



Appendix N

Preliminary Site Investigation

Darwin Ship Lift Project Preliminary Site Investigation



Darwin Ship Lift Project Preliminary Site Investigation

Client: Northern Territory Government

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Executive Summary

AECOM Australia Pty Ltd was engaged by the Northern Territory Government (NTG) to conduct a preliminary site investigation (PSI) at the terrestrial portion (the site) of the Darwin Ship Lift Project (the Project) location (formerly known as the Ship Lift and Marine Industries (SLAMI) Project).

The site is located at 865 and 869 Berrimah Road, East Arm, Darwin and is comprised of the following three parcels within Hundred of Bagot; Parcel 5420, Parcel 5163, and Parcel 6370.

The NTG's primary objective for this investigation was to ascertain the likelihood for potential human health or environmental risks existing at the site due to legacy contamination from present or historical uses. To address this objective, AECOM conducted a PSI which aimed to:

- obtain an understanding of potential contamination and pollutions risks of historical operations at the site
- develop a conceptual site model (CSM)
- assess potential risks associated with historical site activities.

Site setting and history

The site is a mixed use facility operating as a private marine supply base and publicly accessible boat ramp. It is located on land that is partially reclaimed and elevated with imported fill between the East Arm Wharf (EAW) and the East Arm Port. Historically, East Arm has been used by the Australian Defence Force for special forces training and naval and air resupply. Locations near it were bombed during WWII, however previous investigations across East Arm have found that the site is at low risk of unexploded ordnance.

Online databases viewed during this investigation found the following:

- no groundwater users were reported at or adjacent to the site
- no contaminated site audits have been conducted at locations near the site
- acid sulfate soils (ASS) are considered to have a high probability of occurrence at the site's location
- several cultural and historical heritage sites are located nearby the site, however none are identified within the site's boundaries.

Key activities of the Preliminary Site Investigation

AECOM conducted two site walkovers, including one with limited, targeted surface soil sampling, and two interviews with persons understood to be knowledgeable of the site's history to inform the development of the CSM. The interviews were conducted in October 2020 with representatives from the NTG and Bhagwan Marine who currently lease the western portion of the site.

The NTG representative interviewed by AECOM and the following information relevant to this investigation was discussed:

- portions of the site have been partially reclaimed and elevated with imported fill
- fill imported to site came from the wider Darwin region and is understood to have been clean
- fill thickness at the site ranges up to 8 m thick, with as much as 4 m below the sea level
- subsoil drainage exists across the common use area in the north of the site adjacent to the Multi-user Barge Ramp Facility (MUBRF), with triple interceptors located before outflow to the Darwin Harbour
- the representative noted the historic presence of antifouling substances, vessel hull blasting, and painting as potential contaminants and potentially contaminating activities
- the representative considered it unlikely that significant contamination of soil or groundwater at the site had occurred over its history

- the representative noted that potentially contaminating activities occur at location to the north and west, however dust monitoring conducted at these locations identify no air quality issues

The Bhagwan Marine representative confirmed the following details relevant to this investigation:

- an inventory of fluids stored and used at the site was provided
- the representative confirmed that to their knowledge no spills had occurred at the site
- the representative indicated that vessels are destroyed at the site after being assessed for, and stripped of potential contaminants, such as antifouling, asbestos containing materials, and lead based paint.

Following the historical desktop review, the above targeted interviews and consideration of typical port and marine supply activities associated with the historic land uses, areas of interest were identified and contaminants of potential concern (COPC) were identified.

Limited soil sampling was undertaken for the COPC during a second walkover focusing on the areas of interest.

Analytical results from the targeted sampling identified:

- two trace occurrences of hydrocarbons in soils
- no tributyl tin (TBT) occurrences above the limits of reporting
- heavy metal detections within the range of expected naturally occurring concentrations for the site.

There were no exceedances of adopted screening criteria.

Conceptual Site Model and data gaps

The CSM developed by this investigation does not identify any likely source-pathway-receptor linkages at the site based on the works undertaken. A data gap does remain at the site in relation to minor detections of hydrocarbons noted at two locations at the site. These impacts have not been vertically or laterally characterised by this investigation. The relative risk posed by this data gap is considered low.

Conclusion and recommendations

The following high-level conclusions can be drawn from the findings of the PSI with respect to environmental impacts associated with the historical use of the site:

- no reported spills have been recorded as occurring at the site, and interviews conducted with personnel understood to be knowledgeable of the site were unaware of any unreported spills at the site
- detectable (minor and trace) concentrations of TRH and BTEXN compounds were observed in two surface soil samples analysed at the site, but are considered unlikely to be representative of widespread, larger impacts at the site and are unlikely to pose an unacceptable risk to human health or environmental receptors
- no detectable concentrations of TBT were observed in samples analysed at the site. While it is possible that there are minor TBT impacts at the site, it is considered unlikely that these impacts constitute an unacceptable risk to human health or sensitive environmental receptors
- concentrations of heavy metals observed in samples analysed at the site appear to be representative of background/natural conditions and are orders of magnitude lower than adopted screening criteria.

In addition to these points regarding environmental impacts at the site relating to its historical use, the site is located within a high risk ASS area and is likely to require consideration of managing potential ASS risks. Desktop searches conducted in support of the PSI suggest that the risk for terrestrial UXO is low at the site, and that places of cultural heritage or historical value are located nearby but not within the PSI site boundaries.

This investigation does not have the scope to draw conclusions about the presence or absence of contamination at depth at the site owing to the sampling programme's targeted nature of areas of interest at surface around the site.

The findings of the PSI suggest that further investigations into contamination at the site are unlikely to be required based on the targeted sampling undertaken. While TRH and BTEXN compounds were detected in two soil samples collected at the site, concentrations were at or near detection limits. Other COPCs were not detected during the investigation, and while their absence elsewhere at the site cannot be guaranteed, the available desktop information, anecdotal information from site operators and visual evidence during the site walkover do not suggest that further investigation is required.

It is noted that the investigation does not have the scope to draw conclusions about the presence or absence of contamination at depth at the site owing to the sampling programme's targeted nature of areas of interest at surface around the site. In addition, the investigation is unable to draw conclusions regarding contamination that may be present from historical activities which are not recorded.

While every effort has been made to develop a CSM reflective of the data obtained as part of the scope of works, in the unlikely event that additional contamination is encountered which is inconsistent with known site impacts or sources and alters the CSM, further works may be required to adequately address the risks to all future commercial/industrial site users.

1.0 Introduction

1.1 Background

The Northern Territory Government (NTG) has identified the need for a new ship lift facility and marine industries precinct in Darwin to support the region's status as a growing logistics and marine services hub for northern Australia. In response to this need the NTG called for proposals from suitably qualified organisations to design and construct what is now known as the Darwin Ship Lift Project (the Project).

The Project site is situated approximately 6.5 km south-east of the Darwin Central Business District (CBD), on the East Arm Peninsula within Darwin Harbour, east of East Arm Wharf (EAW) and on the southern side of Berrimah Road (Figure 1 and Figure 2). The ship lift and transfer system will consist of an approximately 103 m long ship lift with onshore facilities for similarly sized vessels. The facility will enable the maintenance and servicing of Australian Defence Force and Australian Border Force vessels, along with commercial and private vessels, including those servicing the oil, gas and marine industries

This Preliminary Site Investigation (PSI) has been prepared in order to identify potential risks to the environment and users from terrestrial site (the site) based contamination related to historical uses at the site. The site is located at 865 and 869 Berrimah Road, East Arm, Darwin and is comprised of the following three parcels within Hundred of Bagot; Parcel 5420, Parcel 5163, and Parcel 6370.

The Terms of Reference (ToR) for the Project EIS identifies requirements for how the proposed design mitigates impacts in relation to environmental constraints and potential impacts and risks to the surrounding environment including long-term legacy contamination. This PSI sets out to address this ToR.

1.2 Objective

The NTG's primary objective for this investigation was to ascertain the likelihood for potential human health or environmental risks at the site due to legacy contamination from present or historical land uses. To address this objective, AECOM conducted a PSI which aimed to:

- obtain an understanding of potential contamination and pollution risks of historical operations at the site
- develop a conceptual site model (CSM)
- assess potential risks associated with historical site activities.

1.3 Scope of work

The following scope of work was undertaken as part of the PSI.

1.3.1 Desktop review

- review of publicly available information from government databases on the history of the site and nearby properties
- review of any relevant documentation such as permits, licenses, dangerous goods storage, waste management, regulatory correspondence and previous environmental reports or audits as provided by the NTG, Paspaley and Baghwan Marine (where available and appropriate)
- a web-based review of current and historical aerial photographs of the project area to identify historical land uses that may indicate a potential for contaminating activities
- review of current and historical site plans (where available)
- review of web-based information to determine the site's contaminated sites status, groundwater and bore information from database searches; and heritage searches.

Current Certificate of Title information and details of historical ownership was provided by the Northern Territory Department of Infrastructure, Planning and Logistics (DIPL).

1.3.2 Site walkover

A site walkover was conducted to identify visual signs of potential environmental concern on or immediately adjacent to the site and to evaluate any factors highlighted in the public record. The site walkover included the following activities:

- a visual reconnaissance of accessible areas of the site to observe signs of spills, stressed vegetation, evidence of the presence of buried tanks, pits or buried waste, subsidence, unusual soil discolorations, or other unnatural items, which may indicate the possible presence of environmental impacts on the site
- visual observation of neighbouring properties to identify the presence and proximity of sensitive receptors that could be impacted by site activities, as well as off-site activities or conditions that could potentially impact on the site
- interviews with personnel familiar with the site: one from NTG and another from Bhagwan Marine who currently lease the western portion of the site
- recording of the site with photographs to document features such as unusually discoloured soil, stressed vegetation or other significant features such as hazardous materials visible from the surface (e.g. asbestos)
- identifying site infrastructure and equipment with potential to cause contamination (such as fuel storage infrastructure)
- looking for evidence of groundwater and surface water occurrence, groundwater seepage, surface water bodies, and water movement (drainage ditches)
- locations of any notable observations were recorded for inclusion within subsequent reporting.

