scope of services set out in the contract between Jacobs and Delta Electricity (the Client). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any), from observations made during the investigations and data from analytical laboratories. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs' Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

DOCUMENT 6e

Vales Point Power Station

Consolidated PFAS Report – Part 1

Jacobs

14 December 2018

JACOBS

Vales Point Power Station

Delta Electricity

Consolidated PFAS Report

Revision 4

14 December 2018

Important note about your report

The sole purpose of this report is to present the findings of the consolidated PFAS report for the Vales Point Power Station prepared by Jacobs for Delta Electricity (the Client). This report was produced in accordance with and is limited to the scope of services set out in the contract between Jacobs and the Client. The scope of services, as described in this report, was developed with the Client.

The scope of services was not intended to provide a definitive or quantitative investigation of the environmental impacts, performance and compliance of the project. Environmental conditions may exist within the project area that is beyond the scope of our investigations and this report.

The findings presented in this report are professional opinions based solely upon information and data provided or made available by the Client or otherwise available in the public domain including:

- Visual observations made during a site inspection
- Documentation made available by the Client.

Jacobs has relied upon and presumed that these data are accurate and representative of the environmental conditions within and adjacent to the site. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete, or if site conditions change then it is possible that our conclusions as expressed in this report may change.

Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession and by reference to applicable auditing procedures and practice at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report.

Except as specifically stated in this report, Jacobs makes no statement or representation of any kind concerning the suitability of the project area for any purpose or the permissibility of any use. Use of the project area for any purpose may require planning and other approvals and, in some cases, NSW EPA and accredited site auditor approvals. Jacobs 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 investigations and/or works.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of and for the exclusive use of the Client, and is subject to and issued in accordance with the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for or in respect of any use of or reliance upon this report by any third party.

3. PFAS

The following provides a discussion on the properties of PFAS and their fate and transport within the environment. This information has been sourced from the HEPA (2018) *National Environmental Management Plan* (PFAS NEMP, 2018).

PFAS is an abbreviation for per-and polyfluoroalkyl substances. These are manufactured chemicals that have been used for more than 50 years. PFAS make products non-stick, water repellent, and fire, weather and stain resistant.

PFAS have been used in a range of consumer products, such as carpets, clothes and paper, and have also been used in firefighting foams, pesticides and stain repellents. PFAS resist physical, chemical and biological degradation, and are very stable. This stability creates a problem: PFAS last for a long time. There are many types of PFAS, with the best known being perfluorooctane sulfonate (PFOS), perfluorooctanoic acid (PFOA) and perfluorohexane sulfonate (PFHxS).

Molecules of PFAS are made up of a chain of carbon atoms flanked by fluorine atoms, with a hydrophilic group at their head. Their high solubility in water means that PFAS readily leach from soil to groundwater, where they can move long distances. When the groundwater reaches the surface, the PFAS will enter creeks, rivers and lakes. There it can become part of the food chain, being transferred from organism to organism.

In Australia, PFAS have been used for a long time in both consumer products and industrial applications and there are now PFAS contaminated sites resulting from these various uses, including from the use of firefighting foams that contained PFAS. Over time, the chemicals have worked their way through the soil to contaminate surface and ground water, and have migrated into adjoining land areas. PFAS are also present in our landfills and wastewater treatment facilities and more broadly in the environment.

Contents

Figures

Appendix A – Jacobs (2018a) PFAS Groundwater Monitoring

Appendix B – Jacobs (2018b) Additional PFAS Investigation

- PFAS has been detected in groundwater samples collected from the selected areas as part of previous investigations. Six samples reported PFOS concentrations above the respective guidelines (protection of aquatic ecosystems) and one sample reported PFOS+PFHxS concentrations above recreational water guidelines. Groundwater samples reporting concentrations above guideline values were collected from A Station, Transformer Area and the water treatment plant (southern side of cooling water canal) and the sewage treatment plant and the chlorine plant (northern side of cooling water canal). Groundwater monitoring undertaken by Jacobs in 2018 was in accordance with current nationally endorsed guidelines. With the exception of one monitoring well location (which reported PFAS concentrations above recreational water guidelines), all samples reported PFAS concentrations below (protection of aquatic ecosystem, drinking water and recreational water). It is unlikely that PFAS concentrations in groundwater at the site (where sampled), with the exception of one location (VC-MW02) is representing a risk to current receptors. The concentrations of PFAS detected in VC-MW02 (above recreational water guidelines) is unlikely to represent a significant exposure risk considering the low concentrations detected in adjacent wells (elevated PFAS concentrations in groundwater is not widespread) and low to no detection of PFAS in receiving surface waters.

- Previous PFAS sampling and analytical results may have been affected by false/positives associated with sample methods, sample containers, decontamination procedures and analytical methods. With the exception of PFAS concentrations detected in VS-MW02, all other monitoring locations (where analytical information was available) returned reduced concentrations of PFAS compounds between the groundwater sampling undertaken by ERM in 2014/2015 and Jacobs in 2018. The reduction of PFAS concentrations could be associated with false/positive results associated with the sampling programs undertaken in 2014 and 2015. These false/positives are likely to indicate that earlier concentrations of PFAS reported in groundwater wells and other media are likely to be conservative and represent increased concentrations. With respect to groundwater, more reliance should be placed on the PFAS concentrations detected in wells monitored as part of the Jacobs (2018) monitoring event.

- Additional PFAS investigations undertaken at the site in November 2018 indicated that groundwater between the operational area of the site and Mannering Park is not impacted by PFAS; surface water and sediments within the ash dam (Mannering Lake) do not represent a secondary source of PFAS contamination and surrounding waterways (Wyee Creek, Mannering Creek and Mannering Bay) are not impacted by PFAS associated with discharges from the ash dam.

Based on the conclusions detailed above, Jacobs consider that where sampled, PFAS from the site does not pose a significant risk to current receptors on and/or off-site. Considering the likely presence of a secondary source of PFAS in soils below the operational areas of the site and some minor elevated concentrations of PFAS detected in groundwater, Jacobs do not recommend additional PFAS soil investigations at the site (subject to no change in the site use). To monitor the PFAS detected in groundwater, Jacobs recommend the following:

- It is likely that some secondary sources of PFAS (PFAS in soil) are present below the operational areas of the power station. These secondary sources (currently) are unlikely to represent a significant source to groundwater contamination or a risk to groundwater receptors or receiving environments. However, whilst the secondary source remains on-site, the potential remains for this secondary source to impact groundwater especially in the event that site conditions change (namely demolition and removal of hardstand areas which could increase direct infiltration of water into sub-soils). Annual monitoring from

- ERM (June 2015) *Project Symphony – Vales Pont Power Station. Updated Groundwater Quality Assessment* (ERM, 2015)
- Aurecon (July 2015) *Vales Point Ash Dam Management Plan 2015 – 2020* (Aurecon, 2015)
- Umwelt (October 2015) *Vales Point Power Station Ash Dam Groundwater Stage 3 Investigation Report* (Umwelt, 2015b)
- Delta Electricity (January 2017) *Vales Point Land Management Plan 2017 – 2021* (Delta, 2017a)
- Jacobs (July 2017) *Vales Point Additional Baseline Contamination Assessment* (Jacobs, 2017)
- Delta Electricity (October 2017) *PFAS Investigations at Vales Point Power Station* (Delta, 2017b)
- Robert Carr and Associates (2017-2018) *Environmental Report – Analysis of Surface and Lake Water, Vales Point Power Station* (RCA, 2017-2018)
- HEPA (January 2018) *PFAS National Environmental Management Plan* (PFAS NEMP, 2018)
- Jacobs (March 2018) *PFAS Groundwater Monitoring – Vales Point Power Station* (Jacobs, 2018a)
- Jacobs (December 2018) *Additional PFAS Investigation – Vales Point Power Station* (Jacobs, 2018b)

- Ecologically significant areas (Mannering Bay wetlands, Wyee Creek wetlands)
- Recreational areas (Tom Barney Oval, Chain Valley Bay Reserve and Lake Macquarie).

4.3 Hydrology

The information from the ERM (2014a) report indicated the following with respect to the hydrology of the site.

The site is located within the Lake Macquarie catchment area with Lake Macquarie identified as the main hydrological feature. Local waterways and waterbodies were summarized as follows:

- Chain Valley Bay located immediately to the north east of the site
- Mannering Bay and Wyee Bay located immediately to the west and north of the site respectively
- Vales Point cooling water canal, which enters the site at Chain Valley Bay inlet and exits the site at Wyee Bay outlet
- Chain Valley Bay retention basin, located approximately 300m north east of the operational area and forms part of the site contaminated water management system
- Wyee Creek and the Wyee Creek diversion channel located along the north western site boundary and functions as part of the ash dam overflow system
- Vales Point ash dam reservoir
- Three settling ponds associated with the on-site sewage treatment works
- Five settling ponds associated with the coal storage area.

The site is likely to be influenced by two sub-catchments to the north east (operational power station areas) and south west (ash dam) separated by Rutleys Road. Surface water flows in areas to the north east (outside of the operational area) are likely to discharge to Lake Macquarie. Surface water flows on site are likely to be controlled by on-site clean water (discharged to the cooling water canal) and dirty water systems (discharged to the Chain Valley Bay retention basin and the ash dam). Surface water flows in the south western portion of the site (including decant water from the ash dam) would eventually discharge to the ash dam reservoir.

Information obtained from a site inspection undertaken by Jacobs on the 27 February 2018 indicated the following with respect to the surface water systems present at the site.

Operational Areas

- Surface water falling onto areas to the west of B Station and areas to the north of the cooling water canal that enter into formalized sub-surface drains discharge to the cooling water canal

Groundwater gauging works undertaken during the ERM (2014a) investigation indicated that groundwater levels beneath the site ranged from 0.739 m below ground level (mbgl) in VO-MW12 (ash dam) to 9.8mbgl within the underlying alluvial sediments and highly weathered Munmorah Conglomerate. General groundwater flow direction within the underlying alluvial sediments and highly weathered Munmorah Conglomerate was in a northerly direction towards Lake Macquarie. Localised variations in groundwater flow direction occurs at the ash dam including:

- Westerly flow direction measured downgradient of the south western portion of the ash dam
- Easterly flow direction measured downgradient of the south eastern portion of the ash dam
- Northerly flow direction towards Mannering Bay measured downgradient of the north western portion of the ash dam.

Groundwater flow direction across the site (based on information from the ERM, 2014a report) is presented as **Figure 3**.

4.5 Geology

The information from the ERM (2014a) report indicated the site is underlain by Munmorah Conglomerate comprising conglomerate and medium to coarse-grained sandstone with minor siltstone and claystone. The area underlying the ash dams was mapped as man-made fill overlying Munmorah Conglomerate. Areas surrounding Mannering Bay and Wyee Bay tributaries are located on quaternary sediments compromising gravel and sand.

The generalized lithology encountered during the drilling program included hardstands (within operational areas) overlying fill material (0m to 2.8m in depth) comprising sandy gravel to gravelly sandy clay, alluvial sediments (0m to 6m in depth) comprising clayey sand to sandy clay and moderately weathered to unweathered conglomerate bedrock (3.4. to >15m).

Figure 5.1: Sampling Locations (ERM, 2014a)

Table 5.1 details the soil and groundwater samples that were collected for PFAS analysis (PFOS, PFOA, 6:2 FTS and 8:2 FTS) during the ERM (2014a and 2014b) investigations. Where PFAS has been detected, concentrations have been compared against guideline values detailed in the PFAS NEMP (2018).

With respect to the PFAS analysis undertaken as part of the ERM (2014a and 2014b) investigation, the following was noted:

- Although not specifically stated, it is likely that samples (soil and water) for PFAS analysis were placed in laboratory supplied containers which may have contained Teflon lid inserts. The Teflon inserts could provide false positive PFAS results. The current standard for laboratory supplied sample containers for PFAS analysis is to not contain Teflon inserts.

- Decontamination procedures adopted by ERM included the use of DECON 90. The WA DER (February 2016) *Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)*, (WA DER, 2016) details that DECON 90 should not be used for decontamination of equipment used during PFAS investigations as this product may contain PFAS compounds.

- PFAS analysis was undertaken by ALS using in-house methods. Current analytical methods for PFAS include ISO 25101 – Water quality - Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) -- Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry and ASTM D7979 – Standard Test Method for Determination of Perfluorinated Compounds in Water, Sludge, Influent, Effluent and Wastewater by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS). It is not clear as to whether the laboratory's in house methods are consistent and comparable with current analytical methods.

- The ERM PFAS suite included PFOA, PFOS, 6:2 FTS and 8:2 FTS. Current analytical PFAS suites include additional PFAS compounds including compounds which are now listed within endorsed guidance including PFHxS.

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
		PFOS - 0.0006 mg/kg	Below NEMP (2018) soil exposure scenario for all land uses. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure). Below NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)			
VB-MW05	0.9-1.1	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-MW05		No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
VB-SB07	0.3	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB07		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-SB07	0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB07		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-SB08	0.2	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB08		

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
			Below NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)			
		8:2 FTS - <0.001 mg/kg	Concentrations below LOR			
VB-SB10	0.3	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB10		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR			
		PFOS - 0.0051 mg/kg	Below NEMP (2018) soil exposure scenario for all land uses. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure) Exceeds NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)			
		8:2 FTS - <0.001 mg/kg	Concentrations below LOR			
VB-SB10	1.0	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB10		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-SB11	0.7	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB11		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR			

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
		8:2 FTS - <0.001 mg/kg				
VB-SB13	0.2	PFOA - <0.0005 mg/kg 6:2 FTS - <0.005 mg/kg PFOS - <0.0005 mg/kg 8:2 FTS - <0.001 mg/kg	Concentrations below LOR	VB-SB13		Soil bore only. No samples collected for PFAS analysis
VB-SB13	1.0	PFOA - <0.0005 mg/kg 6:2 FTS - <0.005 mg/kg PFOS - <0.0005 mg/kg 8:2 FTS - <0.001 mg/kg	Concentrations below LOR	VB-SB13		Soil bore only. No samples collected for PFAS analysis
VB-SB17	0.3	PFOA - <0.0005 mg/kg 6:2 FTS - <0.005 mg/kg PFOS - <0.0005 mg/kg 8:2 FTS - <0.001 mg/kg	Concentrations below LOR	VB-SB17		Soil bore only. No samples collected for PFAS analysis
VB-SB19	0.3	PFOA - <0.0005 mg/kg 6:2 FTS - <0.005 mg/kg PFOS - <0.0005 mg/kg 8:2 FTS - <0.001 mg/kg	Concentrations below LOR	VB-SB19		Soil bore only. No samples collected for PFAS analysis

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
			Exceeds NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)			
		8:2 FTS - <0.001 mg/kg	Concentrations below LOR			
VB-SB26	0.2	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB26		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR			
		PFOS – 0.0019 mg/kg	Below NEMP (2018) soil exposure scenario for all land uses. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure) Equal to NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)			
		8:2 FTS - <0.001 mg/kg	Concentrations below LOR			
VB-SB27	0.1	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB27		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
B Station						
VA-MW05	0-0.2	**PFOA - 0.0007 mg/kg**	Below NEMP (2018) soil exposure scenario for all land uses.	VA-MW05		No samples collected for PFAS analysis

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
VA-MW02	0-0.2	PFOA - <0.0005 mg/kg	Concentrations below LOR	VA-MW02	PFOA - <0.02 µg/L	Concentrations below LOR
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR		6:2 FTS - <0.1 µg/L	
		PFOS - 0.0026 mg/kg	Below NEMP (2018) soil exposure scenario for all land uses. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure) Exceeds NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)		PFOS - <0.02 µg/L	
VA-SB02	0.4-0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VA-SB02		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
VA-MW01	0.4-0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VA-MW01	PFOA - <0.02 µg/L	Concentrations below LOR
		6:2 FTS - <0.005 mg/kg			6:2 FTS - <0.1 µg/L	
		PFOS - <0.0005 mg/kg			PFOS - <0.02 µg/L	
VA-SB01	0.15-0.35	PFOA - <0.0005 mg/kg	Concentrations below LOR	VA-SB01		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
Transformer Area						

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
VC-MW01	0.4-0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VC-MW01		No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
VC-MW01	3.9-4.1	PFOA - <0.0005 mg/kg	Concentrations below LOR	VC-MW01		No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
VC-SB03	0-0.2	PFOA - <0.0005 mg/kg	Concentrations below LOR	VC-SB03		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR			
		PFOS - 0.0022 mg/kg	Below NEMP (2018) soil exposure scenario for all land uses. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure). Exceeds NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds).			
VC-MW03	0-0.2	PFOA - <0.0005 mg/kg	Concentrations below LOR	VC-MW03		No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
Main Store						

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
Chlorine Plant - Fire Training Area						
VM-MW01			No samples collected for PFAS analysis	VM-MW01	PFOA - <0.02 µg/L	Concentrations below LOR
					6:2 FTS - <0.1 µg/L	
					PFOS - <0.02 µg/L	
VM-MW03			No samples collected for PFAS analysis	VM-MW03	**PFOA - 0.08 µg/L**	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
					6:2 FTS - <0.1 µg/L	Concentrations below LOR
					PFOS – 3.52 µg/L	Exceeds NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
Chain Valley Retention Basin						
No samples collected for PFAS analysis						
Ash Dam						
No samples collected for PFAS analysis						
AFFF Storage Area						
No samples collected for PFAS analysis						
Fuel Oil Tanks						
No samples collected for PFAS analysis						
Adjoining TransGrid Transformer Yard						

5.2 Umwelt (February 2015a)

The Umwelt (February 2015) investigation focused on surface water and groundwater quality within and immediately surrounding the ash dam. No PFAS sampling and analysis was undertaken as part of this investigation.

The results of the investigation did indicate that there were no clear trends that would indicate that the surface water in the ash dam was strongly influencing the groundwater quality in the vicinity of the ash dam. There were also no clear trends to indicate that water was leaching from the ash dam such that it was affecting groundwater quality. The report did note that even though the available data suggested that there was no notable evidence of ash dam water unacceptably leaching trace elements to groundwater, it was noted that a full 12 months of data were not available for all the bores. A report containing the full 12 months of data was submitted in October 2015 (refer to Section 5.5).

5.3 ERM (2015)

The ERM (2015) assessment was commissioned to review the currency and validity of Environmental Due Diligence reports previously prepared by ERM (2014a and 2014b) in relation to the site.

PFOS and PFOA were detected in groundwater around the boundary of the former A Station demolition area (VB-MW01 and VB-MW02) and in areas occupied by the water (VI-MW01) and sewage (VL-MW02) treatment plants (ERM, 2014a). These four wells in which PFOS/PFOA was detected in July 2014 were resampled as part of the ERM (2015) assessment. Measured concentrations of PFOS and PFOA were detected in all four groundwater samples collected. The concentrations of PFOA were below the adopted screening value for all four samples collected during both monitoring events. The concentrations of PFOS in groundwater at VB-MW01 and VB-MW02 exceeded the adopted human health screening value while the concentrations at VI-MW01 and VL-MW02 remained largely consistent and below the adopted human health screening value. Measured concentrations of PFOS at VB-MW02 exceeded the adopted screening value in both monitoring events with the concentration remaining largely consistent. Whilst PFOS was detected at VB-MW01 during the ERM (2014b) investigation, the measured concentration was below the human health (drinking water) screening value. The measured concentration at this location had increased by a factor of 2 to marginally exceed the screening value. However, on the basis that groundwater is not extracted for potable use within the vicinity of the operational area of the site, these order of magnitude variations for the PFOS concentrations detected in VB-MW01 were considered not to represent a significant risk to human health.

Groundwater sampling locations from the ERM (2015) investigation are presented as **Figure 5.3**.

Table 5.2 details the groundwater samples that were collected for PFAS (PFOS, PFOA, 6:2 FTS) analysis during the ERM (2015) assessment. Where PFAS has been detected, concentrations have been compared against guideline values detailed in the NEMP (2018).

Table 5.2: PFAS Analytical Results (ERM, 2015)

Groundwater Location	Concentration	Comment
A Station		
VB-MW01	**PFOA - 0.16 µg/L**	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	6:2 FTS - <0.1 µg/L	Concentrations below LOR
	PFOS - 0.26 µg/L	Exceeds NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
VB-MW02	**PFOA - 0.12 µg/L**	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	6:2 FTS - <0.1 µg/L	Concentrations below LOR
	PFOS - 1.14 µg/L	Exceeds NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
Water Treatment Plant		
VI-MW01	**PFOA - 0.19 µg/L**	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	6:2 FTS - <0.1 µg/L	Concentrations below LOR
	PFOS – 0.16 µg/L	Exceeds NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
Sewage Treatment Plant		
VL-MW02	PFOA - <0.02 µg/L	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	6:2 FTS - <0.1 µg/L	Concentrations below LOR
	PFOS – 0.11 µg/L	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water

With respect to the PFAS analysis undertaken as part of the ERM (2015) assessment, the following was noted:

- Although not specifically stated, it is likely that samples (soil and water) for PFAS analysis were placed in laboratory supplied containers which may have contained Teflon lid inserts. The Teflon inserts could

- A return water system was installed in 1995 to stop the continuous discharge of ash dam water and dissolved ash by-products directly to Wyee Creek. The Return Water System promotes the beneficial reuse of the water in the power station and allows surplus water from the ash dam to be dispersed into Lake Macquarie via the power station outfall canal (a licensed discharge point under the EPL).

- A pumping station for the return water system draws water from the Wyee Dam retention pond.

- The return water is pumped via a pipeline and discharged into one of the existing one million gallon water tanks (previously used for domestic water) adjacent to the power station entrance road. From the Return Water Head Tank, the return water flows under gravity to the existing sluice water pit at the Vales Point Ash Plant. Blowdown drains on the Return Water Tank and a branch off the gravity section of pipework allow for controlled and monitored discharge of return water to the Vales Point outfall canal.