During a second site visit, targeted samples were collected and analysed for compounds of potential concern identified during the desktop searches and interviews.

The sample collection for the PSI focused on surface sampling only and did not include any intrusive soil sampling at depth or groundwater sampling or testing for asbestos containing materials (ACM), per- and poly-fluoroalkyl substances (PFAS), potential acid sulphate soils (PASS), or lead in paint on any buildings on the site.

1.3.3 Reporting

This PSI provides a description of the findings of the desktop review and site walkover together with an assessment of environmental risk and recommendations for further assessment and/or management (as required).



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 DATUM GDA 1994, PROJECTION MGA ZONE 52

0 820 1,640 2,460 3,280
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Data sources:
 Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2021).

LEGEND
 Project footprint

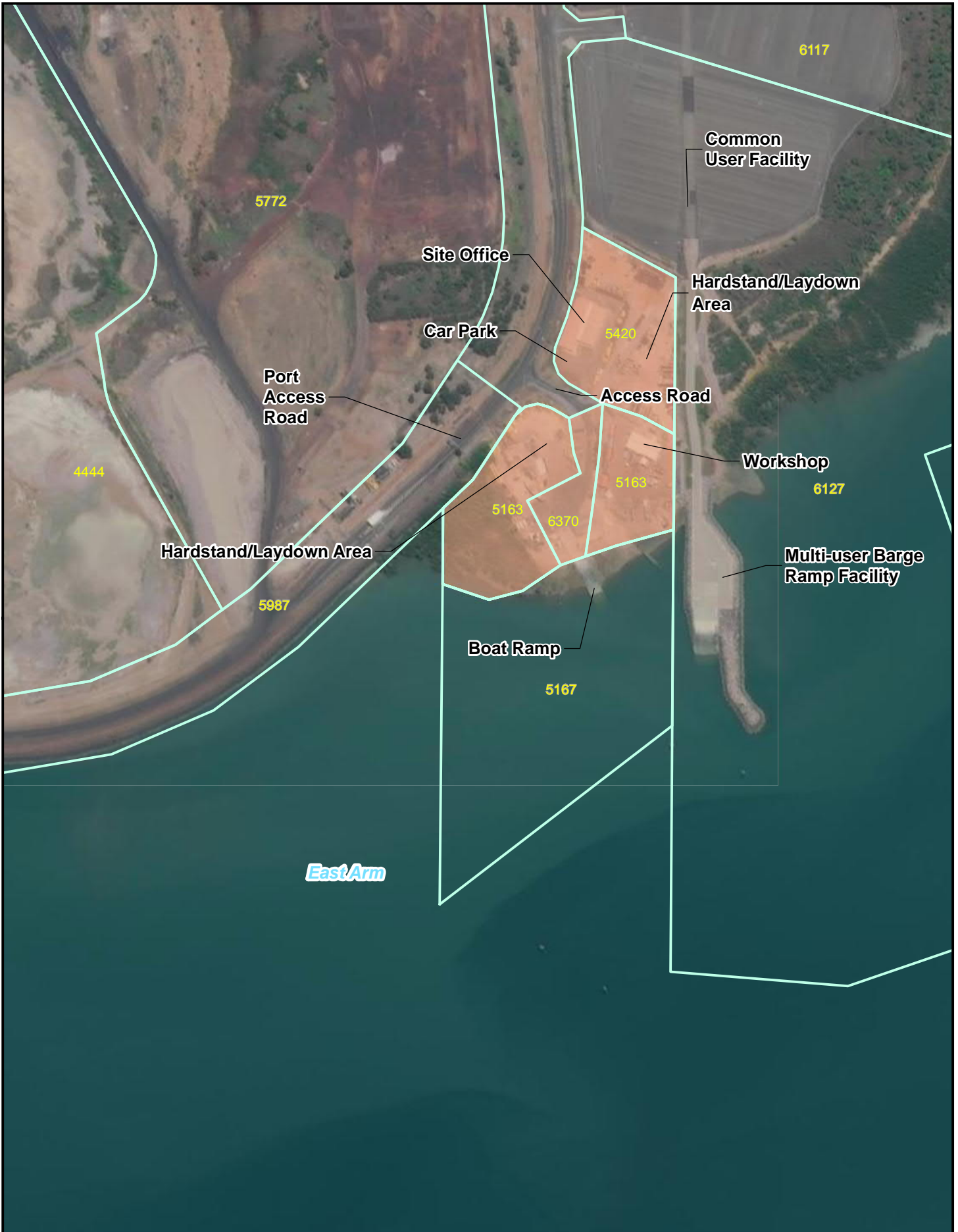
Note:
 The layout is indicative only

Site location

NORTHERN TERRITORY
 GOVERNMENT OF AUSTRALIA
 DARWIN SHIP LIFT PROJECT

Figure
 1

A4 size



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 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2021).

LEGEND

- Cadastral boundary
- Existing site area

Site layout

NORTHERN TERRITORY
 GOVERNMENT OF AUSTRALIA
 DARWIN SHIP LIFT PROJECT

Figure
 2

2.0 Site Setting

2.1 Site identification and setting

The Project site is situated approximately 6.5 km south-east of the Darwin CBD, on the East Arm Peninsula within Darwin Harbour, east of EAW and on the southern side of Berrimah Road.

A summary of the site identification information is provided in Table 1 and a summary of tenure is provided in Table 2. The site location and site layout are shown on Figure 1 and Figure 2, respectively.

Table 1 Site identification information

Items	Details
Site Owner Site Occupiers	Paspaley Pearls Properties Pty Ltd Bhagwan Marine
Site Address	The site is located at 865 and 869 Berrimah Road, East Arm, Darwin
Site Parcels	The site comprises of three parcels of land within Hundred of Bagot: <ul style="list-style-type: none"> Parcel 5420 Parcel 5163 Parcel 6370
Local Govt. Authority:	City of Darwin
Locality	City of Darwin
Current Zoning	Strategic Industry – Port
Current Land use	Common use boat ramp and light industrial marine storage.
Proposed land Use	Ship lift and transfer system

Table 2 Summary of tenure within PSI area

Parcel	Location Name	Parcel area (ha)	Tenure Reference	Owner
5420	Hundred of Bagot	1.72	Freehold	Paspaley Pearls Properties Pty Ltd
5163	Hundred of Bagot	2.65	Crown Lease Term	Paspaley Pearls Properties Pty Ltd
6370	Hundred of Bagot	0.562	Crown Lease Term	Paspaley Pearls Properties Pty Ltd

The site is a mixed use facility operating as a private marine supply base and publicly accessible boat ramp. It has a car park, site office a works depot, marine workshop and hardstand areas. Activities carried out on site, including the storage and maintenance of marine equipment, would likely involve the use of a range of hydrocarbons, oils and degreasers, and products associated with the maintenance, cleaning and wash down of marine equipment including buoys and vessels (KBR 2020).

2.2 Surrounding land use

The site is approximately 700 m east north-east of the East Arm Wharf (EAW) and the Marine Supply Base (MSB) facility, and west of the Darwin Business Park. The mix of land uses surrounding the Project site include:

- West: the EAW and MSB. The EAW and MSB infrastructure supports export and import of dry bulk materials and liquids associated with the mining and petroleum industries, containerised/break bulk (not containerised) and specialised heavy lift cargoes, general cargoes and live cattle exports.

- North: industrial land including the Darwin Port stockpile area and dredge spoil ponds, the Northern Cement plant, the Darwin Vopak Terminal (petroleum import and distribution terminal), the Common User Facility (CUF) and the passenger terminal of the Adelaide - Darwin rail line.
- East: the recently constructed Multi-user Barge Ramp Facility (MUBRF), and Catalina Island.
- South: the southern end of the Project site encompasses the intertidal zone and the East Arm water confluence with Elizabeth River which forms part of Darwin Harbour (KBR, 2018).

Treated wastewater is known to enter the Elizabeth River estuary through:

- Hudson Creek - which has a history of livestock export and light industrial uses and receives inputs from the Darwin Correctional Centre's Sewage Treatment Plant (KBR, 2020).
- Myrmidon Creek - which receives discharged treated effluent from the Palmerston Wastewater Treatment Plant which enters the Elizabeth River estuary at the head of East Arm (AECOM, 2020).

Refer to Figure 1 for surrounding land uses.

2.3 Topography and geology

Geology at the site is comprised of quaternary coastal alluvial sediments such as mud, silt and clays which overlay unconsolidated Cainozoic unconsolidated solids and laterites. Bedrock at the site is understood to be the Burrell Creek Formation which is Orosirian in age (Geological Map Series Sheet 5073). Through interviews conducted with persons knowledgeable with the site and its history, it is understood that much of the site is reclaimed land.

2.4 Hydrogeology

Hydrogeological studies at the site have not been conducted, however, understanding the geology and the site's location on the East Arm Peninsula, the following conceptual hydrogeological outline for the site is considered likely:

- groundwater flow direction is radial from the peninsula, in the direction of the nearest surface water expression
- groundwater quality is expected to be saline
- groundwater levels are generally within the local tidal range
- the greatest transmissivity at the site is within the coarser alluvial sediments overlying bedrock at the site.

2.5 Groundwater resources and beneficial uses

A search of the Department of Environment, Parks and Water Security website accessed in July 2021 did not identify current groundwater users at or within 500 m of the site. Given its adjacency to the marine environment, no beneficial use of groundwater at the site is considered likely.

2.6 Surface water

The site is located at East Arm, within Darwin Harbour. Darwin Harbour is a large estuary that experiences substantial tidal variation, with water quality varying with tide, weather, season and location. The southern harbour area consists of East, West and Middle Arms which merge into a single unit, along with the smaller Woods Inlet, before opening into Beagle Gulf to the north.

The Elizabeth River flows into East Arm, while the Darwin and Blackmore rivers flow into Middle Arm. During the dry season (May to September) the estuary is typically well mixed, but freshwater inflow from rivers during the wet season can result in salinity-based water column stratification in the arms of the harbour (Drewry et al. 2010).

2.7 Contaminated land audits

A review of the contaminated site audits provided by the Northern Territory EPA (NT EPA) in September 2020 found that the Project site is not presently identified as a contaminated site by the NT EPA. This review also found that there are no nearby contaminated sites likely to have impacted the site.