- A groundwater seepage collection system is installed in the Mannering Creek Dam wall to collect seepage from the main ash dam wall. This system diverts any seepage from the wall via pipework to a pit constructed in the original Mannering Creek Dam spillway. Pumps in the pit return the seepage water to the ash storage area.

No specific PFAS sampling and analysis information is contained within this plan.

5.5 Umwelt (October 2015b)

The Umwelt (October 2015) investigation focused on surface water and groundwater quality within and immediately surrounding the ash dam. No PFAS sampling and analysis was undertaken as part of this investigation.

The results of the investigation did indicate that there were no clear trends that would indicate that the surface water in the ash dam was strongly influencing the groundwater quality in the vicinity of the ash dam. There were also no clear trends to indicate that water was leaching from the ash dam such that it was affecting groundwater quality. The comparative analysis covering 12 months of data did not identify clear trends which would indicate impacts on groundwater and that the concentrations of some analytes remain highly temporal and spatially variable.

5.6 Douglas Partners (2016)

The Douglas Partners investigation focused on groundwater quality within the vicinity of underground petroleum storage systems (UPSS) located within the south western portion of the power station. The groundwater monitoring indicated the groundwater levels in the vicinity of the UPSS ranged between 0.99 m bgl to 1.38 m bgl. The groundwater piezometric surface appeared to be relatively flat with probably a slight gradient following the local surface topography towards the north.

No specific PFAS sampling and analysis was undertaken as part of this monitoring.

5.7 Delta Electricity (January 2017a)

No specific PFAS sampling and analysis information is contained within the Vales Point Land Management Plan.

Figure 5.4: Sampling Locations (Jacobs, 2017)

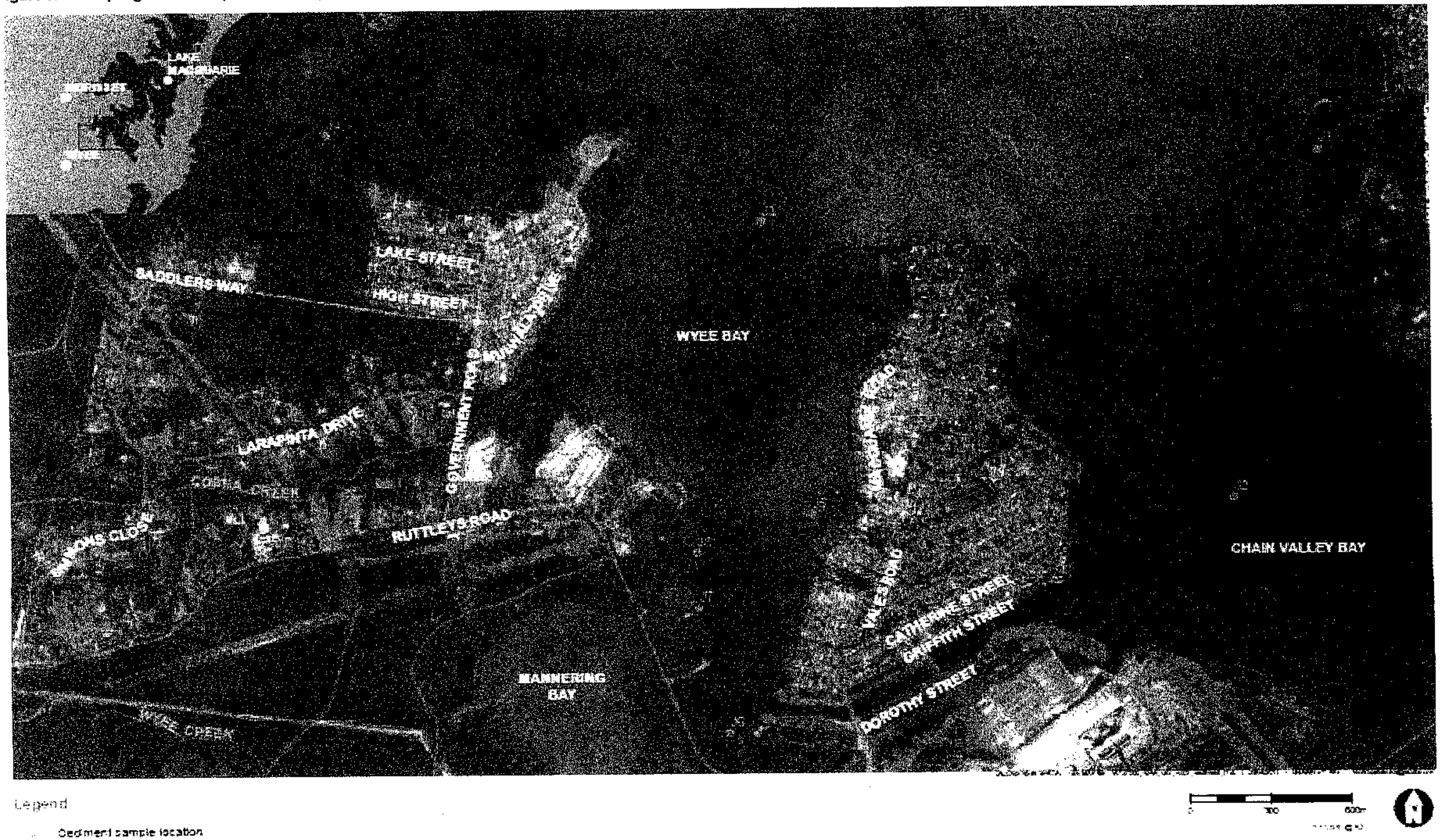


Figure 2 | Wyee Bay sediment investigation

Data sources

Of particular note (with respect to PFAS), was the Delta response to the AFFF enquiry from the NSW EPA (dated 21 October 2016). The response (as provided in the Delta report) is provided in **Table 5.4**.

Table 5.4: NSW EPA AFFF Enquiry Response

NSW EPA Question	Delta Response
1. Does the site currently have a firefighting foam deluge system, or has a system previously existed on site, or is foam stored in tanks for delivery via pump & hose including by vehicles?	The site currently has a firefighting foam deluge system for the Fuel Oil tanks located on the eastern side of the site. Each system consists of a foam maker at the top of the tank which is attached to a pipe reticulation through a deluge valve to a water supply. With the opening of the deluge valve water pressure is exerted on a rubber diaphragm within the foam compound tank, foam solution is passed through a compound metering valve where a solution of the correct proportion is formed. This water/foam liquid mixture is then carried by an above ground pipeline to a fixed aerating foam maker on the top of the tank. A glass diaphragm is sealed in position in the foam chamber to prevent vapour leakage from the tank. When foam pressure is applied, the diaphragm ruptures allowing the foam to enter the tank. The foam is distributed over the oil surface through an internal slotted downpipe.
2. What type of firefighting foam is/has been used?	• Angus FP70 – 3% fluorocarbon protein used in fuel oil deluge system. • Angus 317X – 6% film forming concentrate used in extinguishers. • All 3M PFAS materials removed from site in April 2008.
3. What is the capacity of the system in kg/tonnes/litres?	The fuel oil deluge system has a capacity of 1,264 L (2 x 632 L tanks)
4. How long has the system been in place?	The system was commissioned in 1975.
5. Have foams been used/or are foams currently used in the system?	Angus FP70 – 3% fluorocarbon protein is currently used in the fuel oil deluge system.
6. How is/was foam concentrate stored on site?	Foam concentrate is stored in 20L plastic drums in the Vales Point warehouse and on firefighting trolleys and in extinguishers around the site.
7. Where is or has the foam concentrate been stored on site?	The majority was stored in the Vales Point warehouse. Other 20L drums were stored on firefighting trolleys and in firefighting boxes at various locations around the site.
8. What quantities of foam are currently stored on site?	Approximately 2,560L (128 x 20L drums) of 6% concentrate. Majority in the warehouse.
9. Have there been any incidents/releases involving foam?	Major fire incidents at VP include: I. VP 6A 330/22kV Generator Transformer failure, which resulted in an explosion and fire (2006); II. VP 5A air heater (November, 2011) The recent environmental assessments did not identify any evidence of AFFF contamination in the areas affected by the above mentioned incidents:

- The foam from extinguishers during training are discharged onto metal trays within the concrete pad present within the fire training area. There was no discussion of how the residual foam present on the metal trays is disposed of.

5.10 RCA (2016-2018)

Robert Carr and Associates (RCA) have been commissioned to undertaken water monitoring at the site in accordance with the EPL for the site. As part of this EPL monitoring program, RCA have collected and analysed additional surface water and groundwater samples for PFAS. These additional samples for PFAS analysis have been collected as part of the July 2016, July 2017, September 2017, February 2018 and March 2018 monitoring events.

PFAS concentrations in all samples were below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water, drinking water and recreational water guidelines

Sampling locations from the RCA (2016-2018) monitoring events are presented as **Figure 5.5**.

Table 5.5 details the results of the PFAS analysis for the surface water and groundwater samples collected as part of the RCA (2016-2018) monitoring programs.

With respect to the PFAS analysis undertaken as part of the RCA (2016-2018) monitoring, the following was noted:

- The PFAS analytical tables provided for 2016, 2017 and 2018 list sample sites VPADB, Saddle Dam Drain and Ash Dam Seepage Pit. These locations were not depicted on the figures provided in the September 2017 report. With the exception of the Ash Dam Seepage Pit, all other monitoring locations were included on the figure contained within the February 2018 monitoring report.

- Duplicate samples have been collected, however the supporting reports do not provide information/commentary with respect to what the primary/duplicate pairs were or any qa/qc analysis/commentary with respect to RPDs between the primary and duplicate samples.

- Detailed PFAS sampling methodologies were in the February 2018 monitoring report which were consistent with the PFAS NEMP (2018) and/or the Western Australia Department of Environmental Regulation (January 2017) Contaminated Sites Guidelines - Interim Guideline on the Assessment and Management of Perfluoroalkyl and Ployfluoroalkyl Substances (PFAS), (WA DER, 2017).

For the purposes of reporting, groundwater monitoring well locations VPGM-D3, VPGM-D5 and VPGM-D6 are located adjacent to the Ash Dam and VPGM-D8 and VPGM-D10 are located in buffer areas to the north of operational areas of the power station.

Table 5.5: PFAS Analytical Results – RCA (2016 – 2018)

Location		VPGM D3	VPGM D5	VPGM D6	VPGM D8	VPGM D10	VPGM D3	VPGM D5	VPGM D6	VPGM D8	VPGM D10	VPGM D3	VPGM D5	VPGM D6	VPGM D8	VPGM D10
Date		July 2016					July 2017					September 2017				
Matrix		GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
Compound	Units															
Perfluorobutane sulfonic acid (PFBS)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoropentane sulfonic acid (PFPeS)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	0.0011	<0.0005	<0.0005	<0.0005	<0.0005	0.0013	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptane sulfonic acid (PFHpS)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0003	<0.0003	<0.0003	0.0008	<0.0003	<0.0003	<0.0003	<0.0003	0.0004	<0.0003
Perfluorodecane sulfonic acid (PFDS)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorobutanoic acid (PFBA)	µg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluoropentanoic acid (PFPeA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	0.0009	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	0.0018	<0.0005	<0.0005	<0.0005	<0.0005	0.0015	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorononanoic acid (PFNA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorodecanoic acid (PFDA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroundecanoic acid (PFUnDA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorododecanoic acid (PFDoDA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotridecanoic acid (PFTrDA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotetradecanoic acid (PFTeDA)	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonamide (FOSA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamide (MeFOSA)	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)c	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

GW – Groundwater sample

5.11 Jacobs (2018a)

Jacobs were commissioned in 2018 to undertake PFAS groundwater monitoring at the site. The objectives of the PFAS groundwater monitoring were to:

- undertake a preliminary assessment of PFAS in groundwater around potential sources which haven't been tested previously (e.g. wells around the ash dam and where PFAS has been previously detected in soil samples)
- validate selected results obtained during the ERM (2014) investigation in line with current sampling, sample handling, decontamination and analytical methodologies.

Groundwater monitoring was undertaken at existing wells VA-MW05, VB-MW05, VC-MW01, VC-MW02, VC-MW05, VL-MW02, VM-MW01, VM-MW03, VO-MW02, VO-MW07, VO-MW08, VO-MW10, VO-MW11, VO-MW12, VO-MW13, VO-MW14, VO-MW15, VO-MW18, VO-MW19, VS-MW02, VU-MW16, VU-MW17, VU-MW20, VD-MW05 and VJ-MW02. Where possible, all monitoring was undertaken using low flow (peristaltic pump) methods with one sample (VO-MW11) collected with a dedicated, single use bailer.

All samples were collected in accordance with the relevant methods detailed in the PFAS NEMP and the WA DER (2017) guidelines into laboratory supplied containers and submitted to National Association of Testing Authorities (NATA) accredited laboratories for PFAS (extended suite) analysis. The results of the laboratory analysis were compared to the guideline levels detailed in the PFAS NEMP (2018).

An assessment of groundwater flow direction (based on reduced groundwater levels recorded in each well) indicated the following:

- Groundwater flow direction appears to be generally in a north to north easterly direction from the site (operational area and ash dam) towards Lake Macquarie.
- A number of groundwater monitoring well locations around the ash dam (VO-MW10, VO-MW11 and VU-MW17) reported higher relative groundwater levels and are likely to be influenced by localised groundwater mounding. These well locations are located around the western extent of the ash dam where there is still a significant surface water component.
- Lower relative groundwater levels were recorded in VO-MW12 and VO-MW18. The lower relative groundwater levels recorded at these locations are likely to be influenced by surface water drainage features located adjacent to these monitoring well locations.
- Lower relative groundwater levels are present within the operational area of the power station in the near vicinity of the cooling water canal. The lower relative groundwater levels are likely to be influenced by Lake Macquarie considering the locations of the wells in the near proximity to this feature.
- Higher relative groundwater levels were recorded in the wells surrounding Tom Barney Oval in comparison to reduced groundwater levels recorded within the operational area of the power station. The levels recorded at the locations support a general north easterly groundwater flow direction.

values. Inputs of PFOS + PFHxS from VC-MW02 to receiving water bodies (i.e. Lake Macquarie) at concentrations above recreational guideline value is likely to be minimal considering that concentrations of these compounds in surrounding groundwater wells were low (below recreational guidelines). With the absence of known potable groundwater users on-site or on adjacent, down gradient areas, concentrations of PFAS above drinking water guideline values are unlikely to be of concern.

Samples from groundwater wells VL-MW02, VM-MW01, VM-MW03 and VS-MW02 (previously sampled and analysed for PFAS) were sampled and analysed for PFAS.

Concentrations of PFOS and PFOA in the sample collected from VM-MW01 (chlorine plant – fire training area) were not detected above LOR.

Concentrations of PFOS + PFHxS in samples collected from VL-MW02 (sewage treatment plant), VM-MW03 (chlorine plant – fire training area) and VS-MW02 (transformer yard) exceeded the drinking water (guideline values. With the absence of known potable groundwater users on-site or on adjacent, down gradient areas, concentrations of PFAS above drinking water guideline values are unlikely to be of concern.

Samples from groundwater wells VD-MW05 and VJ-MW02 (located to the north and north east of Tom Barney Oval – hydraulically down gradient of where foam may have been used during power station games) were sampled and analysed for PFAS.

Concentrations of PFOS and PFOA in the sample collected from VD-MW05 were not detected above LOR.

Concentrations of PFOS + PFHxS in the sample collected from VJ-MW02 exceeded the drinking water guideline values. With the absence of known potable groundwater users on-site or on adjacent, down gradient areas, concentrations of PFAS above drinking water guideline values are unlikely to be of concern.

Table 5.6 details the groundwater samples that were collected for PFAS (PFOS, PFOA, PFOS+PFHxS) analysis during the Jacobs (2018) monitoring program. Where PFAS has been detected, concentrations have been compared against guideline values detailed in the PFAS NEMP (2018).

Table 5.6: PFAS Analytical Results (Jacobs, 2018a)

Groundwater Location	Concentration	Comment
A Station		
VB-MW05	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- 0.07 µg/L	Equal NEMP (2018) drinking water guidelines. Below NEMP (2018) recreational guidelines
B Station		
VA-MW05	PFOA - <0.01 µg/L	Concentrations below LOR

Groundwater Location	Concentration	Comment
	PFOS – 0.03 µg/L	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	PFOS+PFHxS- 0.16 µg/L	Exceeds NEMP (2018) drinking water guidelines. Below NEMP (2018) recreational guidelines
Adjoining TransGrid Transformer Yard		
VS-MW02	**PFOA – 0.04 µg/L**	Below NEMP (2018) drinking water, recreational and aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water guidelines
	PFOS – 0.03 µg/L	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	PFOS+PFHxS- 0.54 µg/L	Exceeds NEMP (2018) drinking water guidelines. Below NEMP (2018) recreational guidelines
Tom Barney Oval		
VD-MW05	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VJ-MW02	**PFOA – 0.02 µg/L**	Below NEMP (2018) drinking water, recreational and aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water guidelines
	PFOS – 0.02 µg/L	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	PFOS+PFHxS- 0.15 µg/L	Exceeds NEMP (2018) drinking water guidelines. Below NEMP (2018) recreational guidelines
Ash Dam		
VO-MW02	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VO-MW07	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VO-MW11	PFOA - <0.01 µg/L	Concentrations below LOR

Groundwater Location	Concentration	Comment
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR

With the exception of PFAS concentrations detected in VS-MW02, all other monitoring locations (where analytical information was available) retumed reduced concentrations of PFAS compounds between the groundwater sampling undertaken by ERM in 2014/2015 and Jacobs in 2018. The reduction of PFAS concentrations could be associated with false/positive results associated with the sampling programs undertaken in 2014 and 2015. These false/positives are likely to indicate that earlier concentrations of PFAS reported in groundwater wells are likely to be conservative and represent increased concentrations. Although concentrations of PFAS detected in VS-MW02 during March 2018 had increased in comparison to those reported in 2014, the concentrations detected were still below recreational water use and protection of aquatic ecosystems guidelines.

The Jacobs (2018a) PFAS monitoring report is provided in **Appendix A.**

5.12 Jacobs (2018b)

Jacobs were commissioned in 2018 to undertake an additional PFAS investigation at the site to meet the requirements detailed in correspondence from the NSW EPA to Delta dated 21 September 2018.

The objectives of the additional PFAS investigation were to:

- Further assess potential PFAS concentrations in groundwater between the operational area of the site and Mannering Park
- Further assess potential PFAS concentrations in surface water and sediment within and in areas immediately surrounding the ash dam.

The additional PFAS investigation involved the following:

- Collection of three sediment samples (MB-SS01, MB-SS02 and MB-SS03) and one surface water sample (MB-SS02) in Mannering Bay
- Collection of one sediment and surface water sample (ML-SS01) in the ash dam reservoir (Mannering Lake)
- Collection of one sediment and surface water sample (WC-SS01) in Wyee Creek upstream of the confluence of Wyee Creek and Wyee Channel
- Collection of one sediment and surface water sample (WC-SS02) in Mannering Creek upstream of the confluence of Mannering Creek and Vales Point licence discharge point LDP18 in Wyee Channel
- Collection of groundwater samples from existing groundwater well locations VU_MW15, VL_MW01 and VPGMD10.

- The power station and transformer area are covered by a deluge system. Information from Delta representatives indicated that the deluge system for the power station and transformer area has never contained AFFF
- An AFFF dosing station is located to the south east of the power station adjacent to the coal conveyor. The AFFF product used on-site could not be ascertained during the site inspection. Anecdotal information from a Delta representative indicate that the foam is only dispensed into the deluge system of the fuel oil installation located to the south east of the power station adjacent to the coal conveyor.
- Information from on-site drainage plans indicate that all drains from the former A station discharged to the cooling water canal. Discharges to drains in the vicinity of the B station discharge to the Chain Valley Bay retention basin and are then transferred to the Ash Dam.
- Sediments from the cooling canal are periodically dredged and disposed of to the ash dam.
- Observations made during the site inspection indicated that fire cupboards were present on the TransGrid switchyard site. Jacobs could not access the switchyard to assess the contents of the fire cupboards.
- Inquiries at Delta and information from TransGrid indicated that there have been no fires at the Transgrid switchyard where AFFF are likely to have been used.
- When the local power stations were owned and operated by the State Government, power station safety games were routinely held at Tom Barney Oval. During these games, small quantities of AFFF from fire extinguishers may have been released onto Tom Barney Oval as part of the competitions. The exact nature of the activities undertaken during the power station games (especially those associated with AFFF releases) are not fully understood.

5.14 Summary

The following provides a summary of the sampling and analytical testing undertaken for PFAS in soil, sediment and groundwater across the site.

The number of samples collected and analysed, detections and concentrations above relevant guideline levels are provided in **Table 5.7 (soil)**, **Table 5.8 (sediment)**, **Table 5.9 (groundwater)** and **Table 5.10 (surface water)**. Note that groundwater samples collected in 2014 and 2015 cannot be compared against drinking water and recreational guidelines as samples were not analysed for PFHxS.