2.8 Acid sulphate soils

A review of the ASS Risk Mapping database (ASRIS 2017) classifies the area around the site as having a high probability of occurrence. The ASS risk mapping search results are presented in Appendix A.

2.9 Unexploded ordnance

A search of the Australian Department of Defence unexploded ordnance database site did not identify any UXO areas within the site. A desktop report completed by G-TEK (G-TEK, 2017) viewed by AECOM noted that East Arm was previously known as Quarantine Island, with sections of it used for “detaining crews, passengers, etc” until it was transferred for military purposes during WWII. During WWII it was used as a lugger maintenance section (LMS) and a flying boat base (FBB).

The area used for the LMS is to the east of the site, and “should not have generated any ordnance related material that will create UXO risk for the SLAMI Site [now known as the Project site]” (G-TEK 2017). During East Arm’s use as an FBB, it is possible that magazines may have stored ammunition and explosives at or nearby the site. G-TEK note that “up to 22 aircraft mooring buoys and 2 marine vessel mooring buoys were positioned in the waters off the RAAF FBB in East Arm”. While there may be some remnant mooring and infrastructure from RAAF usage, G-TEK do not believe that they present an ordnance risk.

Quarantine Island was known to house an anti-aircraft battery site, however its position is nearby Casey Street, to the east of the site. During Japanese air raids on Darwin in 1942, Catalina flying boats at mooring in Darwin Harbour and East Arm were strafed and sunk, however these losses were to the west of the site. There is no record of the LMS, FBB, Quarantine Battery or other military infrastructure or units in the area being attacked during any of the Japanese air raids (G-TEK, 2017).

In conjunction with the above, and citing the ongoing use of the site and the area around the site since WWII, G-TEK consider the risk posed by potential onshore UXO to be as low as reasonably practicable (G-TEK, 2017).

2.10 Cultural Heritage

Cultural heritage has been assessed for the Project by Earthsea Pty LTD and can be found in the EIS Appendix N: Cultural Heritage Assessment. This assessment found the likelihood of unexpected cultural heritage finds to be low due to previous disturbance.

3.0 Site History

3.1 Site history

The site appears to have been vegetated by natural scrub and mangrove until 1927, when the Commonwealth of Australia acquired East Arm properties for the purpose of establishing a quarantine station, with associated facilities located to the north of the site (KBR 2020).

The site and its surrounds were used during WWII for a range of activities including the FBB and the LMS. The FBB comprised a number of components, including a large tarmac hardstand, hangar, workshop and stores with associated maritime infrastructure. The LMS included a large concrete ramp enabling Catalinas to be taken in and out of the water (the RAAF Catalina Ramp), a concrete slipway with iron rails to serve the Marine Section vessels and a timber jetty (Cosmos 2015).

The FBB also included a range of offshore marine infrastructure, including permanent Catalina and vessel moorings comprised of at least 22 seaplane moorings, nine marine craft buoys, five lugger buoys, three warping and steadying buoys, three marker buoys, and one submarine buoy (Cosmos 2015).

Maintenance and repair activities, including refuelling, were largely conducted on the hardstand area at the base; however, some maintenance works such as engine tuning, minor repairs and supply activities were carried out on the Catalinas whilst they were on their moorings, under tow or taxiing (Cosmos 2015).

These activities both on land and over water would most likely have involved the storage and use of a range of oils, fuels, lubricants, paint, paint stripper and solvents, glues, insecticides and pesticides, degreasers, aircraft wash and polishes and acids both on the hardstand, and over water. Usage and spills of these chemicals may have resulted in their release into the surrounding environment (KBR 2020).

In the 1980s, the former RAAF Catalina Ramp was opened to the public by the NTG for use as a recreational boat ramp. The boat ramp became one of the most popular ramps in Darwin Harbour due to its length, which enabled small craft to easily access the harbour waters during most tidal phases. However, in 2005 the boat ramp was no longer required to support recreational boating as a new recreational boat ramp was constructed at East Arm, north of Catalina Island (KBR 2020).

From the 1960s until 2008, tributyltin (TBT) was widely used as a component of ship anti-fouling paints, after which they were banned from use. Given the persistence of TBT within marine sediments (Furdeck et al, 2016) there is the potential for it to be present at the site.

3.2 Historical site ownership

Historical site ownership of each of the parcels of land comprising the site is presented below in Table 3 and presented in Figure 2.

Table 3 Historical site ownership

Parcel	Location Name	Parcel area (ha)	Tenure Reference	Previous Tenures
5420	Hundred of Bagot	1.72	Freehold	<p><i>Current tenure:</i> Estate in fee simple – granted 20/12/2004. Ownership has not changed since time of grant.</p> <p><i>Parent parcels:</i> Sections 3122, 5421, Hundred of Bagot</p> <p><u>Previous ownership of Section 3122</u></p> <ul style="list-style-type: none"> • CLT 804 to Paspaley Pearling Company, granted 17/04/1988, surrendered 24/02/1993 • Estate in fee simple to Paspaley Pearling Company – registered 24/02/1993 • Transfer of estate in fee simple to Northern Territory of Australia on 17/12/2004

Parcel	Location Name	Parcel area (ha)	Tenure Reference	Previous Tenures
				<ul style="list-style-type: none"> Estate in fee simple cancelled on 17/12/2004 <u>Section 5421</u> Was vacant Crown land at the time of grant, it was previously part Section 1784 – previous ownership Estate in fee simple to Commonwealth of Australia registered 3 May 1984 Estate in fee simple transferred to Northern Territory of Australia on 14/05/1987
5163	Hundred of Bagot	2.65	Crown Lease Term	Current tenure: CLT 2147 – granted 20/12/2004 Ownership of lease has not changed since time of grant. <i>Parent parcels:</i> Sections 3122, 5421, Hundred of Bagot Previous ownership as per Section 5420
5167	Hundred of Bagot	5.76	Crown Lease in Perpetuity	Current tenure: CLP 5167 – granted 20/12/2004 Ownership of lease has not changed since time of grant. No previous titles granted – tenure prior to grant was vacant Crown land (sea floor).
6370	Hundred of Bagot	0.562	Crown Lease Term	Added to CLT 2147 on 11/07/2013 Previously Territory road reserve (boat ramp access) – road closed to allow grant of lease
7398	Hundred of Bagot	29.83		Vacant Crown land – no previous tenures. This is an historical lot from which the site and other surround lots were parcelled out in subdivisions.

3.3 Dangerous goods licenses

There are no current dangerous goods licenses for chemical storage at the site (per comms, NTG). Interviewees were unaware if dangerous goods licenses have historically existed for chemical storage at the site.

3.4 Historical aerial photography

Historical aerial photographs are provided in plates below.



Plate 1 Historical aerial photograph of site - 1975

A concrete boat ramp (eastern portion) and an historical crash boat slipway (southern portion) exist at the site, serviced by Berrimah Road which appears unsealed at this point in time. Clearings/lots exist west of Berrimah Road, however no structures appear to exist at the site.



Plate 2 Historical aerial photograph of site - 2000

The boat ramp and slipway persist at the site; however Berrimah Road has been redirected past the site and the access road and portions of the site have been sealed. A sealed carpark has been installed servicing the concrete jetty, with a laydown/yard enclosure housing sea containers in an area north of the carpark. A warehouse has been constructed to the north east of the eastern boat ramp, and this area appears sealed with what appears to be blue metal gravel. Off site development to the northwest is in progress.



Plate 3 Historical aerial photograph of site - 2006

The boat ramp and slipway persist at the site. Contents of laydown/storage yard to north of concrete jetty has been removed and shrubs have grown considerably. Warehouse in the east of the site remains, with items stored at this portion of the site appearing more organised around the warehouse. Development appears to have been completed to the northwest of the site, with the portion pictured used as a laydown area.



Plate 4 Historical aerial photograph of site - 2010

The boat ramp and slipway persist at the site. Clearing of the site and the area to the north has occurred and a fence around the site has been installed. The area previously used as a car park is now being used as a laydown, and the previous laydown area to the north (left to overgrow in the previous Plate) is being utilised again. Boats are being stored onshore in the eastern portion of the site, which is also being used as a laydown.



Plate 5 Historical aerial photograph of site - 2012

Boats have been removed from the eastern portion of the site and the former carpark area is no longer being used as a laydown.



Plate 6 Historical aerial photograph of site - 2013

The area north of the site which was previously cleared has been developed and a warehouse has been built on it. Land to the northwest previously used as a laydown is no longer used in this manner. A new wharf/wet berth has been constructed to the north east of the concrete boat ramp.



Plate 7 Historical aerial photograph of site - 2016

Installation of the MUBRF is under construction to the east of the site. Additional sea containers are being stored at the area in the western portion of the site and the former carpark area has additional items, such as tyres and intermediate bulk containers (IBCs), stored on it. This area has also been expanded with a concrete pad installed on the shoreline which is understood to be used for the burning of seized fishing boats.



Plate 8 Historical aerial photograph of site - 2019

The western portion of the site has been expanded to include additional land to the north which is being used to store what appears to be tanks. The area to the north of the site has been developed and is now also being used for the storage in a laydown capacity.

3.5 Summary of relevant previous investigations

AECOM are not aware of any previous environmental investigations relevant to this scope of works that have occurred at the site.

3.6 Site interviews

Two interviews were conducted with persons knowledgeable with the site; one from the NTG on 13 October 2020 and one from Bhagwan Marine on 20 October 2020.

3.6.1 Representative from the Northern Territory Government

The NTG representative was interviewed by AECOM on 13 October 2020 and identified that portions of the site have been partially reclaimed and raised with imported clean fill from across the wider Darwin area. The representative noted that fill thickness at the site is up to 8 m thick, with approximately 4 m below the high tide mark at the site, and up to 4 m above it. The site was discussed as separate areas;

- the common use area in the north and east which is largely sealed
- the paved area adjacent to the barge ramp
- the western portion of the site leased to Bhagwan Marine.