Table 5.7: Summary of Soil PFAS Results

Site Location	Soil Samples (No.)	Depth Range (m)	Detections above LOR	Detections above NEMP (2018)	Comment
A Station	27	0.1-1.5	6	3	PFOS in three soil samples exceeded the NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)

Water Treatment Plant	2	1	1	PFOS in one sample exceeded the NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
Sewage Treatment Plant	5	3	1	PFOS in one sample exceeded the NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
Chlorine Plant – Fire Training Area	4	2	1	PFOS in one sample exceeded the NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
Adjacent TransGrid Transformer Yard	6	1	0	
Tom Barney Oval	2	1	0	
Ash Dam	26	8	1	PFOS in one sample exceeded the NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water (potential anomaly result from VO-MW15)
Buffer Land (north of power station)	10	3	0	
Between operational area of the site and Mannering Park	3	0	0	

Table 5.10: Summary of Surface Water PFAS Results

Site Location	Surface Water Samples (No.)	Detections above LOR	Detections above NEMP (2018)	Comment
Colling Water Canal	6	6	0	
Surrounding Ash Dam	4	4	0	
Mannering Lake	1	0	0	
Mannering Bay	1	0	0	
Mannering Creek	1	0	0	
Wyee Creek	1	0	0	

6. Receptors

Potential receptors to PFAS contamination (if present) from the site have been assessed based on the following:

- The physical characteristics of PFAS compounds in the environment (highly soluble and mobile)
- Migration pathways including local and regional conditions (soil types, groundwater depth, flow gradients, on-site and off-site surface water features)
- Commercial/industrial use of the site
- Mixed land use surrounding the site including areas of residential land use
- Use of water resources down gradient of the site
- Potential exposure pathways.

The potential receptors to PFAS contamination (if present) from the site are detailed below:

- On-site workers could be exposed to contamination present in soils (mainly in unsealed areas or where excavation activities are being undertaken) – Dermal, ingestion, inhalation
- Aquatic ecosystems within surrounding waterways including Lake Macquarie, Wyee Creek, Wyee Bay and Mannering Bay – Dermal, ingestion
- Beneficial groundwater users (licensed and unlicensed) in the near vicinity of the site including bores used for stock and domestic purposes. This would include consumers of poultry products and home grown vegetables from where groundwater is used under license for stock and domestic purposes (there are three licensed groundwater bores within 1km of the site) - Ingestion
- Primary and secondary contact users of Lake Macquarie – Dermal, ingestion
- Consumers of species (fish, crustaceans, etc) caught within Lake Macquarie and adjoining waterways – Ingestion.

		PFOS and PFOA detected in surface soils (0-0.2m) at selected locations at concentrations below the PFAS NEMP (2018) human health and ecological guideline values. Detections of PFAS compounds in surface soils maybe attributable to spreading of impacted soils from adjoining areas during construction or from possible leaks and spillages associated with AFFF storage. Where surface soils remain under hardstand areas, unlikely to represent a contamination risk to underlying groundwater. The detection of PFAS compounds may also be attributable to or be influenced by false/positive results during earlier investigations associated with the use of detergents during decontamination, Teflon inserts in sample containers and laboratory analytical methods. Where tested, PFAS were not detected in groundwater samples collected from B Station at concentrations exceeding the NEMP (2018) guidelines for the recreational water use and protection of aquatic ecosystems. The absence of PFAS concentrations (above the guideline levels) in groundwater samples from B Station suggests that soils containing detectable concentrations of PFAS beneath this area are not contributing to groundwater at measurable to significant concentrations.
Transformer Area	Soils (surface and depth)	The air heater fire in 2011 may have been extinguished with AFFF. PFOS detected in soils (0m to 1.1m) at selected locations at concentrations below the PFAS NEMP (2018) human health and ecological guideline values. Detections of PFAS compounds in soils maybe attributable to vertical migration of AFFF impacted water through site hardstand and leaks within sub-surface drains during firefighting activities. It is also possible that PFAS impacted sediments may be present within the sub-surface drains. The absence of PFAS compounds in groundwater from up gradient areas (i.e. B Station) is likely to suggest that groundwater migrating onto the transformer area is not contributing to PFAS concentration in soil beneath this area. Detections of PFAS compounds in surface soils maybe also be attributable to spreading of impacted soils from adjoining areas during construction or from possible leaks and spillages associated with AFFF storage. Where tested, PFAS were not detected in groundwater samples collected from the transformer area at concentrations exceeding LOR with the exception of PFOS+PFHxS concentrations exceeding the NEMP (2018) recreational water guidelines in VC-MW02. The detection of PFAS compounds may also be attributable to or influenced by false/positive results during earlier investigations associated with the use of detergents during decontamination, Teflon inserts in sample containers and laboratory analytical methods. PFAS may be present as a secondary source/s below the transformer area. The secondary source/s may contain PFAS concentrations below the respective soil guidelines, but still maybe contributing to PFAS concentrations in groundwater. Recent groundwater monitoring indicates that concentrations in groundwater down gradient of the secondary source/s (if present) and adjacent to the cooling water canal are below the NEMP (2018) guidelines for the protection of aquatic ecosystems but above the NEMP (2018) recreational water guidelines.

Training Area		is the possibility of over spray during these exercises or inappropriate disposal of residual foam. The area surrounding the training area in unsealed. No soil sampling for PFAS analysis was undertaken within the chlorine plant - fire training area. PFOA and PFOS were detected above LOR in groundwater at selected locations. At one groundwater well location (VM-MW03), concentrations of PFOS exceeded the NEMP (2018) guidelines for the protection of aquatic ecosystems. The detection of PFAS compounds may also be attributable to or influenced by false/positive results during earlier investigations associated with the use of detergents during decontamination, Teflon inserts in sample containers and laboratory analytical methods. PFAS may be present as a secondary source/s below the chlorine plant or be influenced by the PFAS known to be present in groundwater at the up gradient sewage treatment plant. Recent groundwater monitoring indicates that concentrations in groundwater down gradient of the secondary source/s and adjacent to the cooling water canal are below the NEMP (2018) guidelines for recreational use and the protection of aquatic ecosystems.
Chain Valley Bay Retention Basin	Water and/or sediment within retention pond	No media sampling (soil, sediment, surface water and/or groundwater) for PFAS analysis has been undertaken in areas within and adjacent to the retention pond. The retention pond takes dirty water discharges from the operational area of B Station and the transformer area and discharges (under normal conditions) to the ash dam. No known fires or use of AFFF has been undertaken within B Station of the transformer area. However, minor quantities of AFFF may have been stored within firefighting trolleys and in firefighting boxes and minor fires may have been extinguished with AFFF from extinguishers. Residual foam could have been discharged to the retention pond.
Tom Barney Oval	Soils (surface and depth)	No soil sampling for PFAS analysis was undertaken within Tom Barney Oval. PFAS was detected in one groundwater at concentrations above the LOR but below the NEMP (2018) guidelines for recreational water and the protection of aquatic ecosystems. PFAS may be present as a secondary source/s below Tom Barney Oval. Secondary source/s maybe contributing to PFAS concentrations detected in groundwater albeit at concentrations below the NEMP (2018) guidelines for the protection of aquatic ecosystems.
Ash Dam	Sediment from cooling water canal Water and/or sediment within retention pond	PFAS was not detected above LOR or the SAC in sediment samples collected from the ash dam. The absence of detectable concentrations of PFAS in sediment from the ash dam is likely to indicate that sediment is not a secondary PFAS source. Surface water samples analysed for PFAS did not report concentrations exceeding the NEMP (2018) recreational water and protection of aquatic ecosystems guidelines.

8. Conceptual Site Model

To assist in understanding the potential PFAS exposure at the site, Jacobs developed the following conceptual site model (CSM) for the site based on the information reviewed, an understanding of site settings, potential contamination associated with known historical and current site operations, and potential receptors to contamination (if present). The CSM is detailed in **Table 8.1**.

Location	Source	Contaminants of Concern	Contamination Mechanism	Contamination Depth	Receptor	Comments
B Station	Soils beneath the operational areas	PFAS	Reuse of potential PFAS contaminated soils during construction	Surface	Site users	Soil samples collected do not indicate PFAS exposure risk to site occupants under current land use
	Soils below storage areas		Leaks and spills from AFFF on firefighting trolleys and in firefighting boxes infiltrating into sub-soils through joints, cracks within the hardstand area	Surface and depth	Site users and groundwater	Soil samples collected do not indicate PFAS exposure risk to site occupants under current land use. Groundwater samples collected do not indicate PFAS exposure risk to receptors.
Transformer Area	Soils in the vicinity of heater fire (2011)	PFAS	Infiltration of AFFF and AFFF impacted surface water during firefighting activities into sub-soils through joints, cracks within the hardstand area	Surface and depth	Site users and groundwater	Soil samples collected do not indicate PFAS exposure risk to site occupants under current land use. PFAS concentrations detected in soil samples (although under guidelines) or other secondary sources maybe contributing to elevated concentrations of PFAS detected within and down gradient of A Station.
	Soils beneath the operational areas		Reuse of potential PFAS contaminated soils during construction	Surface	Site users	Soil samples collected do not indicate PFAS exposure risk to site occupants under current land use. PFAS concentrations detected in soil samples (although under guidelines) or other secondary sources maybe contributing to elevated concentrations of PFAS detected down gradient of the transformer area (VC-MW02).
Main Store	Soils below storage areas	PFAS	Leaks and spills from AFFF infiltrating into sub-soils through joints, cracks within the hardstand area	Surface	Site users	Soil samples collected do not indicate PFAS exposure risk to site occupants under current land use.
Sewage Treatment Plant	Water and/or sediment within settlement ponds	PFAS	Leaking settlement pond	Depth	Groundwater	Previous analytical results and groundwater level measurement indicated PFAS impacts in groundwater adjacent to settlement pond.

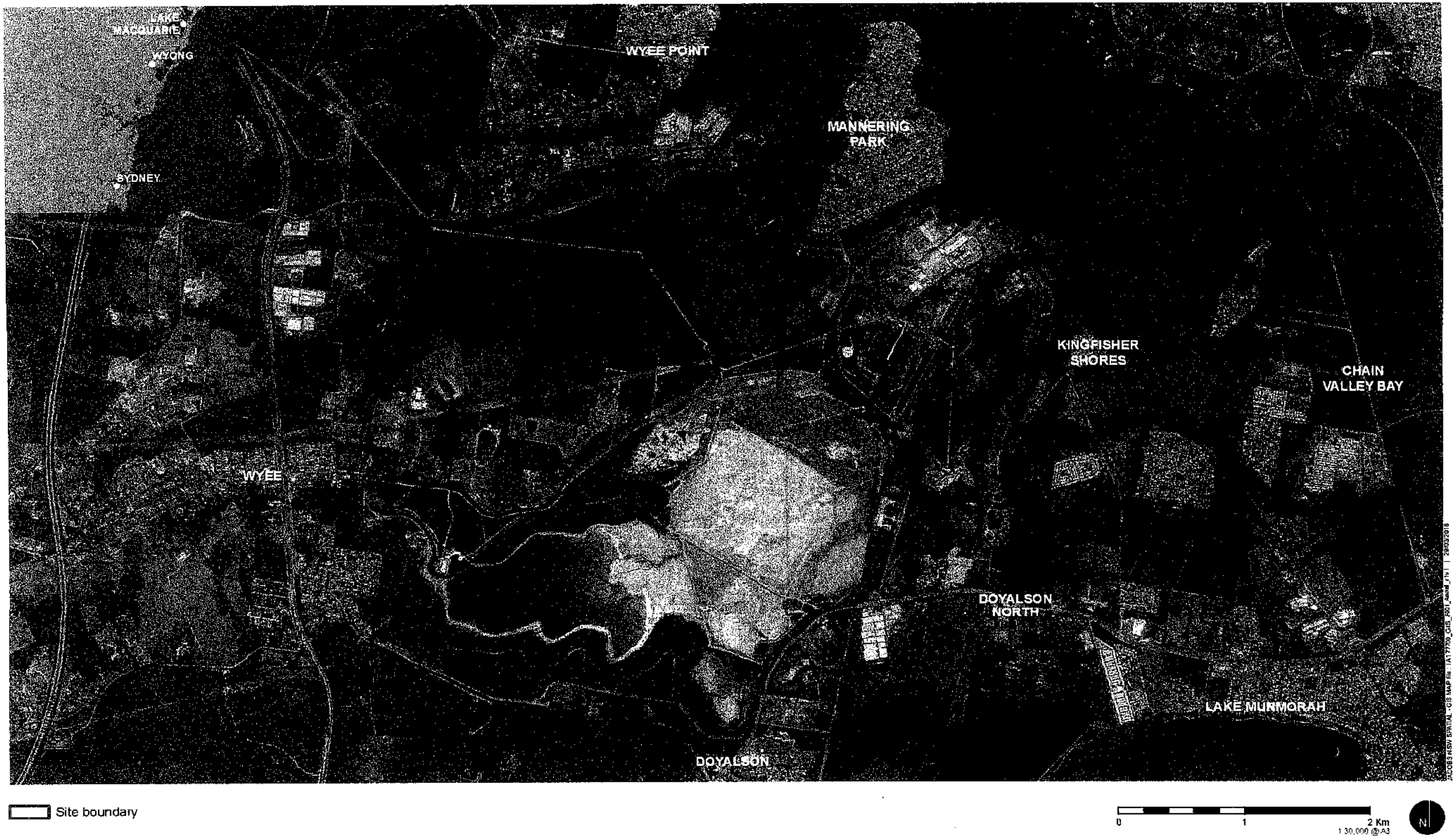
Location	Source	Contaminants of Concern	Contamination Mechanism	Contamination Depth	Receptor	Comments
						Station) do not represent an exposure risk to receptors.
Fuel Oil Tanks	Concrete beneath and soils immediately surrounding facility	PFAS	Infiltration of AFFF and AFFF impacted water during testing of deluge system	Surface and depth	Site users and groundwater	Soils within the AFFF storage area could contain PFAS. Groundwater monitoring data indicates that concentrations of PFAS in areas down gradient of the AFFF storage area (i.e. B Station) do not represent an exposure risk to receptors.
Areas adjoining TransGrid Transformer Yard	Potential fires and AFFF storage (neither confirmed)	PFAS	AFFF use during fires and leaks and spills from AFFF on firefighting trolleys and in infiltration into sub-soils	Surface and depth	Site users and groundwater	Soil samples collected do not indicate PFAS exposure risk to site occupants under current land use. Groundwater samples collected do not indicate PFAS exposure risk to receptors.
Groundwater users in Mannering Park	Soils beneath the operational areas	PFAS	Rainwater infiltration through on-site soils containing PFAS	Depth	Groundwater	Groundwater samples collected between the operational areas of the site and Mannering Park do not indicate PFAS exposure risk to receptors.

2018. The reduction of PFAS concentrations could be associated with false/positive results associated with the sampling programs undertaken in 2014 and 2015. These false/positives are likely to indicate that earlier concentrations of PFAS reported in groundwater wells and other media are likely to be conservative and represent increased concentrations. With respect to groundwater, more reliance should be placed on the PFAS concentrations detected in wells monitored as part of the Jacobs (2018a) monitoring event.

- Additional PFAS investigations undertaken at the site in November 2018 (Jacobs, 2018b) indicated that groundwater between the operational area of the site and Mannering Park is not impacted by PFAS; surface water and sediments within the ash dam (Mannering Lake) do not represent a secondary source of PFAS contamination and surrounding waterways (Wyee Creek, Mannering Creek and Mannering Bay) are not impacted by PFAS associated with discharges from the ash dam.

Based on the conclusions detailed above, Jacobs consider that where sampled, PFAS from the site does not pose a significant risk to current receptors on and/or off-site. Considering the likely presence of a secondary source of PFAS in soils below the operational areas of the site and some minor elevated concentrations of PFAS detected in groundwater, Jacobs do not recommend additional PFAS soil investigations at the site (subject to no change in the site use). To monitor the PFAS detected in groundwater, Jacobs recommend the following:

- It is likely that some secondary sources of PFAS (PFAS in soil) are present below the operational areas of the power station. These secondary sources (currently) are unlikely to represent a significant source to groundwater contamination or a risk to groundwater receptors or receiving environments. However, whilst the secondary source remains on-site, the potential remains for this secondary source to impact groundwater especially in the event that site conditions change (namely demolition and removal of hardstand areas which could increase direct infiltration of water into sub-soils). Annual monitoring from selected groundwater wells for a period of two years should be undertaken to assess that these secondary sources are not impacting upon groundwater beneath the site. Following completion of the two annual monitoring rounds, a review should be undertaken to reassess the requirements for ongoing monitoring. The annual monitoring should include location VO-MW15 to further confirm the results obtained during the Jacobs (2018) monitoring program.



Data sources
Jacobs 2018
Ausimage 2016
LPI 2018

Figure 1 | Site location

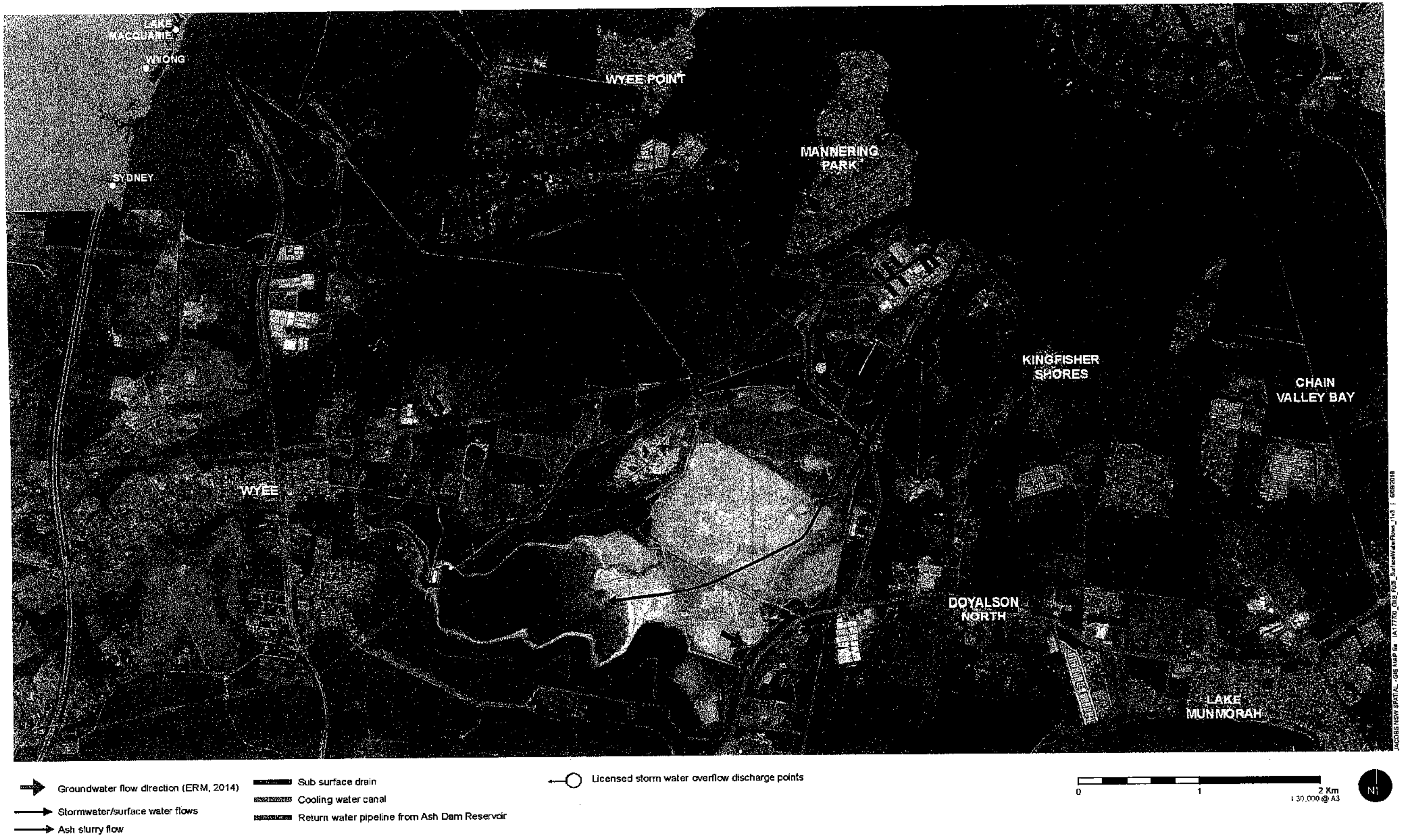


Figure 3 | Surface water and groundwater flows

Data sources
Jacobs 2018
Ausimage 2016
LPI 2018

Data sources
Jacobs 2018
Ausimage 2016
LPI 2018

Figure 5a | Groundwater samples collected for PFAS analysis (ERM, 2014)

Appendix A – Jacobs (2018a) PFAS Groundwater Monitoring

PFAS Groundwater Monitoring - Vales Point Power Station

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V1	17/04/18	Technical Review	RLG	17/04/18	MS
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V3	30/04/18	For Issue			

1 Introduction

Jacobs Group (Australia) Pty Ltd (Jacobs) was commissioned by Delta Electricity (Delta) to undertake groundwater monitoring for per- and polyfluoroalkyl substances (PFAS) contamination in groundwater at the Vales Point Power Station located at Mannering Park, NSW (referred to hereinafter as the site).

The location of the site is presented as **Figure 1**.

This report details the works undertaken during the PFAS groundwater monitoring undertaken at the site, field observations and the sample analysis results with an assessment against the guideline values listed HEPA (January 2018) PFAS National Environmental Management Plan (PFAS NEMP, 2018).

This report has been prepared in general accordance with the requirements specified for a Detailed Site Investigation as detailed in the NSW EPA (1997) *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites.*

3 Objectives and Scope of Works

The objectives of the PFAS groundwater monitoring were as follows:

- undertake a preliminary assessment of PFAS in groundwater around potential sources which haven't been tested previously (e.g. wells around the ash dam and where PFAS has been previously detected in soil samples); and
- validate selected results obtained during the 2014 ERM investigation in line with current sampling, sample handling, decontamination and analytical methodologies.

The proposed scope of works undertaken to address the objectives are detailed below.