Within the common user area dirt has occasionally been stockpiled on hardstand. It is unknown if this dirt has been contaminated, but the site representative considered this unlikely. Subsoil drainage exists under both the common use area and the area leased to Bhagwan Marine. The drainage runs into a collector (believed to be a triple interceptor). Stormwater samples have historically been collected, the site representative indicated that no exceedances of adopted environmental screening criteria were noted, however these results were not available to AECOM.

The NTG representative considered it unlikely that any significant contamination of soil or groundwater, that may pose a risk to human health or the environment, had occurred at the common user area, or the barge ramp area. He cited heritage and archaeological surveys completed in 2012 ahead of the construction of the barge ramp in 2016 as indicating historical Australian Defence Force use being mostly confined to the east of the site ('Z Camp') and within the estuary of the Elizabeth River immediately south of the site.

He considered the potential for the site to be impacted by nearby activities, namely at East Arm Point to the west and the concrete works to the north, however indicated that routine dust monitoring of fugitive dust leaving these sites identified no air quality issues. His appraisal of activities at the Bhagwan Marine leased area was limited, however he noted that this area of the site likely received some bulk liquids, including antifouling compounds, and that it had been used to burn illegal boats seized offshore of Australia, but he was not aware of any specific environmental concerns potentially arising from the use of this portion of the site.

In addition, it is noted that monitoring was undertaken at a location on the boundary of the MUBRF and the Project, after a rainfall event, during the construction of the MUBRF. The report noted , concentrations of copper, lead and chromium (above ANZECC 2000 screening criteria) in stormwater draining from the MUBRF site prior to discharging into Darwin Harbour (AECOM 2018).

3.6.2 Representative from Bhagwan Marine

A Bhagwan Marine representative was interviewed by AECOM on 20 October 2020 to identify potentially contaminating activities during the tenure of Bhagwan Marine at the western portion of the site. The representative confirmed that:

- no previous environmental investigations had been conducted at the site
- there was no active spill register at the site
- there were no active dangerous goods licenses for the site
- to their knowledge there were no historical dangerous goods licenses.

The representative was able to provide an inventory of liquids stored at the site:

- approximately 200 L of paints, noted to be securely stored inside an onsite paint storage unit
- approximately 205 L of diesel, noted to be securely stored in a bunded tank within a shed at the site
- miscellaneous oils (up to 50 L), possibly un-bunded, stored in the shed.

In addition to these fluids, fire extinguishers are kept at the site, however no foams are kept on site. The fire extinguishers are not believed to contain PFAS compounds. The representative mentioned that fluids were handled over hardstand and that to his knowledge, there had been no spills at the site.

Servicing of Bhagwan Marine vehicles and boats occurs off site, however painting and antifouling of vessels has occurred at the site. These are applied by roller on site over concrete hardstand, and not by spray gun.

The site is also used for the destruction of vessels seized after illegally entering Australian waters. The representative stated that as many as ten vessels might be destroyed at the site annually, and that the process for doing so was generally as follows:

- vessels are stripped of fluids and – where appropriate – hazardous materials such as methyl bromide and asbestos are safely disposed of off site
- vessels are moved to concrete pad
- vessels are burnt under supervision.

The representative noted that while the site was principally used for the storage of marine equipment, the site had also been used in support of some hull builds and that scrapping and disassembly had occurred at the site on an as required basis. The site has not been used as a landfill for scrap or domestic waste during Bhagwan Marine's tenure. During the wet season occasional finds of steel and plastic are made after rainfall has caused them to weather out of soil horizons at the site. They also noted that small sinkholes had on occasion opened up at the site over the wet season.

3.7 Summary of contaminants of potential concern

A list of contaminants of potential concern (COPC) identified by the desktop study and site walkover is provided below in Table 4.

Table 4 Contaminants of potential concern

Contaminant	Rationale for inclusion
Standard metals (arsenic, chromium, copper, mercury, nickel)	Common pollutant in port areas
Cadmium	Common pollutant in port areas
Lead	Common pollutant in port areas
Hexavalent Chromium	Common pollutant in port areas
Zinc	Common pollutant in port areas
Total Recoverable Hydrocarbons (TRH)	Common pollutant in port areas and evidence of on site storage of fuel
Benzene, Toluene, Ethylbenzene, Xylenes, and Naphthalene (BTEXN)	Common pollutant in port areas and evidence of on site storage of fuel
Total nitrogen	Palmerston wastewater treatment outfall located upstream, inputs from Elizabeth River and Hudson Creek catchments
Total phosphorus	

Contaminant	Rationale for inclusion
TBT	No longer used as an antifoulant, but still potentially present in port environments.
Radionuclides*	Uranium and thorium exported from EAW

Note: While radionuclides were identified as a COPC, analysis was outside of the scope of works considered herein as results from dust monitoring conducted at East Arm has conformed to guidelines established for management of the port.

4.0 Methodology

AECOM conducted two site walkovers, including one with limited, targeted soil sampling. The first site walkover was conducted on the 17 September 2020 and identified areas of interest and potential contamination. During the second site walkover, conducted on 18 November 2020, eight locations of interest were selected for soil sampling. The soil sampling methodology is presented below.

4.1 Soil sampling

Soil samples were collected at eight locations. These locations were identified during the site walkover and by the desktop assessment as having the potential to have received or been impacted by contaminants related to historical use at the site. These locations are presented on Figure 3.

Soil samples were collected from the upper 10 cm of the soil horizon at the site, using a trowel and placed into laboratory supplied jars. The jars were chilled in an esky and sent to Australian Laboratory Services Pty Ltd (ALS) in Darwin. Between samples the trowel was cleaned with Decon90 and rinsed in potable water. New disposable nitrile gloves were used at each location.

4.2 Laboratory selection

The laboratory selected to conduct the analysis of soil samples were NATA accredited. AECOM utilised the services of ALS Darwin.

4.3 Analytical suites

During the targeted fieldwork phase, the following primary samples were submitted to ALS for analysis:

- eight primary soil samples for TRH, BTEX-N
- eight primary soil samples for standard suite eight heavy metals
- three primary soil samples for tributyl tin (TBT)
- three primary soil samples for hexavalent and trivalent chromium
- one primary soil sample for nutrients and pathogens.

The analytical results for the samples listed above are presented in Appendix C with laboratory documentation, including chain of custody (COC) forms and quality control reports, presented in Appendix D.

4.4 Laboratory analytical data validation process

Data validation of the samples collected during the field visit is provided below. Minor QA/QC nonconformances were identified in the laboratory data, but they are not considered likely to have a material implication to decision-making on the project. QA/QC results including duplicates are presented in full in Table C.1 and Table C.2 in Appendix C.

The following conformances were identified in the data validation process:

- no method blank, laboratory duplicate or laboratory control spike outliers were noted in the laboratory's quality documentation.
- no holding time exceedances were recorded for the sample analyses.

The non-conformances identified by the data validation process are listed below:

- sample temperatures were above prescribed limits (<6°C) but were below ambient sample temperatures.
- exceedances of acceptable RPD levels (30%) were noted once between primary and intra-laboratory duplicate samples:

- Zinc RPD failure observed between SS002 and QC001 (RPD = 30%). Noting the heterogeneity of the sample media, this exceedance is considered unlikely to impact the validity or representative nature of the data.
- matrix spike recoveries could not be determined for the following analytes:
 - copper (SS001); background level greater than or equal to 4x spike level
 - zinc (SS001); background level greater than or equal to 4x spike level
 - nitrite plus nitrate as N (SS007); background level greater than or equal to 4x spike level.
- matrix spike recoveries were less than the lower data quality threshold in one sample:
 - tripropyltin in SS001 (4.7% recovery, thresholds 35 – 130%).
- a quality control sample frequency non-conformance was noted for moisture content analysis. This is not considered material to the investigation as it is not a contaminant of concern.

Overall, these discrepancies are not considered to have a material implication on the validity of the laboratory data.

Laboratory results are summarised in Table C.3 in Appendix C and laboratory documents are presented in Appendix D

4.5 Tier 1 risk assessment criteria

Tier 1 risk assessment criteria have been adopted for potential human health and ecological receptors in line with the proposed future site use are presented below in Table 5 which presents Health Investigation Levels (HILs) and Health Screening Levels (HSLs) adopted and Table 6 which presents Ecological Investigation Levels (EILs) and Ecological Screening Levels (ESLs) adopted. Tier 1 assessment criteria are developed not as clean-up levels, but rather as an indication that further investigation may be required at a site for the protection of human health or ecological values (NEPC 2013).

EILs are calculated by summing the ambient background concentration (ABC) of a naturally occurring element with the acceptable added contaminant load (ACL) for the land use relevant to the site. For the purposes of this investigation, the ACL is being treated as a de facto EIL, and should it be required at a later date, an ABC for the relevant elements may be determined for East Arm to enable comparison.

Table 5 Human Health Tier 1 risk assessment criteria

Criteria	Rationale
NEPM 2013 Table 1A(1) HILs Commercial/Industrial D Soil	The current and likely future use for the site is commercial / industrial and therefore HIL D criteria were deemed appropriate to screen soil data against. This will provide an indication of the presence of residual soil impacts (non-hydrocarbon impacts), and potential risk of direct contact with soil based on the samples targeted for analysis.
NEPM 2013 Table 1A(3) Commercial/Industrial Soil Health Screening Level (HSL) D for Vapour Intrusion in Sand	The amended NEPM 2013 (NEPC, 2013) presents health screening levels (HSLs) for petroleum compounds which have been derived through consideration of risks to human health, with the focus being on the vapour exposure pathway. The HSLs have been calculated using parameters that generally correspond to data available and as such aim to provide levels that are realistic rather than overly conservative. Full detail on their derivation and their application is provided in 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, E. and Nadebaum, P., 2011). The current and likely future use for the site is commercial / industrial and therefore HSL D were deemed appropriate to screen soil data against.

Criteria	Rationale
NEPM 2013 Table 1B(7) Management Limits Commercial / Industrial, Fine Soil	Applied for consideration of the future management of the site.