- Low flow sampling (peristaltic pump) from 18 locations (VA-MW05, VB-MW05, VC-MW01, VC-MW02, VC-MW05, VL-MW02, VM-MW01, VM-MW03, VO-MW02, VO-MW07, VO-MW08, VO-MW10, VO-MW12, VO-MW15, VO-MW19, VS-MW02, VU-MW16, VU-MW17)
- Collection of samples from groundwater wells
- Laboratory analysis of 22 samples (18 primary + 4 qa/qc) for routine level PFAS (extended suite)
- Results of the sampling to be included in the consolidated PFAS report.

Initial groundwater monitoring undertaken by Jacobs in March 2018 (as detailed above) indicated elevated PFAS within groundwater monitoring well VO-MW15 located at the western end of the ash dam. Also, anecdotal information indicated that aqueous film forming foam (AFFF) may have been used during power station safety games held on Tom Barney Oval in the past. The additional scope of works undertaken to further address potential PFAS issues at the western end of the ash dam and Tom Barney Oval are detailed below.

- Low flow sampling (peristaltic pump) from 8 locations (VO-MW15, VO-MW14, VO-MW13, VU-MW20, VO-MW11 and VO-MW18 located at the western end of the ash dam and VD-MW05 and VJ-MW02 located adjacent to Tom Barney Oval)
- Collection of samples from groundwater wells
- Laboratory analysis of 10 samples (8 primary + 2 qa/qc) for routine level PFAS (extended suite)
- Results of the sampling to be included in the consolidated PFAS report.

Groundwater monitoring locations are presented on **Figure 1.**

The vertical extent of the investigation was limited to the depths of the existing groundwater wells (i.e. groundwater present within the alluvial sediments located beneath the site.

The monitoring was undertaken over three days and results are unlikely to be significantly affected by temporal conditions.

Step 5 - Develop a Decision Rule

The purpose of this step was to define the parameter of interest, specify the action level and combine the outputs of the previous DQO steps into an "if…then…" decision rule that defines the conditions that would cause the decision maker to choose alternative actions.

The parameters of interest (or Contaminants of Concern) have been determined based on background information and to establish baseline chemical conditions and contaminant concentrations. The action level (Site Assessment Criteria) will be used to decide if the parameter represents a potentially unacceptable risk for commercial/industrial land use, human health and/or the environment. If the measured concentration of a compound exceeds the action levels in groundwater, then this is deemed to present a potential unacceptable risk considering the current land use, adjoining land use and environmental receptors. This also indicates that refinement of the Site Assessment Criteria (SAC) by undertaking Detailed Risk Assessment (DRA) is warranted.

Step 6 - Specify Acceptable Limits on Decision Errors

There were decided to be two types of errors:

a) Deciding that the site is acceptable for commercial/industrial use (i.e. no risk to site users and/or receptors) when it actually is not acceptable. The consequence of this error may be unacceptable health risk for site users, adjoining site users and receiving environments; or

b) Deciding that the site is unacceptable for commercial/industrial use (i.e. risk to site users and/or receptors) when it actually is acceptable. The consequence of this error is that the client will pay for further investigation / remediation that are not necessary.

The more severe consequences are with decision error (a) since the risk of jeopardising human health and/or the environment outweighs the consequences of paying more for further assessment and management. It will not be possible to conduct statistical hypothesis tests as the proposed monitoring program consists of the collection of one round of samples only (with the exception of the resampling of MO-MW15 to assess anomalous results).

Step 7 - Optimising the Design for Obtaining Data

The purpose of this step was to identify a resource-effective data collection design for generating data that are expected to satisfy the DQO.

The resource effective data collection design that was expected to satisfy the DQO is described in detail in **Section 6** of this report. To ensure the design satisfies the DQO a comprehensive Quality Assurance and Quality Control Plan was implemented as described in **Section 7** of this report.

Dedicated, single use sample tubing and bailer (VO-MW11 only) was used to purge and to sample all wells. All samples were collected using new disposable nitrile gloves, changed between sample locations.

5.3 Method of Sample Collection, Storage and Handling

PFAS compliant laboratory supplied sample containers were used to contain the groundwater samples. All sample containers were labelled with the sample number, project number, date obtained and sampler and site name. This information was repeated on the CoC form.

Care was taken to minimise disturbance of the sample to avoid aeration by minimising the distance between the outlet tubing and the container and tilting the container so that discharge flowed gently down the inner walls.

Once filled, the caps were checked to ensure that they were secure and then placed within an esky / cool box in which a cooling medium had been added to keep the samples below a temperature of approximately 4° C. Custody seals were placed on the esky / cool box for delivery to the laboratory.

5.4 Sample Logging and Documentation

While on site, the Jacobs field staff completed sampling field data sheets which document (where applicable):

- Time of sample collection
- Weather
- Unique sample identification number
- Sample location and depth
- Static Water Level
- Water quality screening results (DO, Temperature, Redox potential, pH and conductivity)
- Presence or absence of odour (nature and intensity)
- Colour of the water
- Presence or absence of sediment in the well
- Well condition and purging volumes.

All samples, including QA samples, were transported to the primary laboratory under CoC procedures and maintained in an ice-filled cooler. The CoC detailed the following information:

- Site identification
- The sampler
- Nature of the sample
- Collection date of the sample

6 Quality Control Plan

Field and laboratory QA/QC requirements compliant with NEPC (2013) requirements (where applicable) were undertaken as part of the field work program as outlined below.

6.1 Field QA/QC Programme

Field QA/QC for this project consisted of the collection of blind replicate (groundwater), split replicate (groundwater), trip blank and trip spike samples.

6.1.1 Environmental Samples

Environmental samples or field samples were the representative groundwater samples collected for analysis to determine aspects of their chemical composition.

6.1.2 Blind Duplicate Samples

Blind duplicate samples were provided by the collection of two environmental samples from the same location. These samples were preserved, stored, transported, prepared and analysed in an identical manner. The results of analyses on the blind replicate sample pair were assessed by calculating the Relative Percentage Differences (RPDs) between the results. The RPD was calculated as the difference between the results divided by their mean value and expressed as a percentage. If the RPD exceeded the adopted Data Acceptance Criteria (See Section 6.3) for any analytes, additional investigation would be required, or justification provided for not conducting additional investigation.

Blind duplicate samples were generally collected at a rate of one duplicate for every 20 environmental samples in accordance with AS 4482.1-2005.

6.1.3 Split Replicate Samples

Split replicate samples provided a check on the analytical proficiency of the laboratories. Split replicate samples were provided by the collection of two environmental samples from the same location. These samples were preserved, stored and transported in an identical manner. The spilt samples were analysed by the secondary laboratory. The results of analyses on the split replicate replicate sample pair were assessed by calculating the RPDs between the results. The RPD was calculated as the difference between the results divided by their mean value and expressed as a percentage. If the RPD exceeded the adopted Data Acceptance Criteria for any analytes, additional investigation would be required, or justification provided for not conducting additional investigation.

Split replicate samples were generally collected at a rate of one duplicate for every 20 environmental samples in accordance with AS 4482.1-2005.

6.2 Laboratory QA/QC Programme

The reliability of test results from the analytical laboratories was monitored according to the QA/QC procedures used by the NATA accredited laboratory. The QA/QC programme employed by Eurofins (the primary laboratory) specified holding times, extraction dates, method descriptions, Chain of Custody (COC) requirements, analysis, LORs and acceptance criteria for the results. Laboratory QA/QC requirements undertaken by Envirolab and Eurofins are based on NEPM requirements and are outlined below (NEPC, 2013).

6.2.1 Laboratory Duplicate Samples

Laboratory duplicates provided data on analytical precision for each batch of samples.

QA/QC sample	DQI	Objectives	Acceptance criteria
Laboratory duplicates	Precision	To ensure precision of the analysis method and replicability of analysis due to potential sample heterogeneity. Assessment as per blind replicates and split samples	As per laboratory QC report
Matrix spike recoveries	Accuracy	To assess the effect of the matrix on the accuracy of the analytical method used. Assessment is undertaken by determining the percent recovery of the known spike or addition to the sample. $\% \text{ Recovery} = 100 \times \frac{C - A}{B}$ Where: A = Concentration of analyte determined in the original sample; B = Added Concentration; C = Calculated Concentration.	As per laboratory QC report
Method blanks	Accuracy	To assess potential bias introduced by the laboratory analytical method for a relevant analyte. A method blank assesses the component of the analytical result introduced from laboratory equipment. Each blank is analysed as per the original samples.	Analytical result < LOR

7.3 Laboratory QC

Laboratory QC data is presented in full in the laboratory certificates in **Appendix C**.

7.3.1 Laboratory Duplicates

RPDs for all laboratory duplicates for groundwater samples conformed to the DAC.

7.3.2 Laboratory Control Samples

Recoveries for all laboratory control samples for groundwater samples conformed to the DAC.

7.3.3 Surrogates

Recoveries for all laboratory surrogate samples for groundwater samples conformed to the DAC.

7.3.4 Matrix Spikes

Recoveries for all matrix spike control samples for groundwater samples conformed to the DAC.

7.3.5 Method Blanks

All method blanks for groundwater samples reported analyte concentrations below the laboratory LOR and therefore conformed to the DAC.

7.3.6 Sample Holding Times

All groundwater samples were extracted and analysed within the specified holding times. .

7.3.7 Sample Condition

All samples were received by the analytical laboratories in correctly preserved and chilled containers with no reported breakages. The individual sample receipts are presented with the laboratory reports in **Appendix C**.

7.4 QA/QC Assessment

It is concluded that laboratory data are of acceptable quality and are considered useable in making conclusions and recommendations regarding the site.

Table 8.1: Investigation criteria for groundwater and surface water for the protection of human health (µg/L) (Department of Health, 2017)

Exposure scenario	PFOS + PFHxS	PFOA
Drinking water	0.07	0.56
Recreational water	0.7	5.6

Based on a review of licensed groundwater wells, there are no wells down gradient of the site which are used for potable water use. Therefore, the guideline values for recreational water will be used as the Tier 1 risk screening criteria for surface water bodies.

8.2 Investigation criteria for ecological protection

The PFAS NEMP includes surface water guideline values for ecological protection. Groundwater guideline values for ecological protection have not been established.

The PFAS NEMP includes guideline values for PFOS and PFOA in surface water for the protection of aquatic ecosystems. These are based on the technical draft default guideline values developed by the Australia and New Zealand Environment Conservation Council (ANZECC).

The PFAS NEMP states that the draft guidelines do not account for effects which result from the bio-magnification of toxicants in air-breathing animals or in animals which prey on aquatic organisms.

It is noted that the PFAS NEMP includes investigation levels for the protection of aquatic ecosystems based on 99% species protection – high conservation value ecosystems, 95% species protection – slightly to moderately disturbed systems, 90% species protection – highly disturbed systems and 80% species protection - highly disturbed systems. In NSW the 95% species protection level – slightly to moderately disturbed ecosystems, is applied except for waterways that mainly flow through relatively undisturbed national parks, world heritage areas or wetlands of outstanding ecological significance where the 99% species protection values are applied (DEC, 2006). Therefore, the 95% species protection values have been adopted as the investigation criteria for surface water ecological protection direct toxicity. These values are presented in **Table** .

Table 8.2: Investigation criteria for surface water ecological protection direct toxicity (µg/L) (PFAS NEMP, HEPA 2018)

Exposure Scenario	PFOS	PFOA
Freshwater direct toxicity, slightly to moderately disturbed ecosystems (95% species protection)	0.13	220

Well ID	Relative Height (m AHD TOC)	Groundwater Level (m BTOC)	Relative Level of Groundwater (m AHD)
VO-MW14	18.36	4.12	14.24
VO-MW15	18.37	3.24	15.13
VO-MW18	15.64	4.34	11.3
VU-MW20	28.19	Dry	

Notes:

- m BTOC – m below top of casing
- m TOC – m top of casing
- Relative level of groundwater reported as metres AHD
- AHD levels from ERM (2014)
- Groundwater levels as measured 5.4.18 and 6.4.18

An assessment of groundwater flow direction (based on reduced groundwater levels recorded in each well) is provided below:

- Groundwater flow direction appears to be generally in a north easterly direction from the site (operational area and ash dam) towards Lake Macquarie.
- A number of groundwater monitoring well locations around the ash dam (VO-MW10, VO-MW11 and VU-MW17) reported higher relative groundwater levels and could be influenced by localised groundwater mounding. These well locations are located around the western extent of the ash dam where there is still a significant surface water component.
- Lower relative groundwater levels were recorded in VO-MW12 and VO-MW18. The lower relative groundwater levels recorded at these locations are likely to be influenced by surface water drainage features located adjacent to these monitoring wells.
- Lower relative groundwater levels are present within the operational area of the power station in the near vicinity of the cooling water canal. The lower relative groundwater levels are likely to be influenced by Lake Macquarie considering the locations of the wells in the near proximity to this feature.
- Higher relative groundwater levels were recorded in the wells surrounding Tom Barney Oval. The levels recorded at the locations support a general north easterly groundwater flow direction.
- A higher relative groundwater level was reported in VL-MW02 (compared to surrounding wells). This groundwater level may be locally influenced by the ponds of the sewage treatment plant.

9.2 Groundwater Analytical Results

Groundwater analytical results from samples collected from groundwater wells are presented below and in **Table B**. Laboratory certificates of analysis are presented in **Appendix C**.

9.2.1 General Water Quality Parameters

General water quality parameters measured during the groundwater monitoring are presented in **Table 9.3** and **Table 9.4**.

Table 9.3: General Water Quality Parameters (March 2018)

- Higher electrical conductivity was recorded in wells located adjacent to ash dam discharge point (VO-MW12) and VO-MW18. It is understood that the sub-catchment for VO-MW18 is influenced by water from areas to the south east of the ash dam.
- Higher electrical conductivity was recorded in wells VA-MW05, VB-MW05, VC-MW02 and VC-MW05 which are located in the near proximity to the marine waters of Lake Macquarie and Mannering Bay (higher conductivity could indicate a degree of mixing from these adjacent marine water bodies).
- No apparent trends could be assessed for dissolved oxygen and redox based on the readings recorded.

9.2.2 PFAS

The concentrations of PFAS compounds in all groundwater samples analysed were below the SAC with the exception of the following:

- PFOS + PFHxS concentrations in samples VS-MW02 (0.54 µg/L), VL-MW02 (0.43 µg/L – spilt replicate result), VM-MW03 (0.16 µg/L), VC-MW05 (0.2 µg/L) and VJ-MW02 (0.15 µg/L) exceeded the drinking water guideline value (0.07 µg/L).
- PFOS + PFHxS concentrations in samples VC-MW02 (1.89 µg/L) and VO-MW15 (2.7 µg/L) exceeded the drinking water (0.07 µg/L) and recreational water use (0.7 µg/L) guidelines values. Resampling of VO-MW15 in April 2018 reported PFOS + PFHxS concentrations below LOR.
- PFOS concentrations in sample VO-MW15 (1.4 µg/L exceeded the protection of aquatic ecosystems (95%) guideline value (0.13 µg/L). Resampling of VO-MW15 in April 2018 reported PFOS + PFHxS concentrations below LOR.

Samples from groundwater wells VB-MW05, VA-MW05, VC-MW01, VC-MW02 and VC-MW05 (located down gradient of areas where PFAS have been previously detected in soil and groundwater samples, but had not been subject to previous PFAS analysis) were sampled and analysed for PFAS.

Concentrations of PFOS and PFOA in samples collected from VB-MW05 (A Station), VA-MW05 (B Station) and VC-MW01 were not detected above LOR.

Concentrations of PFOS + PFHxS in samples collected from VC-MW02 and VC-MW05 (transformer area) exceeded the drinking water (VC-MW02 and VC-MW05) and recreational water use (VC-MW02 only) guideline values. Inputs of PFOS + PFHxS from VC-MW02 to receiving water bodies (i.e. Lake Macquarie) at concentrations above recreational guideline value is likely to be minimal considering that concentrations of these compounds in surrounding groundwater wells were low (below recreational guidelines). With the absence of known potable groundwater users on-site or on adjacent, down gradient areas, concentrations of PFAS above drinking water guideline values are unlikely to be of concern.

Samples from groundwater wells VL-MW02, VM-MW01, VM-MW03 and VS-MW02 (previously sampled and analysed for PFAS) were sampled and analysed for PFAS.

Concentrations of PFOS and PFOA in the sample collected from VM-MW01 (chlorine plant – fire training area) were not detected above LOR.

Concentrations of PFOS + PFHxS in samples collected from VL-MW02 (sewage treatment plant), VM-MW03 (chlorine plant – fire training area) and VS-MW02 (transformer yard) exceeded the drinking water (guideline values. With the absence of known potable groundwater users on-site or on adjacent, down gradient areas, concentrations of PFAS above drinking water guideline values are unlikely to be of concern.

A comparison of the results reported during PFAS groundwater monitoring rounds undertaken in 2014, 2015 and 2018 is provided in **Table 10.1** below

Table 10.1: Comparison of PFAS Groundwater Monitoring Data

Location	Groundwater Well	PFOS (µg/L) - 2014	PFOA (µg/L) - 2014	PFOS (µg/L) - 2015	PFOA (µg/L) - 2015	PFOS (µg/L) - 2018	PFOA (µg/L) - 2018
A Station	VB-MW01	0.13	0.04	0.26	0.16	NA	NA
	VB-MW02	1.53	0.08	1.14	0.12	NA	NA
	VB-MW05	NA	NA	NA	NA	<LOR	<LOR
B Station	VA-MW06	<LOR	<LOR	NA	NA	NA	NA
	VA-MW03	<LOR	<LOR	NA	NA	NA	NA
	VA-MW02	<LOR	<LOR	NA	NA	NA	NA
	VA-MW01	<LOR	<LOR	NA	NA	NA	NA
	VA-MW05	NA	NA	NA	NA	<LOR	<LOR
Transformer Area	VC-MW04	<LOR	<LOR	NA	NA	NA	NA
	VC-MW05	NA	NA	NA	NA	0.09	0.02
	VC-MW02	NA	NA	NA	NA	0.09	0.4
	VC-MW01	NA	NA	NA	NA	<LOR	<LOR

11 Conclusions and Recommendations

Jacobs has undertaken the groundwater monitoring for PFAS contamination at the Vales Point Power Station located at Mannering Park NSW.

Based on site observations and the results of the laboratory analysis, PFAS compounds are present within groundwater at selected locations surrounding the operational areas of the power station site. contamination is present within soils and groundwater beneath the site. PFAS compounds were not detected at concentrations above LOR in groundwater monitoring wells surrounding the ash dam.

A number of groundwater wells reported PFOS + PFHxS concentrations above drinking water guidelines. With the absence of known potable groundwater users on-site or on adjacent, down gradient areas, concentrations of PFAS above drinking water guideline values are unlikely to be of concern.

One location (VC-MW02) reported concentrations of PFOS + PFHxS concentrations above the protection of aquatic ecosystems guidelines. Inputs of PFOS + PFHxS from VC-MW02 to receiving water bodies (i.e. Lake Macquarie) at concentrations above recreational guideline value is likely to be minimal considering that concentrations of these compounds in surrounding groundwater wells were low (below recreational guidelines).

Based on the results of the monitoring, the following is recommended:

- It is likely that some secondary sources of PFAS (PFAS in soil) are present around the operational areas of the power station. Based on the results of the report, these secondary sources (currently) are unlikely to represent a significant source to groundwater contamination or a risk to groundwater receptors or receiving environments. However, whilst the secondary source remains on-site, the potential remains for this secondary source to impact groundwater especially in the event that site conditions change (namely demolition and removal of hardstand areas which could increase direct infiltration of water into sub-soils). Annual monitoring from selected groundwater wells for a period of two years should be undertaken to assess that these secondary sources are not impacting upon groundwater beneath the site. Following completion of the two annual monitoring rounds, a review should be undertaken to reassess the requirements for ongoing monitoring. The annual monitoring should include location VO-MW15 to further confirm the results obtained during the Jacobs (2018) monitoring program.

12 Limitations

The sole purpose of this report and the associated services performed by Jacobs is to assess the condition of the site (with respect to soil and groundwater contamination) in accordance with the scope of services set out in the contract between Jacobs and Delta Electricity (the Client). That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any), from observations made during the investigations and data from analytical laboratories. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs' Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

Water Treatment Plant	VI-MW01	<LOR	<LOR	0.16	0.19	NA	NA
Sewage Treatment Plant	VL-MW01	<LOR	<LOR	NA	NA	NA	NA
	VL-MW02	0.17	<LOR	0.11	<LOR	0.06	0.02
	VL-MW03	<LOR	<LOR	NA	NA	NA	NA
Chlorine Plant – Fire Training Area	VM-MW01	<LOR	<LOR	NA	NA	<LOR	<LOR
	VM-MW03	3.52	0.08	NA	NA	0.03	0.01
Adjoining TransGrid Transformer Yard	VS-MW05	<LOR	<LOR	NA	NA	NA	NA
	VS-MW04	<LOR	<LOR	NA	NA	NA	NA
	VS-MW03	<LOR	<LOR	NA	NA	NA	NA
	VS-MW02	<LOR	<LOR	NA	NA	0.03	0.04
	VS-MW01	<LOR	<LOR	NA	NA	NA	NA

With the exception of PFAS concentrations detected in VS-MW02, all other monitoring locations (where analytical information was available) returned reduced concentrations of PFAS compounds. The reduction of PFAS concentrations could be associated with false/positive results associated with the sampling programs undertaken in 2014 and 2015. These false/positives are likely to indicate that earlier concentrations of PFAS reported in groundwater wells are likely to be conservative and represent increased concentrations. Although concentrations of PFAS detected in VS-MW02 during March 2018 had increased in comparison to those reported in 2014, the concentrations detected were still below recreational water use and protection of aquatic ecosystems guidelines.