Table 6 Ecological Tier 1 risk assessment criteria – EILs and ESLs

Criteria	Rationale
NEPM 2013 Table 1B(5) Generic EILs for Commercial / Industrial	Risk to nearby ecological receptors by potential impacts in soil at the site is unknown. EILs for a commercial/industrial land use, based on a coarse soil type have been applied to the top 2 m of soil profile beneath the site, should these be exceeded then the need for developing site specific EILs or further investigation may be required.
NEPM 2013 Table 1B(6) ESLs for Commercial / Industrial areas in coarse soil	Risk to nearby ecological receptors by potential impacts in soil at the site is unknown. ESLs for a commercial/industrial land use, based on a coarse soil type have been applied to the top 2 m of soil profile beneath the site.



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1:3,000 when printed at A4
 DATUM GDA 1994, PROJECTION MGA ZONE 52

0 30 60 90 120
 Metres

Data sources:
 Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
 Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2021).

LEGEND

- Sampling location
- Site areas of interest
- ▭ Cadastral boundary
- ▭ Site layout

Site areas of interest

NORTHERN TERRITORY
 GOVERNMENT OF AUSTRALIA
 DARWIN SHIP LIFT PROJECT

Figure
3

5.0 Field Results

Field observations documented in the preliminary site walkover and subsequent field sampling event are presented below in Section 5.1 and 5.2, respectively.

5.1 Site walkover

A preliminary site walkover was conducted by AECOM staff on 17 September 2020, identifying areas of interest and potential contamination. These areas are described in **Table 7** and are presented in Figure 3. A site walkover photolog is also presented in Appendix E.).

Table 7 Locations of interest

Waypoint	Location Description/Use	Observations	Contaminants of Potential Concern
117	Boat burning location	Elevated concrete pad with grasses growing around it	Antifouling substances, TRH, BTEXN, heavy metals
118	Historical Storage	Concrete waste stored, rusted drums and scrap metal dumped within edge of mangroves	TRH, BTEXN, heavy metals
119	Storage and laydown	Sea containers and miscellaneous items stored	TRH, BTEXN, heavy metals
120	Historical site	Containers and miscellaneous items stored as laydown area. Historical USTs at this location.	TRH, BTEXN, metals
121	Disused generator	Generator stored at site	TRH & BTEXN
122	Historical AST storage area	Crane storage and other miscellaneous items	TRH & BTEXN
123	Historical crane lift	Crane storage and other miscellaneous items	TRH & BTEXN
124	Disused generator	Generator stored at site	TRH & BTEXN
125	Combustible liquid sea container	Faint hydrocarbon odour adjacent to chemical storage	TRH, BTEXN, oils, lubricants
126	IBC laydown area	IBCs stored unbanded on pallets	TRH, BTEXN, oils, lubricants, antifouling substances
127	IBC laydown area	Stained ground around sea container	TRH, BTEXN
128	IBCs of oil and other fluids	IBCs stored unbanded on pallets	TRH, BTEXN, oils, lubricants, antifouling substances
129	Underground septic	Gravel surface, unbanded sewage tanks stored in vicinity	Nutrients and pathogens
130	Storage container	Warning sign saying no smoking or ignition sources within 3 m, possible storage area for volatile substances	TRH & BTEXN
131	Tyre storage	Used as storage for waste tyres, possibly received other waste from vehicles	TRH & BTEXN
132	Storage area	Hydrocarbon odour	TRH & BTEXN

Waypoint	Location Description/Use	Observations	Contaminants of Potential Concern
133	Two storage units	Possible historical use as oil disposal	TRH, BTEXN, oils, lubricants
134	Sewage containers	Unbunded over gravel, stored with other waste/rubbish	Nutrients and pathogens
135	Within laydown area	Broken oil drum and spill to ground	TRH & BTEXN
136	Historical AST location	Sea container emplaced at/over former AST location	TRH & BTEXN
137	Disused generator	Small structure housing a generator, IBCs stored around generator, surface is grassed	TRH & BTEXN.

5.2 Soil sampling field observations

Eight locations of interest were selected for soil sampling in a second site visit conducted on 18 November 2020. These locations, the samples collected at them and a description of the soil are listed below in Table 8 and presented in Figure 3. Again, pictures of the sampling locations are provided in the site sampling photo log in Appendix E.

Table 8 Soil samples

Waypoint	Soil Sample	Location Description	Soil Description
117	SS001	Boat burning location	Sandy CLAY, light brown, minor medium gravels
118	SS004	Historical storage	Sandy CLAY, light brown, medium gravels
122	SS005	Historical AST storage area	Sandy CLAY, light brown, fine gravels
125	SS002	Combustible liquid sea container	SAND, light brown, fine gravels, slight hydrocarbon odour
126	SS003	IBC laydown area	SAND, light brown, fine gravels
127	SS006	IBC laydown area	Sandy CLAY, light brown, medium gravels
132	SS008	Storage area	Sandy CLAY, light brown, medium gravels
134	SS007	Sewage containers	Sandy CLAY, light brown, fine gravels.

6.0 Analytical Results

Eleven primary samples were collected as part of the investigation, with eight collected from areas of interest and analysed for COPCs, and a further three collected from background locations and placed on hold. These three samples were not analysed as analytical results from the areas of interest did not necessitate the development of ambient background concentrations of metals at the site. Results of the laboratory analyses are discussed below and presented in full in Table C.3 in Appendix C.

6.1 Hydrocarbon results

All samples were analysed for hydrocarbon compounds, with detectable concentrations reported at two locations only; one reported at the laboratory limit of reporting (LOR) at SS001, the location of the boat burning site, and a second location marginally above LOR noted at the SS006, a location used for the storage of IBCs and barrels. No screening criteria were exceeded.

6.2 BTEXN results

All samples were analysed for BTEXN compounds, with detections of xylenes at the LOR noted at SS001, the location of the boat burning site. No screening criteria were exceeded and BTEXN were not detected in any other sample.

6.3 Metals results

Selected heavy metals were analysed for in each of the eight samples collected from areas of interest at the site. Higher concentrations of zinc were observed in SS006 (laydown) and SS001 (boat burning pad) compared to levels in other samples collected. Higher concentrations of copper were also observed in SS01. No adopted screening levels were exceeded.

6.4 Nutrients and biological results

Nutrients and coliforms were analysed for in the laydown area where sewage tanks were located (SS007). E. Coli was not detected, with total coliforms detected at 42 CFU/g.

6.5 Tributyltin results

TBT was analysed for in three samples; at the boat burning location and the two laydown areas with intermediate bulk containers (IBCs) stored. No detectable concentrations of TBT were noted.

7.0 Conceptual Site Model

A risk-based approach to contaminated site management requires that investigations be completed and a CSM developed to assess the source, nature and extent of contamination and potential impacts to human health and the environment. Land is deemed to be 'contaminated' where there is a risk of harm, or potential harm, to human health, the environment or environmental values from a substance present at above background concentrations.

The assessment of whether a site is 'contaminated' is founded on a risk-based approach and the development (and continual refinement) of a CSM that describes the possible pathways by which exposure to potential contamination at a site may occur. Development of a CSM is the standard preliminary step in the human health and ecological risk assessment process.

For a particular contaminant to present a risk to receptors, three components must be present:

1. **Source** - A potentially hazardous substance that has been released into the environment.
2. **Receptor** - The human or ecological component potentially at risk of experiencing an adverse response following exposure to the source or derivatives of the source.
3. **Pathway** - A mechanism by which receptors can become exposed to the source or derivatives of the source.

If one of these three is missing from an exposure scenario, then there can be no risk. The fundamental aim of the risk evaluation process is to identify any complete Source-Pathway-Receptor (SPR) linkages that may present an unacceptable risk to a receptor, and to formulate an appropriate management strategy to mitigate the identified risks to acceptable levels.

The preliminary CSM for the site is developed in the sections below. In order to provide context for the identified potential pollutant linkages and allow them to be prioritised, they were qualitatively risk ranked as 'high,' 'medium' or 'low' risk.

7.1 Potential sources of contamination

Interviews with persons familiar with the site identified areas of interest and historical activities at the site which may have resulted in contamination. A site walkover with subsequent targeted sampling and laboratory analysis found minor hydrocarbon and BTEXN impacts. No legacy TBT impacts were noted in the targeted samples analysed from the site, and while concentrations of copper and zinc were detected in the soil sample collected at the edge of the pad where boat burning is conducted at concentrations notably higher than the other soil samples, the levels of impact in this soil sample were several orders of magnitude below the relevant adopted screening criteria.

Table 9 Potential sources

Source	Rationale for inclusion
Fuel/diesel drums stored at the site	Fuel and diesel have historically been stored at the site in drums and an above ground storage tank. Two soil samples collected at the site reported minor concentrations of TRH, and one sample reported minor concentrations (at detection limits) of o-Xylene.
Burned vessels on concrete pad	Illegal fishing vessels have historically been seized, towed to, and destroyed at the site. While the interview confirmed that the vessels were stripped of potential contaminants prior to their destruction, there remains a possibility that some remnant COPCs were present at the time of the vessels' destruction and that the debris has entered the soil from the pad.
Sewage tanks stored at the site	As receivers of untreated waste, there is the potential for pathogens and nutrients within the tanks to impact soil and groundwater at the site should they leak.

7.2 Potential receptors

A list of potential receptors identified by the desktop study and site walkover is provided below in Table 10.

Table 10 Potential receptors

Receptor	Rationale for inclusion
Human health	
On site excavation workers	Future planned work includes excavation and levelling at the site, which has the potential to pose additional risks to workers undertaking these activities.
On site workers	Incidental contact of contaminated soils/dusts at the site poses a potential risk to on site workers.
Off site workers	Incidental contact of contaminated dusts leaving the site poses a potential risk to nearby off site workers.
Ecological	
Darwin Harbour Estuary	Potential for contaminated soil to enter the Darwin Harbour Estuary
Groundwater	Leaching of contaminants from soil into groundwater at the site

7.3 Potential transport mechanisms and exposure pathways

A list of potential transport mechanisms and exposure pathways identified by the desktop and on site investigations is provided below in Table 11.