Samples from groundwater wells VD-MW05 and VJ-MW02 (located to the north and north east of Tom Barney Oval – hydraulically down gradient of where foam may have been used during power station games) were sampled and analysed for PFAS.

Concentrations of PFOS and PFOA in the sample collected from VD-MW05 were not detected above LOR.

Concentrations of PFOS + PFHxS in the sample collected from VJ-MW02 exceeded the drinking water guideline values. With the absence of known potable groundwater users on-site or on adjacent, down gradient areas, concentrations of PFAS above drinking water guideline values are unlikely to be of concern.

10 Discussion

The following provides a discussion based on the results of the monitoring and in consideration of the project objectives as detailed below:

- undertake a preliminary assessment of PFAS in groundwater around potential sources which haven't been tested previously (i.e. wells around the ash dam) and in downgradient areas form where PFAS has been previously detected in soil samples (i.e. A Station, B Station, Transformer Area); and
- validate selected results obtained during the ERM (2014) investigation in line with current sampling, sample handling, decontamination and analytical methodologies.

Based on information from previous investigations, no groundwater sampling for PFAS had been undertaken around the ash dam area. The results of the groundwater monitoring indicated the following with respect to PFAS concentrations in groundwater around the ash dam

Samples for PFAS analysis were collected from groundwater wells VO-MW02, VO-MW07, VO-MW11, VO-MW12, VO-MW13, VO-MW14, VO-MW15, VO-MW18, VU-MW16 and VU-MW17 surrounding the ash dam. With exception of well VO-MW15, all samples reported PFAS concentrations below the laboratory LOR.

Selected PFAS compounds were detected in VO-MW15 at concentrations exceeding the drinking water, recreational water use and protection of aquatic ecosystems guideline values. Based on localised topography, groundwater and surface water levels (Mannering Lake), groundwater at VO-MW15 may be influenced by westerly groundwater flow gradients from localised mounding of surface water within Mannering Lake and easterly groundwater flow gradient from the elevated topography to the west of VO-MW15 (Wyee residential areas). With the absence of PFAS (concentrations below LOR) in other samples collected from around the ash dam and Mannering Lake, the PFAS may be associated with inputs from areas to the west of the groundwater well location. Residential areas are not located up gradient of other groundwater wells sampled from around the ash dam.

Regional groundwater flow direction is likely to be in a north to north easterly direction towards Lake Macquarie. Groundwater wells located to the north (VO-MW12) and north east (VO-MW07 and VO-MW02) of VO-MW15 that were subjected to sampling and analysis did not report PFAS concentrations above LOR. This is likely to indicate that PFAS detected within VO-MW15 is not likely to be present at measurable quantities at down gradient areas which could represent a risk to receptors (Lake Macquarie and beneficial users of groundwater – stock and domestic).

Additional monitoring from VO-MW15 was undertaken in April 2018 to validate the analytical data from the March 2018 monitoring event. The results of the April 2018 monitoring indicated PFAS concentrations below the LOR. The blind and split duplicate samples collected during the April 2018 were duplicate samples from VO-MW15. Both these duplicate samples reported PFAS concentrations below the LOR. The results from the sample collected from VO-MW15 during the April 2018 monitoring event are considered more reliable based on the following:

- All three samples (one primary + two duplicates) collected from VO-MW15 during the April 2018 monitoring event reported PFAS concentrations below the LOR. Only one primary sample was collected from VO-MW15 during the March 2018 monitoring event.
- Samples from VO-MW15 were collected and handled using the same methods during both the March and April 2018 monitoring events.

Location	Electrical Conductivity (µS/cm)	Redox (mV)	pH	Dissolved Oxygen (ppm)	Temperature (°C)
VA-MW05	7800	141.9	4.53	6.77	25.5
VB-MW05	10100	275.1	4.96	5.23	32.0
VC-MW01	9800	311.4	4.88	0.56	37.3
VC-MW02	8056	54.2	5.88	0.0	25.1
VC-MW05	9100	-25.1	5.82	0.09	32.5
VL-MW02	65.3	207.4	4.38	3.47	24.6
VM-MW01	300	28.0	6.88	0.0	35.2
VM-MW03	24.5	1.27	4.85	1.24	35.6
VO-MW02	15409	-87	5.04	2.22	22.0
VO-MW07	134.1	241.6	4.58	3.57	20.8
VO-MW08	Could not be located				
VO-MW10	Sample could not be retrieved using low flow				
VO-MW12	25975	162.8	3.96	7.74	21.6
VO-MW15	17.4	151.9	4.58	1.37	23.2
VO-MW19	Dry				
VS-MW02	15.8	228.2	5.23	4.65	40.2
VU-MW16	676	230.0	4.84	0.71	20.9
VU-MW17	12.9	114.5	4.90	7.84	23.8

Table 9.4: General Water Quality Parameters (April 2018)

Location	Electrical Conductivity (µS/cm)	Redox (mV)	pH	Dissolved Oxygen (ppm)	Temperature (°C)
VD-MW05	2652	-119.6	4.70	<DL	23.9
VJ-MW02	2908	-115.7	5.25	<DL	24.1
VO-MW11	428.4	192.8	4.28	<DL	18.9
VO-MW13	600	-13.7	4.21	0.54	21.6
VO-MW14	320.3	-115.1	5.44	<DL	20.6
VO-MW15	292.7	-97.0	5.04	1.53	22.5
VO-MW18	16039	-107.9	4.08	0.3	20.1
VU-MW20	Dry				

Notes:

- <DL – Less than the detection limit of the water quality meter

The general water quality parameters measured at the respective groundwater well locations indicated the following:

- Groundwater is generally acidic.

9 Results

9.1 Groundwater Flow Gradients

Groundwater levels within each of the wells were measured to allow for the calculation of groundwater flow gradients. The measured and reduced (relative to the survey information contained within the ERM 2014 investigation) groundwater levels are contained in **Tables 9.1** and **9.2.**

Table 9.1: Groundwater Well Level Information (March 2018)

Well ID	Relative Height (m AHD TOC)	Groundwater Level (m BTOC)	Relative Level of Groundwater (m AHD)
VA-MW05	3.16	2.63	0.53
VB-MW05	2.81	2.01	0.8
VC-MW01	2.93	1.99	0.94
VC-MW02	2.98	2.36	0.62
VC-MW05	2.79	2.06	0.73
VL-MW02	8.29	3.63	4.66
VM-MW01	2.93	2.32	0.61
VM-MW03	2.84	2.13	0.71
VO-MW02	7.03	4.69	2.34
VO-MW07	18.69	5.51	13.18
VO-MW08	23.35	Could not be located	
VO-MW10	31.66	8.45	23.21
VO-MW12	11.96	1.14	10.82
VO-MW15	18.37	3.14	15.23
VO-MW19	19.24	Dry	
VS-MW02	2.97	2.44	0.53
VU-MW16	19.69	4.29	15.4
VU-MW17	35.63	4.57	31.06

Notes:

- m BTOC – m below top of casing
- m TOC – m top of casing
- Relative level of groundwater reported as metres Australian Height Datum (AHD)
- AHD levels from ERM (2014)
- Groundwater levels as measured 13.3.18, 14.3.18 and 15.3.18

Table 9.2: Groundwater Well Level Information (April 2018)

Well ID	Relative Height (m AHD TOC)	Groundwater Level (m BTOC)	Relative Level of Groundwater (m AHD)
VD-MW05	6.62	4.15	2.47
VJ-MW02	7.70	4.14	3.56
VO-MW11	32.72	9.75	22.97
VO-MW13	18.53	5.04	13.49

8 Site Assessment Criteria

To address potential health and environmental impacts within the site, analytical test results have been compared against a set of health and ecological based groundwater investigation levels referred to as Site Assessment Criteria (SAC). SAC are considered to be appropriate for the current land use and main potential receptors of concern (i.e. commercial/industrial guidelines, stock drinking water, freshwater receiving water bodies and primary and secondary contact users of Lake Macquarie).

That is, the SAC have been set at levels that provide confidence that contaminant concentrations below the SAC will not adversely affect human health, stock health or aquatic ecosystems.

The NEPM (2013) outlines a tiered approach for the assessment of human health and ecological risks associated with contaminated sites. Three tiers are defined as:

- Tier 1 (or screening level) assessment is the first stage of assessment at the site. It includes a comparison of known site data with published risk-based guidance levels. The assessment provides an initial screening of the data to determine whether further assessment is required. Exceedence of Tier 1 criteria is generally used to define the contaminants that require more detailed assessment at Tier 2.

- A Tier 2 assessment is typically required when one or more contaminants are present at the site at levels that exceed Tier 1 guidance criteria, if there are no appropriate Tier 1 criteria, or if there are unresolved and significant uncertainties (limiting the reliability of the assessment conducted) identified in the Tier 1 assessment). Exceedance of the Tier 2 criteria trigger a Tier 3 risk assessment.

- A Tier 3 assessment may be required where exceedence of Tier 2 site-specific risk-based criteria is judged to represent a potentially unacceptable risk to human health. The Tier 3 assessment typically focuses on the risk-driving contaminants in more detail, although studies aimed at reducing the uncertainties inherent in the modelling of exposure pathways are also common at Tier 3.

- Sample analytical results will be screened against Tier 1 criteria to provide an initial screen of risk to human health or ecological receptors. Where results exceed the investigation Tier 1 criteria, further assessment will be required to determine the potential for unacceptable risks to the relevant receptor (i.e. Tier 2 or 3 assessment).

There are no generic risk screening values for PFAS in the NEPM (2013). However, the PFAS NEMP (2018) provides guideline values to inform site investigations. These guideline values are based on existing nationally-agreed guidelines or have been derived based on recognised processes. The PFAS NEMP notes that the guideline values include a degree of conservatism in order to be protective of affected communities where multiple exposure pathways may be present.

The guideline values cover risks to human health and risks to ecological receptors. The guideline values are described in further detail in the sections below.

8.1 Investigation criteria for the protection of human health

The PFAS NEMP includes guidance values for the sum of PFOS and PFHxS and for PFOA in drinking water and recreational water for the protection of human health. These are based on the guidance issued by Department of Health (2017). The guideline values are presented in **Table 8.1**.

7 Quality Assurance and Quality Control

For the purpose of assessing the quality of data presented in this report, Jacobs collected and analysed various Quality Control (QC) samples (blind duplicate, split replicate and rinsate samples), while the laboratory completed their own internal QC. The current section of this report is focused on the presentation of the results of these QC samples, adherence to Quality Assurance (QA) systems and discussion of deviations, if any from the DAC.

7.1 Field Quality Assurance

All samples were collected by experienced Jacobs environmental scientists, under established Jacobs protocols. Adherence to Jacobs protocols by experienced field staff trained in sample collection and handling techniques ensures the quality and representativeness of the samples collected.

7.2 Field Quality Control

7.2.1 Blind Duplicate and Split Replicate Analysis

The following blind duplicate and split replicate samples were collected for laboratory analysis.

- Blind Duplicate: DUPA (duplicate of groundwater sample VU-MW16), DUPC (duplicate of groundwater sample VL-MW02) and DUPE (duplicate of groundwater sample VO-MW15)
- Split Replicate: DUPB (replicate of groundwater sample VU-MW16), DUPD (replicate of groundwater sample VL-MW02) and DUPF (replicate of groundwater sample VO-MW15).

Three blind duplicate and split replicate groundwater samples were analysed to assess the quality control during the field sampling program. This equates to 14% blind duplicate and split replicate analysis. This blind/split analysis exceeds and therefore conforms to the Australian Standard (AS 4482.1 - 2005) *Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds* requirement of 5%.

The Relative Percentage Differences (RPDs) for all analytes for the blind and split samples taken during the groundwater monitoring program conformed to the DAC with the exception of:

- PFOS (RPD 131%) and perfluorononanoic acid (77%) between primary groundwater sample VL-MW02 and split replicate DUPB.

RPDs calculate the difference in magnitude between two samples and do not take into account the minor differences in actual concentrations. The reason for the differences in concentrations could be attributable to a number of reasons including (but not limited to) inherent differences in the preparation of samples, analytical procedures and analytical equipment used by the different laboratories.

As a conservative approach Jacobs have assessed groundwater quality using the higher reported concentration for PFOS in the split replicate sample. There are no guidelines values for perfluorononanoic acid.

RPD results for the blind duplicate and split replicates are presented in **Table A**.

7.2.2 Laboratory QA

All analysis was undertaken by NATA accredited laboratories using NATA accredited analytical methods.

Laboratory duplicates were performed at a rate of one duplicate for batches of 8-10 samples with an additional duplicate for each subsequent ten samples.

6.2.2 Laboratory Control Samples

Laboratory control samples consisted of a clean matrix (de-ionised water or clean sand) spiked with a known concentration of the analyte being measured. These samples monitored method recovery in clean samples and were used (where required) to evaluate matrix interference by comparison with matrix spikes.

6.2.3 Surrogates

For organic analyses, a surrogate was added at the extraction stage in order to verify method effectiveness. The surrogate was then analysed with the batch of samples and percentage recovery calculated.

6.2.4 Matrix Spike

Matrix spikes consisted of samples spiked with a known concentration of the analyte being measured, in order to identify properties of the matrix that may hinder method effectiveness. Samples were spiked with concentrations equivalent to 5 to 10 times the LOR and percentage recovery calculated.

6.2.5 Method Blanks

Method blanks (de-ionised water or clear sand) were carried through all stages of sample preparation and analysis at a rate of approximately 10%. Analyte concentrations in blanks should be less than the stated LOR. Reagent blanks were run if the method blank exceeded the LOR. The purpose of method blanks was to detect laboratory contamination.

6.3 Data Acceptance Criteria

The QA/QC Data will be assessed against the Data Acceptance Criteria (DAC) provided in **Table 6.1.**

Table 6.1: QA/QC Compliance Assessment

QA/QC sample	DQI	Objectives	Acceptance criteria
Field QA/QC samples			
Blind replicate and split samples	Precision Comparability	To ensure the primary data is reliable and fit for purpose. The assessment of blind replicate and split samples is undertaken by calculating the Relative Percent Difference (RPD) of the replicate or split concentration compared with the original sample concentration. The RPD is defined as: $\text{RPD} = 100 \times \frac{\lvert X1 - X2 \rvert}{\text{Average}}$ Where: X1 and X2 are the concentration of the original and replicate or split samples.	Analysed for the same chemicals as the primary sample. Typical RPDs are noted in AS 4482.1-2005 as between 30 – 50%. Higher RPDs may be acceptable for heterogeneous material or where concentrations are close to the LOR (ie. less than 10 times the LOR).
Trip blanks and rinsate samples	Precision Accuracy Representativeness	Ensure that cross contamination has not occurred from sampling equipment, sampling procedure, or during storage and transport of samples.	Each trip blank and rinsate sample is analysed as per the primary samples. Analytical result < LOR.
Laboratory QA/QC			

- Analyses to be performed
- Sample preservation method.

5.5 Laboratory Analysis – Water

28 (22 primary and six QA/QC samples) groundwater samples were collected and analysed for PFAS.

5.6 Analytical Parameters and Methods

Jacobs commissioned Envirolab as the primary laboratory and Eurofins as the secondary laboratory. Both Envirolab and Eurofins are NATA accredited for the testing undertaken

Where appropriate, the groundwater samples were analysed in accordance with NEPC (2013) using methods based on US EPA approved analytical methods. Specific PFAS analytical methods were based on the following:

- ISO 25101 – Water quality - Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) -- Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry
- ASTM D7979 – Standard Test Method for Determination of Perfluorinated Compounds in Water, Sludge, Influent, Effluent and Wastewater by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS).

5 Fieldwork

Jacobs undertook the groundwater monitoring at the site between 13 March 2018 and 15 March 2018. Additional monitoring was undertaken on 5 and 6 April 2018.

Groundwater monitoring was undertaken at existing wells VA-MW05, VB-MW05, VC-MW01, VC-MW02, VC-MW05, VL-MW02, VM-MW01, VM-MW03, VO-MW02, VO-MW07, VO-MW08, VO-MW10, VO-MW11, VO-MW12, VO-MW13, VO-MW14, VO-MW15, VO-MW18, VO-MW19, VS-MW02, VU-MW16, VU-MW17, VU-MW20, VD-MW05 and VJ-MW02.

The following departures from the scope of works are detailed below:

- VO-MW19: Well was dry (no water to 5.81m, base of well)
- VO-MW10: No water could be recovered from well. Water too deep for sampling method (peristaltic low flow)
- VO-MW08: Could not be located
- VU-MW20: Well was dry (no water to 11.93m, base of well).

Groundwater well locations are presented as **Figure 1**.

5.1 Well Development and Sample Collection

Fieldwork was undertaken in accordance with documented Jacobs procedures by experienced staff.

The monitoring wells were purged prior to sampling in order to remove standing or stagnant water in the well and to ensure that samples collected were representative of the groundwater within the aquifer.

Monitoring wells were purged and sampled using a peristaltic pump. The pump had flow control to minimise drawdown and new dedicated, disposable polyethylene and silicon tubing was used for the collection of each sample.

Groundwater well VO-MW11 was purged and sampled using a disposable, single use bailer (water level too deep for peristaltic pump).

The electrodes of a calibrated water quality meter (placed within a flow cell) were used to measure pH, redox potential (Eh), electrical conductivity, dissolved oxygen and temperature in water purged from the wells. Samples were collected following stabilisation of these water quality parameters (generally ± 10%). A calibration certificate for the water quality meter is presented in **Appendix A.**

Field data sheets are provided in **Appendix B**.

Water generated during monitoring of on-site wells was collected and discharged directly into the ash dam.

5.2 Decontamination Procedures

All non-disposable equipment placed within the groundwater wells (i.e. dipper) was decontaminated between groundwater well locations by rinsing in spring water.

4 Data Quality Objectives

Data Quality Objectives (DQO) are an important component of any sampling and analysis programme as they outline the aims and objectives of the investigation program with respect to the integrity of the data collection and interpretation. In order to establish the DQO and to ensure that they have been achieved the following seven-step process was undertaken. The DQO process has been adopted from the Australian Standard (AS 4482.1-2005) *Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds.*

Step 1 - State the Problem

The problem was to determine if potential PFAS contamination was present in selected groundwater well locations at concentrations which could represent an exposure risk to beneficial groundwater users and receiving environments.

Step 2 - Identify the Decision Statement

The primary decision statement that the contamination investigation will attempt to resolve is:

> "Does PFAS contamination in groundwater at the site pose an unacceptable risk to human or environmental health in the context of the site use, beneficial use of groundwater adjacent to the site and receiving environments"?

Step 3 - Identify inputs to the decision

The following informational inputs were required to resolve the decision statement:

- Information on the environmental site setting including potential source – receptor pathways
- Site observations of groundwater conditions
- Information for off-site water usage
- Laboratory analysis results for groundwater samples from the site
- National Environment Protection (Assessment of Site Contamination) Measure, as revised 2013 (NEPM, 2013)
- HEPA (January 2018) PFAS National Environment Management Plan (NEMP, 2018).

Step 4 - Define the Boundaries of the Study

The objective of the monitoring program was to assess the presence of PFAS in groundwater around potential sources which haven't been tested previously (e.g. wells around the ash dam) and to provide validation of the results obtained during the 2014 ERM investigation in line with current sampling, sample handling, decontamination and analytical methodologies and additional PFAS information from more recent monitoring. As such, the monitoring program was restricted to existing monitoring wells locations VA-MW05, VB-MW05, VC-MW01, VC-MW02, VC-MW05, VL-MW02, VM-MW01, VM-MW03, VO-MW02, VO-MW07, VO-MW08, VO-MW10, VO-MW11, VO-MW12, VO-MW13, VO-MW14, VO-MW15, VO-MW18, VO-MW19, VS-MW02, VU-MW16, VU-MW17, VU-MW20, VD-MW05 and VJ-MW02 located around both the operational power station area and the ash dam.

2 Background

Potential PFAS sources have been identified on the site. Limited soil, sediment, surface water and groundwater investigations for PFAS have been undertaken at the site to date including:

- ERM (July 2014) Project Symphony – Vales Pont Power Station. Stage 2 Environmental Site Assessment (ERM, 2014a)
- ERM (September 2014) A Station – Environmental Site Assessment – Vales Pont Power Station, NSW (ERM, 2014b)
- ERM (June 2015) Project Symphony – Vales Pont Power Station. Updated Groundwater Quality Assessment (ERM, 2015)
- Jacobs (July 2017) Vales Point Additional Baseline Contamination Assessment (Jacobs, 2017)

A review of these investigation reports with respect to PFAS and groundwater indicated the following:

- Although not specifically stated, it is likely that groundwater samples collected during the ERM investigations for PFAS analysis were placed in laboratory supplied containers which may have contained Teflon lid inserts. The Teflon inserts could provide false positive results. The current standard for laboratory supplied sample containers for PFAS analysis is to not contain Teflon inserts.
- Decontamination procedures adopted by ERM included the use of DECON 90. The WA DER (February 2016) *Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS)*, (WA DER, 2016) details that DECON 90 should not be used for decontamination of equipment used during PFAS investigations.
- The ERM PFAS suite included PFOA, PFOS, 6:2 FTS and 8:2 FTS. Current analytical PFAS suites include additional PFAS compounds including compounds which are now listed within endorsed guidance including PFHxS.
- Guidelines values for assessing PFAS risk to receptors have changed since the ERM investigations were undertaken.
- Groundwater monitoring wells around selected potential PFAS sources at the site (including the transfer area and the ash dam) had not been subjected to sampling and analysis for PFAS.