Table 11 Potential transport mechanisms and exposure pathways

Transport mechanism	Rationale for inclusion
Inhalation	There is potential for activities at the site to promote dust and in turn for that dust to be inhaled by on and off site workers. There is potential for vapour inhalation from the volatilisation of soil impacts.
Incidental Ingestion/Dermal contact	There is potential for soil derived dust to be incidentally ingested by on and off site workers or for incidental dermal contact.
Leaching to groundwater	There is potential for contaminants in soil to be leached to groundwater at the site. Lateral migration of groundwater may also in turn impact water quality in the Darwin Harbour Estuary.
Runoff to Darwin Harbour Estuary	There is potential for contaminants in soil to run off into the Darwin Harbour Estuary during rainfall and high-tide events.
Bioaccumulation	There is potential for the bioaccumulation of leached contaminants in fauna in Darwin Harbour.

7.4 Conceptual Site Model

Based on the findings of the background searches, historical ownership of the site, interviews with personnel, site walkover, and limited sampling of soil of the site, a conceptual site model has been developed and is presented below in Table 12.

Table 12 Darwin Ship Lift Project CSM

Potential source	Receptor	Potential pathway	SPR linkage	Justification	Data gaps/Considerations
Fuel/diesel drums stored at the site: • TRH • BTEXN	Human Health: • On site excavation workers • On site workers • Off site workers	Direct contact with or incidental ingestion of impacts in soil	Unlikely	Concentrations of COPCs detected in soil samples analysed are below guideline values	Minor detections of hydrocarbons were noted in the laydown area with barrels and IBCs. The lateral extent of these impacts is unknown. Samples were collected at or near the surface only. It is unknown if there are impacts at depth. Field observations and the interviews conducted did not suggest that a large scale product release has occurred in storage areas at the site, and it is considered unlikely that an unknown release or a sufficient number of incidental releases have occurred to pose an unacceptable risk to present and future users at the site.
Vapour inhalation from volatilisation of impacts in soil					
Burned vessels on concrete pad: • Metals • TBT • TRH • BTEXN		Direct contact with or incidental ingestion of impacts in soil	Unlikely	Concentrations of COPCs detected in soil samples analysed are below guideline values	Trace detection of hydrocarbons were made at the boat burning location and are considered unlikely to represent wider contamination at this location. TBT was not detected in samples collected at this location and may not be present at the site.
Vapour inhalation from volatilisation of impacts in soil					
Sewage tanks: • Pathogens • Nutrients			Direct contact with or incidental ingestion of impacts in soil	Unlikely	E. coli was not detected in samples analysed for pathogens. Coliforms were detected but are likely naturally occurring soil bacteria.
Antifouling substances for marine vessels stored at the site/used on vessels stored at the site: • TBT		Direct contact with or incidental ingestion of impacts in soil	Unlikely	TBT was not detected in soil samples analysed at the site	TBT may have been stored/applied in locations at the site not sampled. It is considered unlikely that undiscovered TBT impacts constituting a potential environmental or health risk exist at the site.
Fuel/diesel drums stored at the site: • TRH • BTEXN	Ecological: • Darwin Harbour Estuary • Fauna within Darwin Harbour Estuary	Leaching to groundwater and transport to Darwin Harbour Estuary and/or direct runoff to Darwin Harbour Estuary	Unlikely	Concentrations of COPCs detected in soil samples analysed are below guideline values	Minor detections of hydrocarbons were made the laydown area with barrels and IBCs. The lateral extent of these impacts is unknown and remains a data gap
Burned vessels on concrete pad: • Metals • TBT • TRH • BTEXN			Unlikely	Vessels are stripped before being burnt. Concentrations of COPCs in soil samples analysed were below adopted guidelines	None
Antifouling substances for marine vessels: TBT			Bioaccumulation within Darwin Harbour Estuary	Unlikely	TBT was not detected in soil samples analysed at the site.

8.0 Conclusion and Recommendations

An evaluation of the data gaps was undertaken in order to inform the conclusions and recommendations of this report. The data gaps are not considered likely to present an unacceptable risk to present or future users of the site, or nearby ecological receptors. The data gaps evaluation, conclusions and recommendations are discussed in Sections 8.1, 8.2 and 8.3, respectively.

8.1 Data gaps evaluation

The hydrocarbon and BTEXN impacts detected at the site were minor, and do not appear to directly correlate to any current on site hydrocarbon storage. Due to the limited and targeted nature of sampling conducted at the site, the lateral and vertical extent of these impacts remains a data gap. The likely provenance of these impacts is minor spills at the site during day to day operations and not a large scale or chronic product release, however the scale and spatial extent of impacted soils at the site is unknown.

Based on the available data - including the indication during interviews with site knowledgeable staff stating that large volumes of hydrocarbons had not been spilt at the site – this data gap is not considered likely to pose an unacceptable risk to present or future users at the site, or the nearby ecological receptors. However, given the long history of the site there is an inherent level of uncertainty relating to past knowledge of the site.

Additional lateral and vertical sampling of these areas could close out this data gap should it be required by the NTG to inform construction planning.

8.2 Conclusions

The following high level conclusions can be drawn from the findings of the PSI with respect to environmental impacts associated with the historical use of the site:

- no reported spills have been recorded as occurring at the site, and interviews conducted with personnel understood to be knowledgeable of the site were unaware of any unreported spills at the site.
- detectable (minor and trace) concentrations of TRH and BTEXN compounds were observed in two surface soil samples analysed at the site, but are considered unlikely to be representative of widespread, larger impacts at the site and are unlikely to pose an unacceptable risk to human health or environmental receptors.
- no detectable concentrations of TBT were observed in samples analysed at the site. While it is possible that there are minor TBT impacts at the site, it is considered unlikely that these impacts constitute an unacceptable risk to human health or sensitive environmental receptors.
- concentrations of heavy metals observed in samples analysed at the site appear to be representative of background/natural conditions and are orders of magnitude lower than adopted screening criteria.

In addition to these points regarding environmental impacts at the site relating to its historical use, the site is located within a high risk ASS area and is likely to require consideration of managing potential ASS risks. Desktop searches conducted in support of the PSI suggest that the risk for land based UXO is low at the site.

This investigation does not have the scope to draw conclusions about the presence or absence of contamination at depth at the site owing to the sampling programme's targeted nature of areas of interest at surface around the site.

8.3 Recommendations

The findings of the PSI suggest that further investigations into contamination at the site are unlikely to be required based on the targeted sampling undertaken. While TRH and BTEXN compounds were detected in two soil samples collected at the site, concentrations were at or near detection limits. Other COPCs were not detected during the investigation, and while their absence elsewhere at the site

cannot be guaranteed, the available desktop information, anecdotal information from site operators and visual evidence during the site walkover do not suggest that further investigation is required.

It is noted that the investigation does not have the scope to draw conclusions about the presence or absence of contamination at depth at the site owing to the sampling programme's targeted nature of areas of interest at surface around the site. In addition the investigation is unable to draw conclusions regarding contamination that may be present from historical activities which are not recorded.

While every effort has been made to develop a CSM reflective of the data obtained as part of the scope of works, in the unlikely event that additional contamination is encountered which is inconsistent with known site impacts or sources and alters the CSM, further works may be required to adequately address the risks to all future commercial/industrial site users.