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JACOBS

PFAS Groundwater Monitoring

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▭ Site boundary

○ PFAS concentrations in groundwater samples below LOR

● PFAS detected. Concentrations below protection of aquatic ecosystems guidelines (NEMP, 2018)

Data sources
Jacobs 2018
Ausimage 2016
LPI 2018

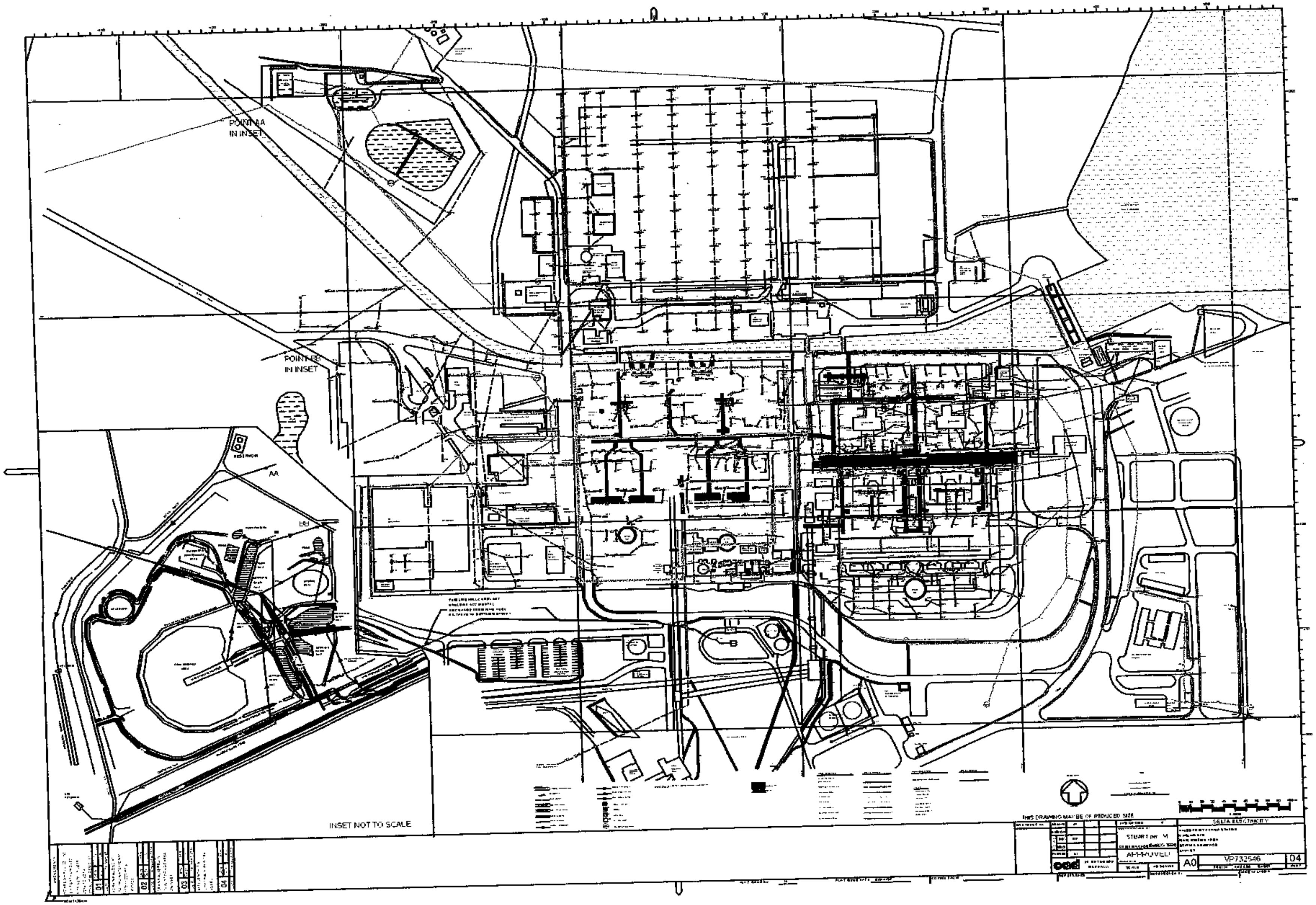
Figure 5b | Groundwater samples collected for PFAS analysis (Jacobs, 2018)

▭ Site boundary

- PFAS concentrations in soil samples below LOR
- PFAS detected. Concentrations below human health, ecological and terrestrial biota guidelines (NEMP, 2018)
- PFAS detected. Concentrations below human health and ecological guidelines (NEMP, 2018). Concentration above terrestrial biota guidelines (NEMP, 2018)

Data sources
Jacobs 2018
Ausimage 2016
LPI 2018

Figure 4 | Soil samples collected for PFAS analysis



JACOBS NSW SPATIAL - GIS MAP file IA177700_GIS_F002_SitePlan_r1v1 | 21/08/2018

Figure 2 | Sub surface drain layout plan

Figures

9. Conclusions and Recommendations

Jacobs have prepared the consolidated PFAS report for the Vales Point Power Station located at Mannering Park NSW.

Based on the information reviewed, an understanding of site settings, potential contamination associated with known historical and current site operations, and potential receptors to contamination (if present), the following conclusions have been made:

- PFAS has been detected in selected soil samples collected from beneath the A Station, B Station and the Transformer Area. Concentrations detected above the respective guideline levels (protection of soil terrestrial biota) are unlikely to represent a risk considering access to soils beneath these areas is restricted. It is unlikely that PFAS concentrations detected in soil at the site (where sampled) represent a risk to current receptors.

- PFAS was not detected above laboratory LOR in sediment samples collected from adjacent to the site within Wyee Bay and adjacent areas of Lake Macquarie. PFAS concentrations in sediments from surrounding waterways (where sampled) do not represent a risk to current receptors.

- PFAS has been detected in surface water samples collected from surrounding waterways and the ash dam at concentrations above laboratory LOR but below the respective guideline levels (protection of aquatic ecosystem, drinking water and recreational water). It is unlikely that PFAS concentrations in surface water surrounding the site (where sampled) represent a risk to current receptors.

- PFAS has been detected in groundwater samples collected from the selected areas as part of previous investigations. Six samples reported PFOS concentrations above the respective guidelines (protection of aquatic ecosystems) and one sample reported PFOS+PFHxS concentrations above recreational water guidelines. Groundwater samples reporting concentrations above guideline values were collected from A Station, Transformer Area and the water treatment plant (southern side of cooling water canal) and the sewage treatment plant and the chlorine plant (northern side of cooling water canal). Groundwater monitoring undertaken by Jacobs in 2018 was in accordance with current nationally endorsed guidelines. With the exception of one monitoring well location (which reported PFAS concentrations above recreational water guidelines), all samples reported PFAS concentrations below (protection of aquatic ecosystem, drinking water and recreational water). It is unlikely that PFAS concentrations in groundwater at the site (where sampled), with the exception of one location (VC-MW02) is representing a risk to current receptors. The concentrations of PFAS detected in VC-MW02 (above recreational water guidelines) is unlikely to represent a significant exposure risk considering the low concentrations detected in adjacent wells (elevated PFAS concentrations in groundwater is not widespread) and low to no detection of PFAS in receiving surface waters.

- Based on the information review, previous PFAS sampling and analytical results may have been affected by false/positives associated with sample methods, sample containers, decontamination procedures and analytical methods. With the exception of PFAS concentrations detected in VS-MW02, all other monitoring locations (where analytical information was available) returned reduced concentrations of PFAS compounds between the groundwater sampling undertaken by ERM in 2014/2015 and Jacobs in

Location	Source	Contaminants of Concern	Contamination Mechanism	Contamination Depth	Receptor	Comments
						Recent monitoring data indicates that concentrations of PFAS do not represent an exposure risk to receptors.
Chlorine Plant Fire Training	Soils (surface and depth)	PFAS	PFAS contamination in soils surrounding firefighting training area from extinguisher use	Surface and depth	Site users and groundwater	Soils within the chlorine plant area could contain PFAS. Previous analytical results indicated PFAS impacts in groundwater. Recent monitoring data indicates that concentrations of PFAS do not represent an exposure risk to receptors.
Chain Valley Retention Basin	Water and/or sediment within retention pond	PFAS	Discharges of PFAS to on-site drainage system	Surface	Surface water and groundwater	Under normal conditions, water from the retention pond discharges to the ash dam. Surface water and groundwater samples collected from eth ash dam do not indicate PFAS exposure risk to receptors.
Tom Barney Oval	Soils where AFFF from fire extinguishers possibly used during power station safety games	PFAS	Infiltration of AFFF during firefighting activities into soils.	Surface and depth	Site users and groundwater	Soils within Tom Barney Oval could contain PFAS. Groundwater monitoring data indicates that concentrations of PFAS in areas down gradient of the Tom Barney Oval do not represent an exposure risk to receptors.
Ash Dam	Sediment from cooling water canal	PFAS	PFAS contaminated sediments from the cooling water canal disposed of at ash dam	Surface and depth	Surface water and groundwater	Surface water and groundwater samples collected do not indicate PFAS exposure risk to receptors. Sediment results do not indicate that a secondary source of PFAS contamination is present within the sediments of the ash dam.
AFFF Storage Area	Concrete beneath and soils immediately surrounding storage area	PFAS	Leaks and spills of AFFF	Surface and depth	Site users and groundwater	Soils within the AFFF storage area could contain PFAS. Groundwater monitoring data indicates that concentrations of PFAS in areas down gradient of the AFFF storage area (i.e. B

- **Table 8.1 – Conceptual Site Model**

Location	Source	Contaminants of Concern	Contamination Mechanism	Contamination Depth	Receptor	Comments
A Station	Soils in the vicinity of former cable tunnel fire (1992)	PFAS	Infiltration of AFFF and AFFF impacted surface water during firefighting activities into sub-soils through joints, cracks within the hardstand area	Surface and depth	Site users and groundwater	Soil samples collected do not indicate PFAS exposure risk to site occupants under current land use. PFAS concentrations detected in soil samples (although under guidelines) or other secondary sources maybe contributing to elevated concentrations of PFAS detected within and down gradient of A Station.
	Soils in the vicinity of sub-surface drains		Infiltration of AFFF and AFFF impacted surface water during firefighting activities into sub-soils through joints, cracks within sub-surface drains	Surface and depth	Groundwater	PFAS concentrations detected in soil samples (although under guidelines) maybe contributing to elevated concentrations of PFAS detected in groundwater well MC-MW02
	Sediment within sub-surface drains		Residual AFFF impacted sediment within sub-surface drains	Surface	Site users and surface water	No sediment samples collected from sub-surface drains. The absence of elevated PFAS concentrations (above guideline levels) in surface water samples collected from the outlet of the cooling water canal and the ash dam (where sediments from the canal are periodically deposited) suggest that sediments from the drains are not contributing significant PFAS loading to receiving areas.
	Soils below storage areas		Leaks and spills from AFFF on firefighting trolleys and in firefighting boxes infiltrating into sub-soils through joints, cracks within the hardstand area	Surface and depth	Site users and groundwater	Soil samples collected do not indicate PFAS exposure risk to site occupants under current land use. PFAS concentrations detected in soil samples (although under guidelines) or other secondary sources maybe contributing to elevated concentrations of PFAS detected within and down gradient of A Station.

		Groundwater samples analysed for PFAS did not report concentrations exceeding the NEMP (2018) recreational water and protection of aquatic ecosystems guidelines. Sediment and surface water samples collected from waterways (Mannering Bay, Mannering Creek and Wyee Cree) surrounding the ash dam did report PFAS concentrations above the LOR of the SAC. The results would indicate that surface water and sediment within the surrounding waterways are not impacted by PFAS associated with discharges from the ash dam. The ash dam currently is unlikely to represent a PFAS source which is impacting upon human health and/or environmental receptors.
AFFF Storage Area	Soils (surface and depth)	No media sampling (soil, sediment, surface water and/or groundwater) for PFAS analysis has been undertaken in areas within and adjacent to the AFFF storage area. If present, PFAS contamination is likely to be sourced from historical spills and leaks and concentrated within the concrete underlying the facility and immediately surrounding soils. Recent groundwater monitoring indicates that concentrations in groundwater down gradient of the AFFF storage area and adjacent to the cooling water canal are below the NEMP (2018) guidelines for the protection of aquatic ecosystems. Groundwater wells located between the cooling water canal and the AFFF storage area (B Station wells) did not contain concentrations of PFAS above respective guideline levels.
Fuel Oil Tanks	Soils (surface and depth)	AFFF is used within the deluge system of the fuel oil tanks. No reported fires have occurred within the fuel oil storage tank area. No media sampling (soil, sediment, surface water and/or groundwater) for PFAS analysis has been undertaken in areas within and adjacent to the fuel oil tanks If present, PFAS contamination is likely to be sourced from the periodic testing of the deluge system and concentrated within the concrete underlying the facility and immediately surrounding soils. Recent groundwater monitoring indicates that concentrations in groundwater down gradient of the fuel oil tanks and adjacent to the cooling water canal are below the NEMP (2018) guidelines for the protection of aquatic ecosystems.
Areas adjoining TransGrid transformer yard	Information to date does not indicate potential PFAS source	No known fires have occurred with the TransGrid transformer yard. Where tested, PFAS were not detected in soil samples at concentrations exceeding LOR. PFAS was detected in one groundwater at concentrations above the LOR but below the NEMP (2018) guidelines for recreational water and the protection of aquatic ecosystems

Water Treatment Plant	Soils (surface and depth) and sub-surface drain sediment.	No soil sampling for PFAS analysis was undertaken within the water treatment plant area. A sample collected from groundwater well location VI-MW01 during 2015, reported concentrations of PFOS exceeding the NEMP (2018) freshwater and marine aquatic ecosystems guideline values (95% species protection). The detection of PFAS compounds may also be attributable to or be influenced by false/positive results during earlier investigations associated with the use of detergents during decontamination, Teflon inserts in sample containers and laboratory analytical methods. PFAS may be present as a secondary source/s below the water treatment plant or be influenced by the PFAS known to be present in the southern portion of the adjoining A Station. Secondary source/s maybe contributing to PFAS concentrations detected in groundwater. Recent groundwater monitoring indicates that concentrations in groundwater down gradient of the secondary source/s and adjacent to the cooling water canal are below the NEMP (2018) guidelines for the protection of aquatic ecosystems.
Main Store	Surface soils (beneath hard stand).	Minor quantities of AFFF may have been or are currently stored within the main store. PFAS was not detected above LOR in soil samples analysed. No groundwater sampling for PFAS analysis was undertaken within the main store area. Recent groundwater monitoring indicates that concentrations in groundwater down gradient of the main store and adjacent to the cooling water canal are below the NEMP (2018) guidelines for the protection of aquatic ecosystems.
Sewage Treatment Plant	Water and/or sediment within settlement ponds	There is no known storage or use of AFFF within the sewage treatment plant. PFAS was not detected above LOR in soil samples analysed. PFOS was detected above LOR at one groundwater location (VL-MW02) adjacent to settlement pond). The concentration of PFOS reported at this location exceeded the NEMP (2018) guidelines for the protection of aquatic ecosystems. More recent groundwater monitoring from this location reported PFAS concentrations below NEPM (2018) recreational water and protection of aquatic ecosystems guidelines. With the absence of PFAS compounds in soils at concentrations exceeding the LOR from the sewage treatment plant and no known AFFF storage, the PFOS concentrations reported in groundwater maybe attributable to water and/or sediment within the settlement ponds. This is further supported by the higher groundwater levels reported at location VL-MW02 compared to other wells within the sewage treatment plant area which could indicate potential connectivity between the well and the ponds. The detection of PFAS compounds may also be attributable to or be influenced by false/positive results during earlier investigations associated with the use of detergents during decontamination, Teflon inserts in sample containers and laboratory analytical methods.
Chlorine Plant - Fire	Soils (surface and depth)	Fire training was undertaken within this area and may have used extinguishes containing AFFF. Although there is a concrete sealed and bunded area on-site, there

7. PFAS Source Assessment

Based on site condition, an understanding of how potential PFAS containing products have been historically used and stored on site and the review of previous investigations, a PFAS source assessment for areas on the site has been undertaken and is detailed in **Table 7.1** below. The sources detailed are those which could potentially impact upon groundwater and surface water and migrate off-site.

Table 7.1: Potential PFAS Sources

Location	Potential Source	Comments
A Station	Soils (surface and depth) and sub-surface drain sediment.	Cable tunnel fire in 1992 was extinguished with foam. Majority of A Station operational area does not have separate clean and dirty water drainage systems (i.e. majority of all surface water discharges to cooling water canal). Minor quantities of AFFF may have been stored within firefighting trolleys and in firefighting boxes. Minor fires may have been extinguished with AFFF from extinguishers. PFOS and PFOA detected in soils (0.3m to 1.5m) at selected locations at concentrations below NEMP (2018) human health and ecological guideline values. Detections of PFAS compounds in soils maybe attributable to vertical migration of AFFF impacted water through site hardstand and leaks within sub-surface drains during firefighting activities, possible leaks and spillages associated with AFFF storage. It is also possible that PFAS impacted sediments may be present within the sub-surface drains. PFOA and PFOS were detected above laboratory levels of reporting (LOR) in groundwater at selected locations. Samples collected from groundwater well location VB-MW02 during 2014 and 2015, reported concentrations of PFOS exceeding the NEMP (2018) guidelines for the protection of aquatic ecosystems. The detection of PFAS compounds may also be attributable to or be influenced by false/positive results during earlier investigations associated with the use of detergents during decontamination, Teflon inserts in sample containers and laboratory analytical methods. PFAS may be present as a secondary source/s below the southern portion of A Station. The secondary source/s may contain PFAS concentrations below the respective soil guidelines, but still maybe contributing to PFAS concentrations in groundwater. Recent groundwater monitoring indicates that concentrations in groundwater down gradient of the secondary source/s (if present) and adjacent to the cooling water canal are below the NEMP (2018) guidelines for the protection of aquatic ecosystems.
B Station	Surface soils (beneath hard stand).	Transformer fire in 2006 was reportedly extinguished using the deluge system which does not contain AFFF. Minor quantities of AFFF may have been or are currently stored within firefighting trolleys and in firefighting boxes. Minor fires may have been extinguished with AFFF from extinguishers.

In summary:

- PFAS has been detected in selected soil samples collected from beneath the A Station, B Station and the Transformer Area. All these areas are located on the operational power station site to the south of the cooling water canal. Concentrations of PFOS in five samples exceeded the NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds). Considering that these areas are covered by hardstand and access to underlying soils is restricted, the soils underlying these areas and associated biota are unlikely to represent a food source to wildlife and/or birds.

- PFAS was not detected in sediment samples collected from adjacent to the site within Wyee Bay, adjacent areas of Lake Macquarie, Mannering Lake, Mannering Bay, Mannering Creek and Wyee Creek.

- PFAS has been detected in samples collected by RCA in 2018 from surrounding surface waters and the ash dam. The concentrations of PFAS detected in surface water samples were below the NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water, drinking water and recreational water guidelines.

- PFAS has been detected in groundwater samples collected from the selected areas as part of previous investigations. Six samples reported PFOS concentrations above the respective NEMP (2018) guidelines (protection of aquatic ecosystems) and one sample reported PFOS+PFHxS concentrations above the NEMP (2018) recreational water guidelines. These samples were collected from A Station, Transformer Area and the water treatment plant (southern side of cooling water canal) and the sewage treatment plant and the chlorine plant (northern side of cooling water canal). PFAS was not detected above LOR or the SAC in groundwater wells located between the operational areas of the site and Mannering Park.

- In consideration of where PFAS has been detected in soils and groundwater and groundwater flow directions, a secondary source of PFAS (PFAS in soil) maybe present below the operational areas of the power station in the vicinity of the southern portion of A Station and the water treatment plant. The sporadic detection of PFAS in groundwater wells adjacent to the southern side of the cooling water canal (including concentration of PFOS+PFHxS exceeding NEMP recreational guidelines in well VC-MW02) could indicate other secondary sources within the operational area of the power station (in the absence of additional soil PFAS data).

- Secondary sources of PFAS (soil and/or water within ponds) maybe present in the vicinity sewage treatment plant and potentially within soils underlying the chlorine pant (former fire training area), however it is noted that no soil samples have been collected in the vicinity of the chlorine plant. The groundwater heights recorded during the Jacobs (2018a) monitoring indicated a groundwater gradient flowing from the sewage treatment plant towards the chlorine plant. Similar concentrations of PFAS were detected in wells (VL-MW02 and VM-MW03) located within these respective areas. The sporadic detection of PFAS in groundwater wells adjacent to the northern side of the cooling water canal could indicate other secondary sources including the TransGrid transformer yard (in the absence of additional soil PFAS data).

B Station	9	0-1.1	2	1	PFOS in one soil sample exceeded the NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)
Transformer Area	7	0-4.1	3	1	PFOS in one soil sample exceeded the NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)
Main Store	1	0.9-1.1	0	0	
Sewage Treatment Plant	1	1.4-1.6	0	0	
Adjacent TransGrid Transformer Yard	6	0.4-1.6	0	0	

Table 5.8: Summary of Sediment PFAS Results

Site Location	Sediment Samples (No.)	Depth Range (m)	Detections above LOR	Detections above NEMP (2018)	Comment
Wyee Bay and Lake Macquarie	8	0.5	0	0	
Mannering Lake	1	0.5	0	0	
Mannering Bay	3	0.5	0	0	
Mannering Creek	1	0.2	0	0	
Wyee Creek	1	0.3	0	0	

Table 5.9: Summary of Groundwater PFAS Results

Site Location	Groundwater Samples (No.)	Detections above LOR	Detections above NEMP (2018)	Comment
A Station	5	5	3	PFOS in three samples exceeded the NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
B Station	6	1	0	
Transformer Area	4	2	1	PFOS+PFHxS in one sample exceeded the NEMP (2018) recreational water guidelines

All samples were collected in accordance with the relevant methods detailed in the PFAS NEMP (2018) and the WA DER (2017) guidelines into laboratory supplied containers and submitted to NATA accredited laboratories for PFAS (extended suite) analysis. The results of the laboratory analysis were compared to the guideline levels detailed in the PFAS NEMP (2018).

The concentrations of PFAS compounds in all groundwater, surface water and sediment samples analysed were below the laboratory LOR and the SAC.

Based on site observations and the results of the laboratory analysis the following was concluded:

- Groundwater between the operational area of the site and Mannering Park has not been impacted by PFAS. The absence of detectable PFAS in groundwater at the locations tested and the groundwater flow direction would indicate that the risk to groundwater users within Mannering Park from an on-site source of PFAS (if present) is low
- Surface water and sediments within the ash dam (Mannering Lake) and Mannering Bay are not impacted by PFAS and sediment is unlikely to represent a secondary source of PFAS contamination at these locations
- Surrounding waterways (Wyee Creek, Mannering Creek and Mannering Bay) are not impacted by PFAS associated with discharges from the ash dam (Mannering Lake).

The Jacobs (2018b) additional PFAS investigation report is provided in **Appendix B**.

5.13 Site Inspection and Anecdotal Information

Anecdotal information and observations made during a site inspection undertaken by Jacobs and Delta representatives on 27 February 2018 and other information provided by Delta with respect to potential PFAS contamination are detailed below:

- Information provided by Delta (article) indicated that a cable tunnel fire occurred beneath the A Station in 1992. The article indicated that the fire was detected shortly after 6pm on 18 June 1992 which spread to underground cabling. The underground cable tunnels were flooded with high expansion foam and with the help of the fire sprinkler systems installed in the tunnels, the fire was extinguished the following day.
- The 2006 transformer fire (B Station) was extinguish by the station deluge system (water only)
- The 2011 Unit 5A Air Heater fire was initially extinguished by the station deluge system (water only) but NSW Fires Services may have used some AFFF on the fire.
- Anecdotal information indicated no recollection of other fires having occurred in the site
- The Vales Point Fire Training area comprises a small concrete pad and bunding (nominal 2m x 2m). Anecdotal information indicated that this area was only used to discharge fire extinguishers. It is not known whether these extinguishers contained PFAS

Groundwater Location	Concentration	Comment
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VO-MW12	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VO-MW13	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VO-MW14	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VO-MW15 (March 2018)	**PFOA – 0.04 µg/L**	Below NEMP (2018) drinking water, recreational and aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water guidelines
	PFOS – 1.4 µg/L	Exceeds NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	PFOS+PFHxS- 2.7 µg/L	Exceeds NEMP (2018) drinking water and recreational guidelines
VO-MW15 (April 2018)	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VU-MW17	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VU-MW16	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VO-MW18	PFOA - <0.01 µg/L	Concentrations below LOR

Groundwater Location	Concentration	Comment
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- 0.02 µg/L	Below NEMP (2018) drinking water and recreational guidelines
Transformer Yard		
VC-MW01	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VC-MW02	**PFOA – 0.04 µg/L**	Below NEMP (2018) drinking water, recreational and aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water guidelines
	PFOS – 0.09 µg/L	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	PFOS+PFHxS- 1.89 µg/L	Exceeds NEMP (2018) drinking water and recreational guidelines
VC-MW05	**PFOA – 0.04 µg/L**	Below NEMP (2018) drinking water, recreational and aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water guidelines
	PFOS – 0.09 µg/L	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	PFOS+PFHxS- 0.2 µg/L	Exceeds NEMP (2018) drinking water guidelines. Below NEMP (2018) recreational guidelines
Sewage Treatment Plant		
VL-MW02	**PFOA – 0.02 µg/L**	Below NEMP (2018) drinking water, recreational and aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water guidelines
	PFOS – 0.06 µg/L	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
	PFOS+PFHxS- 0.17 µg/L	Exceeds NEMP (2018) drinking water guidelines. Below NEMP (2018) recreational guidelines
Chlorine Plant – Fire Training Area		
VM-MW01	PFOA - <0.01 µg/L	Concentrations below LOR
	PFOS - <0.01 µg/L	Concentrations below LOR
	PFOS+PFHxS- <0.02 µg/L	Concentrations below LOR
VM-MW03	**PFOA – 0.01 µg/L**	Below NEMP (2018) drinking water, recreational and aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water guidelines

- A higher relative groundwater level was reported in VL-MW02 (compared to surrounding wells). This groundwater level may be locally influenced by the ponds of the sewage treatment plant.

Samples for PFAS analysis were collected from groundwater wells VO-MW02, VO-MW07, VO-MW11, VO-MW12, VO-MW13, VO-MW14, VO-MW15, VO-MW18, VU-MW16 and VU-MW17 surrounding the ash dam. With exception of well VO-MW15, all samples reported PFAS concentrations below the laboratory LOR.

Selected PFAS compounds were detected in VO-MW15 at concentrations exceeding exceeded the drinking water, recreational water use and protection of aquatic ecosystems guideline values. Based on localised topography, groundwater and surface water levels (ash dam reservoir), groundwater at VO-MW15 may be influenced by westerly groundwater flow gradients from localised mounding of surface water within the ash dam and easterly groundwater flow gradient from the elevated topography to the west of VO-MW15 (Wyee residential areas). With the absence of PFAS (concentrations below LOR) in other samples collected from around the ash dam and Mannering Lake, the PFAS may be associated with inputs from areas to the west of the groundwater well location. Residential areas are not located up gradient of other groundwater wells sampled from around the ash dam.

Regional groundwater flow direction is likely to be in a north to north easterly direction towards Lake Macquarie. Groundwater wells located to the north (VO-MW12) and north east (VO-MW07 and VO-MW02) of VO-MW15 that were subjected to sampling and analysis did not report PFAS concentrations above LOR. This is likely to indicate that PFAS detected within VO-MW15 is not likely to be present at measurable quantities at down gradient areas which could represent a risk to receptors (Lake Macquarie and beneficial users of groundwater – stock and domestic).

Additional monitoring from VO-MW15 was undertaken in April 2018 to validate the analytical data from the March 2018 monitoring event. The results of the April 2018 monitoring indicated PFAS concentrations below the LOR. The blind and split duplicate samples collected during the April 2018 were duplicate samples from VO-MW15. Both these duplicate samples reported PFAS concentrations below the LOR. The results from the sample collected from VO-MW15 during the April 2018 monitoring event are considered more reliable based on the following:

- All three samples (one primary + two duplicates) collected from VO-MW15 during the April 2018 monitoring event reported PFAS concentrations below the LOR. Only one primary sample was collected from VO-MW15 during the March 2018 monitoring event.

- Samples from VO-MW15 were collected and handled using the same methods during both the March and April 2018 monitoring events.

Samples from groundwater wells VB-MW05, VA-MW05, VC-MW01, VC-MW02 and VC-MW05 (located down gradient of areas where PFAS have been previously detected in soil and groundwater samples, but had not been subject to previous PFAS analysis) were sampled and analysed for PFAS.

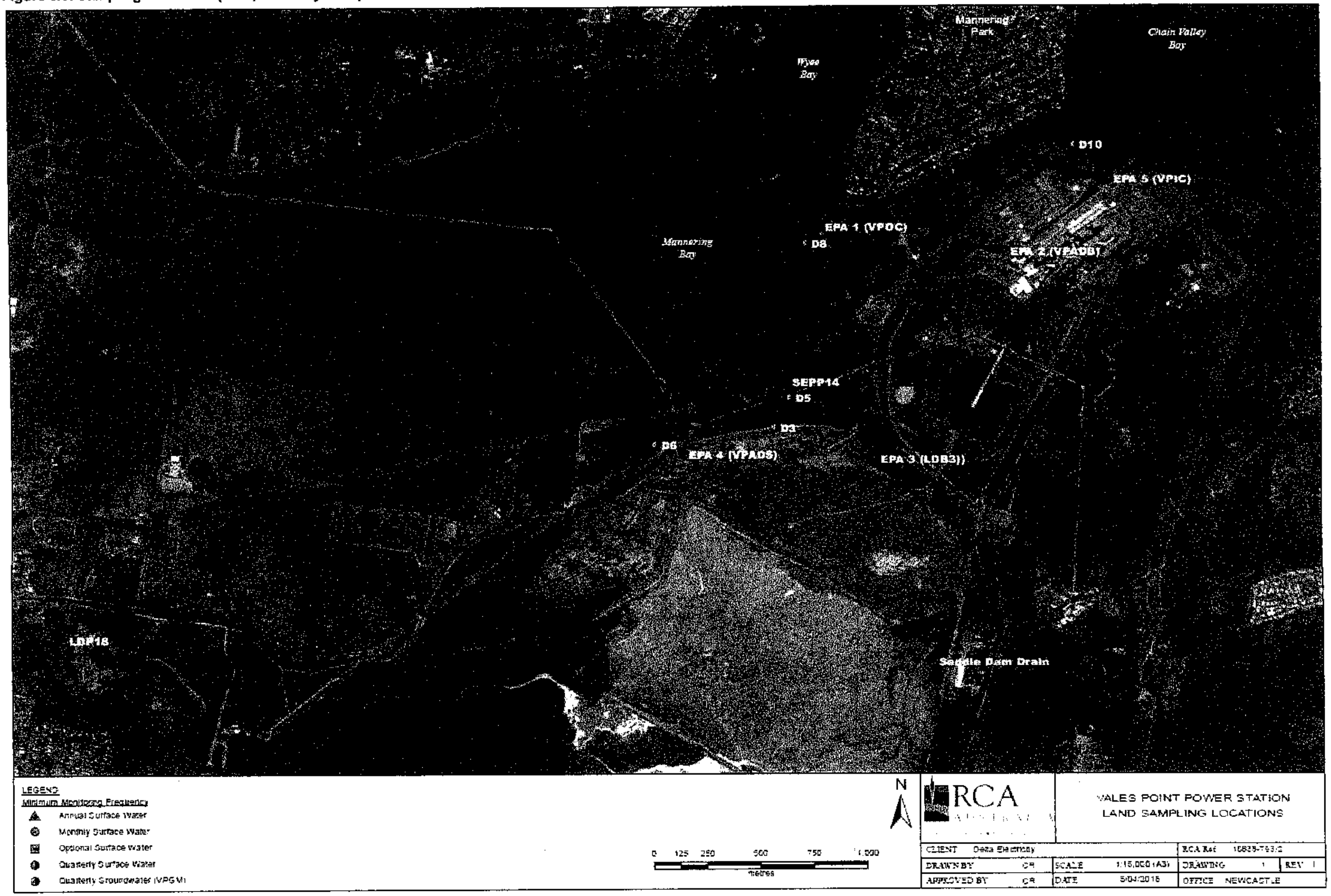
Concentrations of PFOS and PFOA in samples collected from VB-MW05 (A Station), VA-MW05 (B Station) and VC-MW01 were not detected above LOR.

Concentrations of PFOS + PFHxS in samples collected from VC-MW02 and VC-MW05 (transformer area) exceeded the drinking water (VC-MW02 and VC-MW05) and recreational water use (VC-MW02 only) guideline

Location		VPOC	VPADB	VPADBS	ASH DAM SEEPAGE PIT	VPIC	VPGM/D3	VPGM/D5	VPGM/D6	VPGM/D8	VPGM/D10	VPOC	VPADB	VPADS	SADDLE DAM DRAIN	VPIC	VPGM/D3	VPGM/D5	VPGM/D6	VPGM/D8	VPGM/D10
Date		February 2018										March 2018									
Matrix		SW	SW	SW	SW	SW	GW	GW	GW	GW	GW	SW	SW	SW	SW	SW	GW	GW	GW	GW	GW
Compound	Units																				
Perfluorobutane sulfonic acid (PFBS)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoropentane sulfonic acid (PFPeS)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexane sulfonic acid (PFHxS)	µg/L	<0.0005	<0.0005	<0.0005	0.0006	<0.0005	0.0012	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.001	0.0007	<0.0005	0.0019	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptane sulfonic acid (PFHpS)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonic acid (PFOS)	µg/L	0.0008	0.0003	0.0005	0.0013	0.0006	<0.0003	0.0006	0.0008	0.0024	<0.0003	0.0009	0.0008	0.0022	0.0022	0.0005	0.0005	0.0005	0.0006	0.0024	<0.0003
Perfluorodecane sulfonic acid (PFDS)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorobutanoic acid (PFBA)	µg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Perfluoropentanoic acid (PFPeA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0014	0.0007	0.0022	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorohexanoic acid (PFHxA)	µg/L	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0006	0.0006	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroheptanoic acid (PFHpA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctanoic acid (PFOA)	µg/L	<0.0005	<0.0005	<0.0005	0.0012	<0.0005	0.0024	<0.0005	<0.0005	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	0.0009	<0.0005	0.0021	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorononanoic acid (PFNA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorodecanoic acid (PFDA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluoroundecanoic acid (PFUnDA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorododecanoic acid (PFDoDA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotridecanoic acid (PFTrDA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorotetradecanoic acid (PFTeDA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Perfluorooctane sulfonamide (FOSA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Methyl perfluorooctane sulfonamide (MeFOSA)	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamide (EtFOSA)	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoethanol (MeFOSE)	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N-Ethyl perfluorooctane sulfonamidoethanol (EtFOSE)	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
N-Methyl perfluorooctane sulfonamidoacetic acid (MeFOSAA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
N-Ethyl perfluorooctane sulfonamidoacetic acid (EtFOSAA)	µg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
4:2 Fluorotelomer sulfonic acid (4:2 FTS)	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
6:2 Fluorotelomer sulfonic acid (6:2 FTS)	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
8:2 Fluorotelomer sulfonic acid (8:2 FTS)	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
10:2 Fluorotelomer sulfonic acid (10:2 FTS)	µg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

GW – Groundwater sample
SW – Surface water sample

Figure 5.5: Sampling Locations (RCA, February 2018)



	"It is noted that PFOS/PFOA were not detected in groundwater beneath the AEC (Area of Environmental Concern – B-Station Generating Area). These chemicals would have been expected if the extensive use of AFFF had occurred in this area."
10. - Have there been any training exercises involving foam? - What facilities are there for capturing foam during training exercises?	- Yes, foam is used during firefighting training exercises. - Fires are lit within large metal trays on a concrete pad to prevent contamination of the training area when firefighting foam is used to extinguish the fire.
11. - Does system testing take place? - What frequency? - How much foam is used? - Can this be achieved without using PFAS foam? - How is the foam disposed of?	- Yes - Deluge systems are tested on a 5 yearly basis - Up to 300 liters of foam is used. - The current product (Angus FP70) used in the fuel oil deluge system does not contain any PFOS. It does contain trace elements of PFOA. The supplier has advised that they will soon be releasing a new range of fluorine-free foams and also C6 chain fluorinated foams which meet new guidelines. Delta will implement any best practice advice/guidelines provided by the EPA. - Discharged foam and water is pumped from the bund using a vacuum truck and disposed at a licensed waste facility.
12. What quantities of foam have been released and where?	Small amounts are discharged from extinguishers during firefighting training on an annual basis (into metal trays as mentioned previously). Foam is also discharged to a bunded area at the fuel oil tanks during 5 yearly deluge testing as discussed in Question 11.

In summary, the response by Delta to the NSW EPA indicated that AFFF containing PFAS has been used and stored on the site in the past. Specific areas of interest with respect to PFAS use and storage are summarized below:

- Foam is only present within the deluge system for the fuel oil tanks and has a capacity of 1,264 litres. Foam is used (approximately 300 litres) during testing (every 5 years) of this deluge system. The foam is collected within the bunded area of the fuel oil tanks, pumped by a vacuum truck and disposed at a licensed waste facility

- Foam is discharged from extinguishers during annual training within the designated fire training area

- At the time of this response, 2,560 litres of foam was stored on site. The majority of this foam was stored within the warehouse with foam also present within firefighting trolleys and in firefighting boxes at various locations around the site.

With respect to the PFAS information contained within the Delta (2017) investigation, the following was noted:

- There was no discussion of other fire incidents (other than major fires) having occurred on site which required the use of foam (e.g. minor fires)

- There was no discussion of incidents including spills and leaks from AFFF storages which could have released foam concentrate

Table 5.3 details the results of the PFAS analysis for the sediment samples collected as part of the Jacobs (2017) investigation.

Table 5.3: PFAS Analytical Results (Jacobs, 2017)

Sediment Location	Concentration	Comment
	Sediments with Lake Macquarie	
J1-0.5-PFAS	PFBS - <0.0002 mg/kg	No sample reported concentrations exceeding the LOR or respective NEMP (2018) guideline values
J2-0.5-PFAS	PFHxS - <0.0002 mg/kg	
J3-0.5-PFAS	PFOS - <0.0002 mg/kg	
J4-0.5-PFAS	PFBA - <0.001 mg/kg	
J5-0.5-PFAS	PFPeA - <0.0002 mg/kg	
J6-0.5-PFAS	PFHxA - <0.0002 mg/kg	
J7-0.5-PFAS	PFHpA - <0.0002 mg/kg	
J8-0.5-PFAS	PFOA - <0.0002 mg/kg	
	4:2 FTS - <0.0005 mg/kg	
	6:2 FTS - <0.0005 mg/kg	
	8:2 FTS - <0.0005 mg/kg	
	10:2 FTS - <0.0005 mg/kg	

With respect to the PFAS analysis undertaken as part of the Jacobs (2017) investigation, the following was noted:

- Decontamination procedures adopted by Jacobs (2017) included the use of phosphate free detergent. The WA DER (February 2016) Interim Guideline on the Assessment and Management of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS), WA DER (2016) details that phosphate free detergent should not be used for decontamination during PFAS investigations.
- No QA/QC samples (blind duplicates, split replicates, rinsate blanks) were collected or analysed for PFAS during the sediment investigation.

5.9 Delta (October 2017)

The Delta (October 2017) investigation provided a review of PFAS information for the site to support information requested by the NSW EPA. The investigation includes a review of the ERM (2014a and 2014b) and the Jacobs (2017) reports and other information pertaining to PFAS analysis in groundwater wells required to be monitored as part of the Environmental Protection License (EPL).

provide false positive PFAS results. The current standard for laboratory supplied sample containers for PFAS analysis is to not contain Teflon inserts.

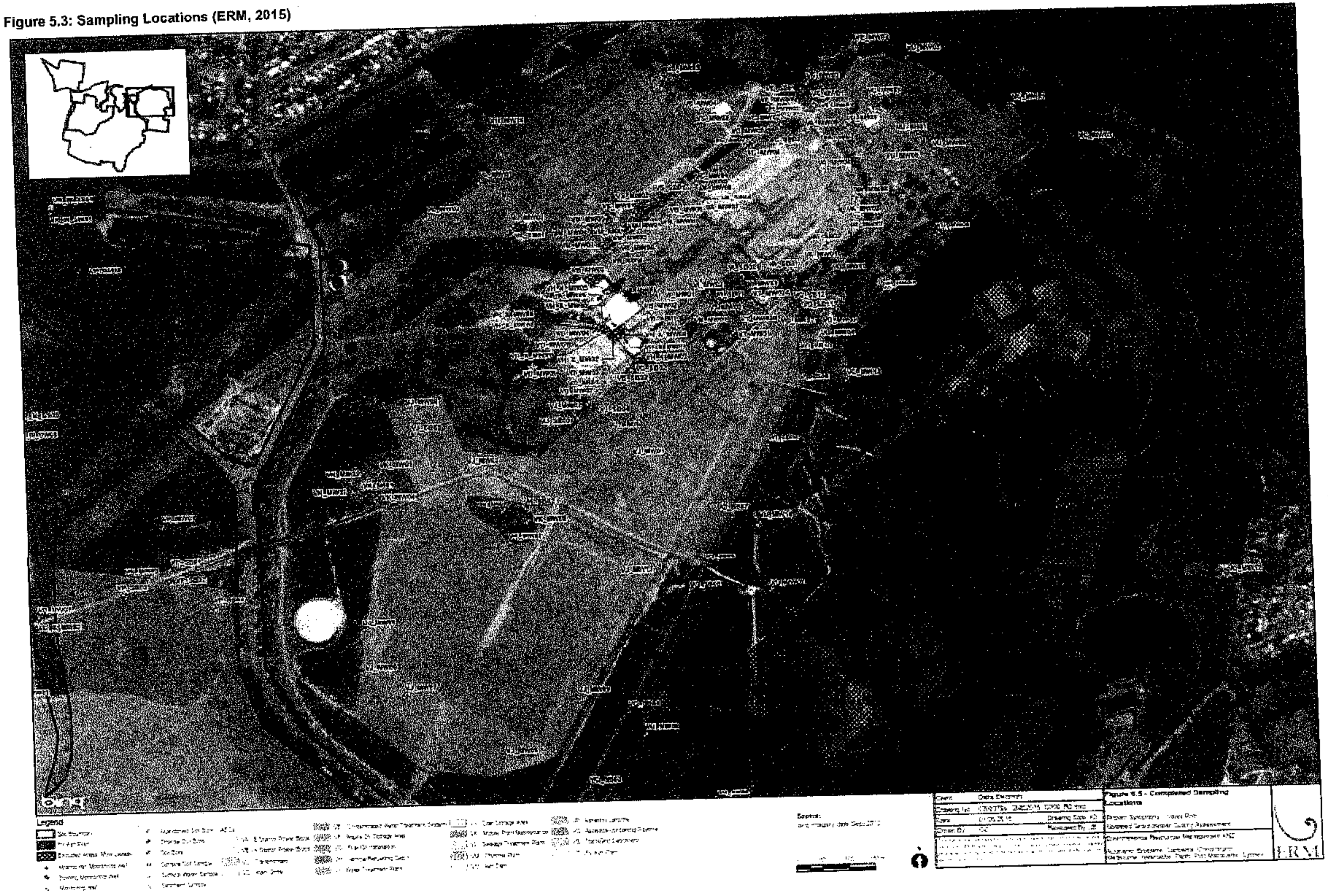
- Decontamination procedures adopted by ERM included the use of DECON 90. The WA DER (2016) guidelines detail that DECON 90 should not be used for decontamination of equipment used during PFAS investigations as this product may contain PFAS compounds.
- PFAS analysis was undertaken by ALS using in-house methods. Current analytical methods for PFAS include ISO 25101 – Water quality - Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanoate (PFOA) -- Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry and ASTM D7979 – Standard Test Method for Determination of Perfluorinated Compounds in Water, Sludge, Influent, Effluent and Wastewater by Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS). It is not clear as to whether the laboratory's in house methods are consistent and comparable with current analytical methods.
- The ERM PFAS suite from the 2015 assessment included PFOA, PFOS and 6:2 FTS. Current analytical PFAS suites include additional PFAS compounds including compounds which are now listed within endorsed guidance including PFHxS.
- Elevated PFOA and PFOS concentrations were detected in groundwater well VM-MW03 during the 2014 investigation located within the Chlorine Plant Fire Training area (highest concentration of PFOS in groundwater reported at this location) but was not subject to testing and analysis for PFAS as part of the 2015 assessment.