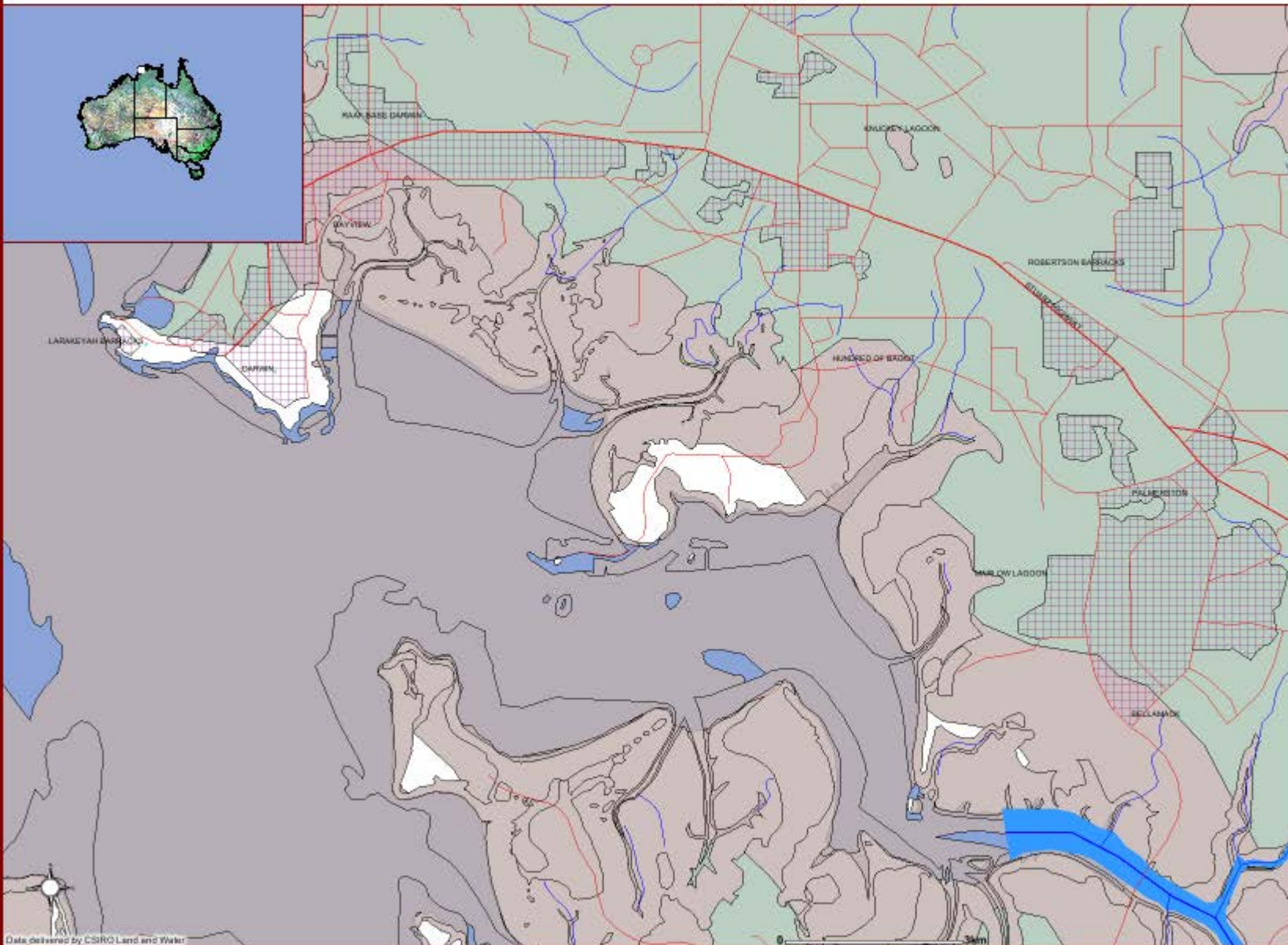
9.0 References

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Appendix A

Acid Sulphate Soil Risk Mapping

ASRIS



- Locations
- Roads (1:250K)
- Highway
- Other Roads
- Streams
- Major
- Minor
- ▨ Buffer Areas
- ▨ Inland Water Bodies
- ASS Reference Sites
- National ASS Atlas
- A1 High Probability/High Confidence
- A2 High Probability/Moderate Confidence
- A3 High Probability/Low Confidence
- A4 High Probability/Very Low Confidence
- A - High Probability/Confidence Unknown
- B1 Low Probability/High Confidence
- B2 Low Probability/Moderate Confidence
- B3 Low Probability/Low Confidence
- B4 Low Probability/Very Low Confidence
- B - Low Probability/Confidence Unknown
- C1 Extremely Low Probability/High Confidence
- C2 Extremely Low Probability/Moderate Confidence
- C3 Extremely Low Probability/Low Confidence
- C4 Extremely Low Probability/Very Low Confidence
- C - Extremely Low Probability/Confidence Unknown
- Base-Map

Data delivered by CSIRO Land and Water

Appendix B

Heritage Authority
Certificate

Appendix C

Analytical Results

Table C.1: Relative Percentage Differences

SDG	ES2040445	ES2040445
Field ID	SS002_201118	QC001_201118
Date	18/11/2020 13:30	18/11/2020 13:30

Analyte	Units	LOR			
TRH - Semivolatile Fraction					
>C10-C16 (minus Naphthalene)(F2)	mg/kg	50	<50	<50	0
>C10-C16 fraction	mg/kg	50	<50	<50	0
>C16-C34 fraction	mg/kg	100	<100	120	18
>C34-C40 fraction	mg/kg	100	<100	<100	0
>C10-C40 fraction (sum)	mg/kg	50	<50	120	82
TRH Volatiles/BTEX					
C6-C10 fraction	mg/kg	10	<10	<10	0
C6-C10 fraction (minus BTEX)(F1)	mg/kg	10	<10	<10	0
Benzene	mg/kg	0.2	<0.2	<0.2	0
Toluene	mg/kg	0.5	<0.5	<0.5	0
Ethylbenzene	mg/kg	0.5	<0.5	<0.5	0
m&p-Xylene	mg/kg	0.5	<0.5	<0.5	0
o-Xylene	mg/kg	0.5	<0.5	<0.5	0
Total Xylenes	mg/kg	0.5	<0.5	<0.5	0
Total BTEX	mg/kg	0.2	<0.2	<0.2	0
Naphthalene (VOC)	mg/kg	1	<1	<1	0
Total Metals by ICP-AES					
Mercury	mg/kg	0.1	<0.1	<0.1	0
Arsenic	mg/kg	5	29	32	10
Cadmium	mg/kg	1	<1	<1	0
Chromium	mg/kg	2	58	57	2
Copper	mg/kg	5	25	23	8
Lead	mg/kg	5	20	20	0
Nickel	mg/kg	2	6	5	18
Zinc	mg/kg	5	152	206	30

*RPDs have only been considered where a concentration is greater than 1 times the EQL.

**High RPDs are in bold (Acceptable RPDs for each EQL multiplier range are: 200 (1-10 x EQL); 50 (10-20 x EQL); 30 (> 20 x EQL))

***Interlab Duplicates are matched on a per compound basis as methods vary between laboratories.

Any methods in the row header relate to those used in the primary laboratory

Appendix D

Laboratory Reports

CERTIFICATE OF ANALYSIS

Work Order : **ES2040445**
Client : **AECOM Australia Pty Ltd**
Contact : **MR CAMERON RITCHIE**
Address : **GPO BOX 3175**
DARWIN NT, AUSTRALIA 0801
Telephone : **+61 08 6208 0000**
Project : **60633505 SLAMI**
Order number : **60633505**
C-O-C number : **----**
Sampler : **JACE EMBERG**
Site : **----**
Quote number : **EP/969/20**
No. of samples received : **14**
No. of samples analysed : **11**

Page : 1 of 8
Laboratory : Environmental Division Sydney
Contact : Brenda Hong
Address : 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone : +61 2 8784 8555
Date Samples Received : 19-Nov-2020 07:30
Date Analysis Commenced : 20-Nov-2020
Issue Date : 27-Nov-2020 17:27



This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

<i>Signatories</i>	<i>Position</i>	<i>Accreditation Category</i>
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Morgan Lennox	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Uma Nagendiram	Subcontracting Coordinator	WRG Subcontracting, Smithfield, NSW



General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EP080: Where reported, Total Xylenes is the sum of the reported concentrations of m&p-Xylene and o-Xylene at or above the LOR.
- MM868 (Coliforms & E. coli in Soils by MPN using Aquachrom ECC) - Analysis is conducted by ALS Scoresby NATA accreditation no. 992, site no. 989.
- EP090 Organotins: Sample 'SS001_201118' shows poor surrogate recovery due to matrix interference. Confirmed by re-extraction and re-analysis.



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	SS001_201118	SS002_201118	SS003_201118	SS004_201118	SS005_201118
Sampling date / time				18-Nov-2020 00:00	18-Nov-2020 00:00	18-Nov-2020 00:00	18-Nov-2020 00:00	18-Nov-2020 00:00	
Compound	CAS Number	LOR	Unit	ES2040445-001	ES2040445-002	ES2040445-003	ES2040445-004	ES2040445-005	
				Result	Result	Result	Result	Result	
EA055: Moisture Content									
Moisture Content	----	1.0	%	<1.0	<1.0	2.9	2.5	<1.0	
EG005(ED093)T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg	14	29	5	48	29	
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1	
Chromium	7440-47-3	2	mg/kg	16	58	17	36	44	
Copper	7440-50-8	5	mg/kg	3130	25	32	18	54	
Lead	7439-92-1	5	mg/kg	43	20	18	30	29	
Nickel	7440-02-0	2	mg/kg	5	6	6	3	9	
Zinc	7440-66-6	5	mg/kg	1500	152	58	192	300	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1	
EG048: Hexavalent Chromium (Alkaline Digest)									
Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	----	<0.5	----	----	
EG049: Trivalent Chromium									
Trivalent Chromium	16065-83-1	2	mg/kg	16	----	17	----	----	
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg	<10	<10	<10	<10	<10	
C10 - C14 Fraction	----	50	mg/kg	<50	<50	<50	<50	<50	
C15 - C28 Fraction	----	100	mg/kg	<100	<100	<100	<100	<100	
C29 - C36 Fraction	----	100	mg/kg	<100	<100	<100	<100	<100	
^ C10 - C36 Fraction (sum)	----	50	mg/kg	<50	<50	<50	<50	<50	
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	<10	<10	<10	
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg	<10	<10	<10	<10	<10	
>C10 - C16 Fraction	----	50	mg/kg	<50	<50	<50	<50	<50	
>C16 - C34 Fraction	----	100	mg/kg	100	<100	<100	<100	<100	
>C34 - C40 Fraction	----	100	mg/kg	<100	<100	<100	<100	<100	
^ >C10 - C40 Fraction (sum)	----	50	mg/kg	100	<50	<50	<50	<50	
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	50	mg/kg	<50	<50	<50	<50	<50	
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2	
Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	SS001_201118	SS002_201118	SS003_201118	SS004_201118	SS005_201118
Sampling date / time				18-Nov-2020 00:00	18-Nov-2020 00:00	18-Nov-2020 00:00	18-Nov-2020 00:00	18-Nov-2020 00:00	
Compound	CAS Number	LOR	Unit	ES2040445-001	ES2040445-002	ES2040445-003	ES2040445-004	ES2040445-005	
				Result	Result	Result	Result	Result	
EP080: BTEXN - Continued									
Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	<0.5	
ortho-Xylene	95-47-6	0.5	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	
^ Sum of BTEX	----	0.2	mg/kg	0.5	<0.2	<0.2	<0.2	<0.2	
^ Total Xylenes	----	0.5	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	
Naphthalene	91-20-3	1	mg/kg	<1	<1	<1	<1	<1	
EP090: Organotin Compounds									
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	----	<0.5	----	----	
EP080S: TPH(V)/BTEX Surrogates									
1,2-Dichloroethane-D4	17060-07-0	0.2	%	99.2	98.0	93.3	94.1	94.7	
Toluene-D8	2037-26-5	0.2	%	109	106	98.8	96.2	99.3	
4-Bromofluorobenzene	460-00-4	0.2	%	118	116	111	109	109	
EP090S: Organotin Surrogate									
Tripopyltin	----	0.5	%	4.70	----	79.9	----	----	