5.4 Aurecon (July 2015)

A review of the Aurecon (July 2015) Vales Point Ash Dam Management Plan indicated the following with respect to site conditions and potential PFAS sources.

- Fly ash from Munmorah Power Station was deposited in the ash dam from the early 1970s until production ceased in 2010.
- The ash slurries are directed to specifically designed and constructed ponds in the ash dam, where the ash solids drop out of suspension and deposit on the bottom of the pond. Ponds 1,2 and 3 have been filled with ash, capped with soil and re-vegetated. Pond 4 is currently being filled with ash product from the power station. Each pond has a control weir that controls the level of water in the pond as the ash is being deposited.
- Decant water leaving the pond through the control weir is clear of solids and is preferentially returned to the power station from the Ash Dam via a Return Water System for reuse in the ash transport system. Additional water enters the Ash Dam from the surrounding catchments during rain events. Water is lost from the Ash Dam area through evaporation and ground seepage. Surplus water in the system may be discharged to Lake Macquarie in accordance with the EPA license conditions. Make-up water for the ash and dust plants is drawn from Lake Macquarie during periods of Return Water System maintenance or low ash dam water levels.

Figure 5.3: Sampling Locations (ERM, 2015)



Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
VS-MW05	0.5-0.7	PFOA - <0.0005 mg/kg 6:2 FTS - <0.005 mg/kg PFOS - <0.0005 mg/kg	Concentrations below LOR	VS-MW05	PFOA - <0.02 µg/L 6:2 FTS - <0.1 µg/L PFOS - <0.02 µg/L	Concentrations below LOR
VS-MW04	0.9-1.1	PFOA - <0.0005 mg/kg 6:2 FTS - <0.005 mg/kg PFOS - <0.0005 mg/kg	Concentrations below LOR	VS-MW04	PFOA - <0.02 µg/L 6:2 FTS - <0.1 µg/L PFOS - <0.02 µg/L	Concentrations below LOR
VS-MW03	0.9-1.1	PFOA - <0.0005 mg/kg 6:2 FTS - <0.005 mg/kg PFOS - <0.0005 mg/kg	Concentrations below LOR	VS-MW03	PFOA - <0.02 µg/L 6:2 FTS - <0.1 µg/L PFOS - <0.02 µg/L	Concentrations below LOR
VS-SB01	0.4-0.6	PFOA - <0.0005 mg/kg 6:2 FTS - <0.005 mg/kg PFOS - <0.0005 mg/kg	Concentrations below LOR	VS-SB01		Soil bore only. No samples collected for PFAS analysis
VS-MW02	0.9-1.1	PFOA - <0.0005 mg/kg 6:2 FTS - <0.005 mg/kg PFOS - <0.0005 mg/kg	Concentrations below LOR	VS-MW02	PFOA - <0.02 µg/L 6:2 FTS - <0.1 µg/L PFOS - <0.02 µg/L	Concentrations below LOR
VS-MW01	1.4-1.6	PFOA - <0.0005 mg/kg 6:2 FTS - <0.005 mg/kg PFOS - <0.0005 mg/kg	Concentrations below LOR	VS-MW01	PFOA - <0.02 µg/L 6:2 FTS - <0.1 µg/L PFOS - <0.02 µg/L	Concentrations below LOR

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
VD-MW05	0.9-1.1	PFOA - <0.0005 mg/kg	Concentrations below LOR	VD-MW05		No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
Water Treatment Plant						
VI-MW01			No samples collected for PFAS analysis	VI-MW01	PFOA - <0.02 µg/L	Concentrations below LOR
					6:2 FTS - <0.1 µg/L	
					PFOS - <0.02 µg/L	
Sewage Treatment Plant						
VL-MW01	1.4-1.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VL-MW01	PFOA - <0.02 µg/L	Concentrations below LOR
		6:2 FTS - <0.005 mg/kg			6:2 FTS - <0.1 µg/L	
		PFOS - <0.0005 mg/kg			PFOS - <0.02 µg/L	
VL-MW02			No samples collected for PFAS analysis	VL-MW02	PFOA - <0.02 µg/L	Concentrations below LOR
					6:2 FTS - <0.1 µg/L	Concentrations below LOR
					PFOS - 0.17 µg/L	Exceeds NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
VL-MW03			No samples collected for PFAS analysis	VL-MW03	PFOA - <0.02 µg/L	Concentrations below LOR
					6:2 FTS - <0.1 µg/L	
					PFOS - <0.02 µg/L	

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
VC-MW05	0.9-1.1	PFOA - <0.0005 mg/kg	Concentrations below LOR	VC-MW05		No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR			
		PFOS - 0.0011 mg/kg	Below NEMP (2018) soil exposure scenario for all land uses. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure) Below NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)			
VC-MW02	0.4-0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VC-MW02		No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR			
		PFOS - 0.0018 mg/kg	Below NEMP (2018) soil exposure scenario for all land uses. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure) Below NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)			
VC-MW04	0.4-0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VC-MW04	PFOA - <0.02 µg/L	Concentrations below LOR
		6:2 FTS - <0.005 mg/kg			6:2 FTS - <0.1 µg/L	
		PFOS - <0.0005 mg/kg			PFOS - <0.02 µg/L	

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
			Below NEMP (2018) soil ecological guideline values (direct exposure)			
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR			
		PFOS - 0.0176 mg/kg	Below NEMP (2018) soil exposure scenario for commercial / industrial land use. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure)			
VA-SB03	0.4-0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VA-SB03		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
VA-MW04	0.9-1.1	PFOA - <0.0005 mg/kg	Concentrations below LOR	VA-MW04		No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
VA-MW06	0.4-0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VA-MW06	PFOA - <0.02 µg/L	Concentrations below LOR
		6:2 FTS - <0.005 mg/kg			6:2 FTS - <0.1 µg/L	
		PFOS - <0.0005 mg/kg			PFOS - <0.02 µg/L	
VA-MW03	0.9-1.1	PFOA - <0.0005 mg/kg	Concentrations below LOR	VA-MW03	PFOA - <0.02 µg/L	Concentrations below LOR
		6:2 FTS - <0.005 mg/kg			6:2 FTS - <0.1 µg/L	
		PFOS - <0.0005 mg/kg			PFOS - <0.02 µg/L	

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
VB-SB20	0.4	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB20		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-SB21	0.4	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB21		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-S22	0.3	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-S22		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-SB25	0.1	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB25		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR			
		PFOS – 0.006 mg/kg	Below NEMP (2018) soil exposure scenario for all land uses. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure)			

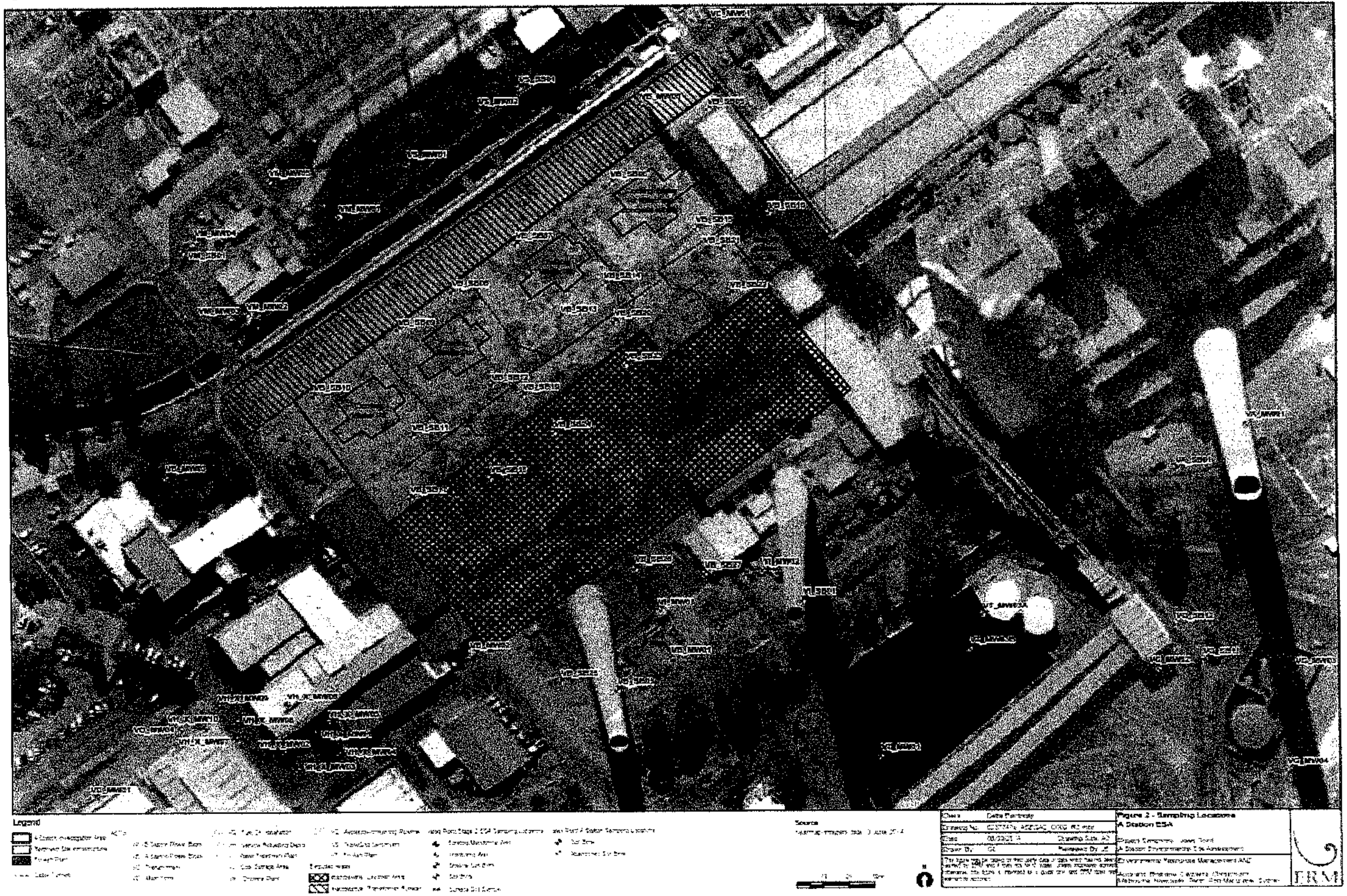
Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
		PFOS - 0.0035 mg/kg	Below NEMP (2018) soil exposure scenario for all land uses. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure) Exceeds NEMP (2018) soil terrestrial biota guideline values (direct exposure for wildlife diet and protective of birds)			
		8:2 FTS - <0.001 mg/kg	Concentrations below LOR			
VB-SB11	1.1	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB11		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-SB12	0.3	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB12		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-SB12	0.8	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB12		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
		6:2 FTS - <0.005 mg/kg				Soil bore only. No samples collected for PFAS analysis
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-SB08	0.7	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB08		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-SB09	0.2	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB09		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
		8:2 FTS - <0.001 mg/kg				
VB-SB09	1.5	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-SB09		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR			
		PFOS - 0.0015 mg/kg	Below NEMP (2018) soil exposure scenario for all land uses. Below NEMP (2018) soil ecological guideline values (direct and indirect exposure).			

Table 5.1: PFAS Analytical Results (ERM, 2014)

Soil Location	Depth (m)	Concentration	Comment	Groundwater Location	Concentration	Comment
A Station						
VB-MW03	1.4-1.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-MW03		No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg				
		PFOS - <0.0005 mg/kg				
VB-MW01	0.4-0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-MW01	**PFOA - 0.04 µg/L**	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
		6:2 FTS - <0.005 mg/kg			6:2 FTS - <0.1 µg/L	Concentrations below LOR
		PFOS - <0.0005 mg/kg			**PFOS - 0.13 µg/L**	Does not exceed NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
VB-MW02	0.4-0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VB-MW02	**PFOA - 0.08 µg/L**	Below NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
		6:2 FTS - <0.005 mg/kg			6:2 FTS - <0.1 µg/L	Concentrations below LOR
		PFOS - <0.0005 mg/kg			**PFOS – 1.53 µg/L**	Exceeds NEMP (2018) aquatic ecosystem (95% protection) exposure scenario for freshwater and marine water
VB-SB01	0.4-0.6	PFOA - <0.0005 mg/kg	Concentrations below LOR	VS-SB01		Soil bore only. No samples collected for PFAS analysis
		6:2 FTS - <0.005 mg/kg	Concentrations below LOR			

Figure 5.2: Sampling Locations (ERM, 2014b)



5. Information review

The results of the information review with respect to site conditions and potential PFAS sources on the site is provided below. The review is based on information contained within previous investigation reports as detailed in **Section 1**), anecdotal information and observations made during a site inspection undertaken by Jacobs and Delta representatives on 27 February 2018 and other information provided by Delta.

5.1 ERM (2014a and 2014b)

The ERM (2014a and 2014b) investigation (incorporating both the Stage 2 Environmental Site Assessment, July 2014 and the A Station Assessment, September 2014) identified a number or areas of interest (AEIs) on-site which could represent a potential PFAS contamination source. These potential PFAS AEIs included:

- B Station Power Block – Vales Point Unit 6A 330/22kV generator transformer failed and resulted in an explosion and fire in 2006.
- Transformer Area – A major fire event occurred in the 5A Heater in 2011.
- TransGrid Switchyard – The Vales Point Fire Training area is located adjacent to the TransGrid Switchyard.

Soil and groundwater sampling locations from the ERM (2014a and 2014b) investigations are presented as **Figures 5.1 and 5.2**.

- Clean water (non-impacted storm water) and dirty water flows (storm water potentially impacted by on-site operation's) from B Station are managed by a formalized sub-surface drainage system, which discharges to the Chain Valley Bay retention basin, is pumped to the Ash Dam
- When required, overflows during extreme rainfall events may be discharged directly to Chain Valley Bay from the retention basin under an Environment Protection License (EPL) discharge conditions.

The drainage system underlying the operational area of the power station is presented as **Figure 2.**

Ash Dam

- Surface water infiltrating the ash dam is recirculated (as groundwater) through the ash dam by the pumping of groundwater from behind the northern ash dam wall adjacent to Mannering Bay
- Surface water flows (including decant water) from the ash dam are directed to the ash dam reservoir. Water from the ash dam reservoir is pumped into gravity tanks and recycled through the ash system with surplus water discharged to the outlet canal at LDP2
- When required, overflows during extreme rainfall events from the ash dam can be discharged to the Wyee Creek diversion channel through LDP18 under an EPL.

Inferred surface water flows across the site are presented as **Figure 3.**

4.4 Groundwater

The ERM (2014a) report indicated that regional groundwater flow direction is generally in a north to north east direction towards Lake Macquarie. Temporal and localized variations in the direction of groundwater flow was considered likely given the low lying nature of the area and the presence of tidally influenced lakes, and the effects on increased hydraulic head created by the wet disposal ash dam.

A search of the Department of Primary Industries (DPI) Office of Water groundwater database (undertaken in March 2018) indicated that three licensed groundwater wells with potential beneficial reuse (i.e. stock, domestic) are located within 1km of the site. The details of these wells are provided in **Table 4.1**.

Table 4.1: DPI Licensed Groundwater Bores Within 1km of the Site

Well ID	License No.	License Status	Use	Well Depth (m)	Location
GW011915	20BL004727	Active	Poultry (Groundwater)	5.4	1km south west of the power station operational area 600m north of the ash dam
GW034560	20BL026221	Active	Domestic	18.3	Approximately 700m north of the site (in Mannering Park)
GW064662	20BL137176	Active	Domestic	24.0	1km west of Vales Point Ash Dam

4. Site Setting

The site setting information is based on information contained within the reports referenced in **Section 1**.

4.1 Site Conditions

The Vales Point Power Station is an operational power station located off Vales Road, Mannering Park NSW (Refer to **Figure 1**). The site comprises the following functional elements (ERM, July 2014a):

- Vales Point Power Station and associated infrastructure. Vales Point Power Station was built in the 1960's as a four-unit station (the former A station). These generating units were decommissioned in the late 1980's and the above ground structures were being demolished at the time of the investigation (2014). Vales Point now operates as two 660 MW generating units, with a total generating capacity of the 1320 MW of electricity (B Station)
- Ash dam and associated pipelines for ash slurry and return water
- Coal storage area, including a truck wash down area, refueling and maintenance area and settling ponds.
- Conveyors transporting coal from nearby mines to the site
- Waste disposal areas including six former asbestos dumps
- Several water treatment systems, including a demineralized water plant, a chlorine plant, a reverse osmosis plant and an oil and grit trap
- Buffer lands surrounding the infrastructure detailed above, including State Environmental Planning Policy (SEPP) 14 listed wetlands to the north and west of the site
- The Wyee Rail coal unloader and Rail to Vales Point (RV) conveyor system located to the north west of the operational area
- A fly ash loading plant, owned and operated by Adelaide Brighton Cement to the south east of the operational area.

4.2 Surrounding Environment

The areas surrounding the site (as detailed in the ERM, July 2014a report) comprises a mixture of uses within 1km of the site including:

- Industrial operations including colliery and sewage treatment plant
- Residential suburbs of Mannering Park (600m), Doyalson East (300m), Wyee (150m) and Wyee Point (adjacent to site)
- Rural residential properties are located adjacent to the ash dam area

selected groundwater wells for a period of two years should be undertaken to assess that these secondary sources are not impacting upon groundwater beneath the site. Following completion of the two annual monitoring rounds, a review should be undertaken to reassess the requirements for ongoing monitoring. The annual monitoring should include groundwater well location VO-MW15 to further confirm the results obtained during the Jacobs (2018a) monitoring program.

Executive Summary

Jacobs Group (Australia) Pty Ltd (Jacobs) was commissioned by Delta Electricity (Delta) to prepare the following consolidated Per- and poly-fluoroalkyl substances (PFAS) report for the Vales Point Power Station located at Mannering Park NSW (referred to hereinafter as the site).

This consolidated PFAS report has been prepared to meet the requirements detailed in correspondence from the NSW EPA to Delta dated 24 January 2018. The requirements of the NSW EPA and where addressed within the consolidated PFAS report is detailed below.

a) A conceptual site model (CSM) – Section 8.

b) A map with identified source areas and soil sample locations to show that sources areas have been adequately sampled – Figure 4.

c) Details on groundwater flow and surface water flow paths, including drainage and storage ponds on-site – Section 4.3 and 4.4 and Figure 3.

d) A map with surface water and groundwater sample locations to delineate if off-site migration of PFAS is occurring – Figures 5a and 5b.

e) Identify potential off-site human and/or ecological receptors and if potential exposure pathways exist – Sections 6 and 8.

f) All data (PFAS concentrations for all samples) and site locations (including QAQC) – Section 5.

g) Assessment of risk against relevant screening values – Section 7.

h) Conclusions and recommendations for further investigation (if required) – Section 9.

Based on the information reviewed, an understanding of site settings, potential contamination associated with known historical and current site operations, and potential receptors to contamination (if present), the following conclusions have been made:

- PFAS has been detected in selected soil samples collected from beneath the A Station, B Station and the Transformer Area. Concentrations detected above the respective guideline levels (protection of soil terrestrial biota) are unlikely to represent a risk considering access to soils beneath these areas is restricted. It is unlikely that PFAS concentrations detected in soil at the site (where sampled) represent a risk to current receptors.

- PFAS was not detected above laboratory LOR in sediment samples collected from adjacent to the site within Wyee Bay and adjacent areas of Lake Macquarie. PFAS concentrations in sediments from surrounding waterways (where sampled) do not represent a risk to current receptors.

- PFAS has been detected in surface water samples collected from surrounding waterways and the ash dam at concentrations above laboratory LOR but below the respective guideline levels (protection of aquatic ecosystem, drinking water and recreational water). It is unlikely that PFAS concentrations in surface water surrounding the site (where sampled) represent a risk to current receptors.

Consolidated PFAS Report - Vales Point Power Station

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1	20/04/2018	DRAFT for client comment	MS	MS	MS
2	30/04/2018	For NSW EPA submission	MS	MS	MS
3	03/12/2018	Incorporation of additional PFAS investigation results	MS	MS	MS
4	14/12/2018	Final	MS	MS	MS