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	SS006_201118	SS007_201118	SS008_201118	QC001_201118	----
Sampling date / time				18-Nov-2020 00:00	18-Nov-2020 00:00	18-Nov-2020 00:00	18-Nov-2020 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2040445-006	ES2040445-007	ES2040445-008	ES2040445-009	-----	----
				Result	Result	Result	Result	----	----
EA055: Moisture Content									
Moisture Content	----	1.0	%	<1.0	<1.0	<1.0	<1.0	----	----
EG005(ED093)T: Total Metals by ICP-AES									
Arsenic	7440-38-2	5	mg/kg	27	14	9	32	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	----	----
Chromium	7440-47-3	2	mg/kg	69	34	23	57	----	----
Copper	7440-50-8	5	mg/kg	45	26	27	23	----	----
Lead	7439-92-1	5	mg/kg	30	21	15	20	----	----
Nickel	7440-02-0	2	mg/kg	10	6	9	5	----	----
Zinc	7440-66-6	5	mg/kg	1120	144	31	206	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	----	----
EG048: Hexavalent Chromium (Alkaline Digest)									
Hexavalent Chromium	18540-29-9	0.5	mg/kg	1.4	----	----	----	----	----
EG049: Trivalent Chromium									
Trivalent Chromium	16065-83-1	2	mg/kg	68	----	----	----	----	----
EK055: Ammonia as N									
Ammonia as N	7664-41-7	20	mg/kg	----	<20	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	----	<0.1	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N (Sol.)	14797-55-8	0.1	mg/kg	----	20.7	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	----	20.7	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser									
Total Kjeldahl Nitrogen as N	----	20	mg/kg	----	550	----	----	----	----
EK062: Total Nitrogen as N (TKN + NOx)									
^ Total Nitrogen as N	----	20	mg/kg	----	570	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	2	mg/kg	----	146	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	10	mg/kg	<10	<10	<10	<10	----	----
C10 - C14 Fraction	----	50	mg/kg	<50	<50	<50	<50	----	----
C15 - C28 Fraction	----	100	mg/kg	130	<100	<100	<100	----	----



Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Sample ID	SS006_201118	SS007_201118	SS008_201118	QC001_201118	----
Sampling date / time				18-Nov-2020 00:00	18-Nov-2020 00:00	18-Nov-2020 00:00	18-Nov-2020 00:00	----	----
Compound	CAS Number	LOR	Unit	ES2040445-006	ES2040445-007	ES2040445-008	ES2040445-009	-----	-----
				Result	Result	Result	Result	----	----
EP080/071: Total Petroleum Hydrocarbons - Continued									
C29 - C36 Fraction	----	100	mg/kg	190	<100	<100	<100	----	----
^ C10 - C36 Fraction (sum)	----	50	mg/kg	320	<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	<10	<10	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	10	mg/kg	<10	<10	<10	<10	----	----
>C10 - C16 Fraction	----	50	mg/kg	<50	<50	<50	<50	----	----
>C16 - C34 Fraction	----	100	mg/kg	260	<100	<100	120	----	----
>C34 - C40 Fraction	----	100	mg/kg	130	<100	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	50	mg/kg	390	<50	<50	120	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	50	mg/kg	<50	<50	<50	<50	----	----
EP080: BTEXN									
Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----	----
Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----	----
Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----	----
meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----	----
ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----	----
^ Sum of BTEX	----	0.2	mg/kg	<0.2	<0.2	<0.2	<0.2	----	----
^ Total Xylenes	----	0.5	mg/kg	<0.5	<0.5	<0.5	<0.5	----	----
Naphthalene	91-20-3	1	mg/kg	<1	<1	<1	<1	----	----
EP090: Organotin Compounds									
Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	----	----	----	----	----
MM868: Coliforms & E.coli by MPN using Aquachrom ECC									
Total Coliforms by MPN	----	10	MPN/g	----	42	----	----	----	----
E.coli by MPN	----	10	MPN/g	----	<10	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1,2-Dichloroethane-D4	17060-07-0	0.2	%	98.6	93.0	97.1	90.9	----	----
Toluene-D8	2037-26-5	0.2	%	106	100	101	92.8	----	----
4-Bromofluorobenzene	460-00-4	0.2	%	110	109	109	101	----	----
EP090S: Organotin Surrogate									
Tripropyltin	----	0.5	%	49.5	----	----	----	----	----



Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Sample ID	QC002_201118	QC003_201118	----	----	----
Sampling date / time				18-Nov-2020 00:00	18-Nov-2020 00:00	----	----	----	
Compound	CAS Number	LOR	Unit	ES2040445-010	ES2040445-011	-----	-----	-----	
				Result	Result	----	----	----	
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	----	----	----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----	
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----	
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	----	----	----	
Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	----	----	----	
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----	
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	----	----	----	
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----	



Surrogate Control Limits

Sub-Matrix: SOIL		Recovery Limits (%)	
Compound	CAS Number	Low	High
EP080S: TPH(V)/BTEX Surrogates			
1,2-Dichloroethane-D4	17060-07-0	73	133
Toluene-D8	2037-26-5	74	132
4-Bromofluorobenzene	460-00-4	72	130
EP090S: Organotin Surrogate			
Tripropyltin	----	35	130

QUALITY CONTROL REPORT

Work Order	: ES2040445	Page	: 1 of 9
Client	: AECOM Australia Pty Ltd	Laboratory	: Environmental Division Sydney
Contact	: MR CAMERON RITCHIE	Contact	: Brenda Hong
Address	: GPO BOX 3175 DARWIN NT, AUSTRALIA 0801	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
Telephone	: +61 08 6208 0000	Telephone	: +61 2 8784 8555
Project	: 60633505 SLAMI	Date Samples Received	: 19-Nov-2020
Order number	: 60633505	Date Analysis Commenced	: 20-Nov-2020
C-O-C number	: ----	Issue Date	: 27-Nov-2020
Sampler	: JACE EMBERG		
Site	: ----		
Quote number	: EP/969/20		
No. of samples received	: 14		
No. of samples analysed	: 11		



This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Inorganics, Smithfield, NSW
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Franco Lentini	LCMS Coordinator	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Morgan Lennox	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Uma Nagendiram	Subcontracting Coordinator	WRG Subcontracting, Smithfield, NSW



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The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key :
 Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
 CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
 LOR = Limit of reporting
 RPD = Relative Percentage Difference
 # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 3379343)									
ES2040445-001	SS001_201118	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	16	19	15.6	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	5	10	58.2	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	14	19	27.5	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	3130	3070	1.80	0% - 20%
		EG005T: Lead	7439-92-1	5	mg/kg	43	45	4.00	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	1500	1810	18.6	0% - 20%
ES2041042-001	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	6	8	28.6	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	<2	3	49.9	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	<5	7	37.2	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	5	0.00	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	10	12	16.1	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	12	20	49.3	No Limit
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 3380688)									
ES2041463-005	Anonymous	EG005T: Lead	7439-92-1	5	mg/kg	76	72	6.00	0% - 50%
ES2040445-007	SS007_201118	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	34	39	11.7	0% - 50%
		EG005T: Nickel	7440-02-0	2	mg/kg	6	6	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	14	14	0.00	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	26	36	31.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	21	23	10.9	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	144	175	19.3	0% - 20%
ES2041463-005	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.00	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	10	9	0.00	No Limit



Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 3380688) - continued									
ES2041463-005	Anonymous	EG005T: Nickel	7440-02-0	2	mg/kg	5	6	0.00	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	187	190	1.90	0% - 20%
		EG005T: Copper	7440-50-8	5	mg/kg	103	108	5.01	0% - 20%
		EG005T: Zinc	7440-66-6	5	mg/kg	70	70	0.00	0% - 50%
EA055: Moisture Content (Dried @ 105-110°C) (QC Lot: 3379345)									
ES2040445-003	SS003_201118	EA055: Moisture Content	----	0.1	%	2.9	2.8	4.43	No Limit
ES2041130-001	Anonymous	EA055: Moisture Content	----	0.1	%	7.2	8.2	12.3	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3379342)									
ES2040445-001	SS001_201118	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
ES2041042-001	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3380689)									
ES2040445-007	SS007_201118	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
ES2041463-005	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EG048: Hexavalent Chromium (Alkaline Digest) (QC Lot: 3374174)									
ES2040420-001	Anonymous	EG048G: Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	<0.5	0.00	No Limit
EK055: Ammonia as N (QC Lot: 3383786)									
ES2041011-001	Anonymous	EK055: Ammonia as N	7664-41-7	20	mg/kg	<20	<20	0.00	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 3380303)									
ES2040445-007	SS007_201118	EK057G: Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	<0.1	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 3380304)									
ES2040445-007	SS007_201118	EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	20.7	20.5	0.768	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 3374216)									
ES2040445-007	SS007_201118	EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	550	560	0.00	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 3374215)									
ES2040797-009	Anonymous	EK067G: Total Phosphorus as P	----	2	mg/kg	711	630	12.1	0% - 20%
ES2040445-007	SS007_201118	EK067G: Total Phosphorus as P	----	2	mg/kg	146	155	5.92	0% - 20%
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 3374836)									
ES2040445-001	SS001_201118	EP071: C15 - C28 Fraction	----	100	mg/kg	<100	<100	0.00	No Limit
		EP071: C29 - C36 Fraction	----	100	mg/kg	<100	<100	0.00	No Limit
		EP071: C10 - C14 Fraction	----	50	mg/kg	<50	<50	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 3377526)									
ES2040955-005	Anonymous	EP080: C6 - C9 Fraction	----	10	mg/kg	<10	<10	0.00	No Limit
ES2040955-004	Anonymous	EP080: C6 - C9 Fraction	----	10	mg/kg	<10	<10	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 3374836)									
ES2040445-001	SS001_201118	EP071: >C16 - C34 Fraction	----	100	mg/kg	100	110	0.00	No Limit
		EP071: >C34 - C40 Fraction	----	100	mg/kg	<100	<100	0.00	No Limit
		EP071: >C10 - C16 Fraction	----	50	mg/kg	<50	<50	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 3377526)									



Sub-Matrix: SOIL				Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)	
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 3377526) - continued										
ES2040955-005	Anonymous	EP080: C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	0.00	No Limit	
ES2040955-004	Anonymous	EP080: C6 - C10 Fraction	C6_C10	10	mg/kg	<10	<10	0.00	No Limit	
EP080: BTEXN (QC Lot: 3377526)										
ES2040955-005	Anonymous	EP080: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.00	No Limit	
		EP080: Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	0.00	No Limit	
		EP080: Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	0.00	No Limit	
		EP080: meta- & para-Xylene	108-38-3	0.5	mg/kg	<0.5	<0.5	0.00	No Limit	
			106-42-3							
			95-47-6	0.5	mg/kg	<0.5	<0.5	0.00	No Limit	
ES2040955-004	Anonymous	EP080: ortho-Xylene	91-20-3	1	mg/kg	<1	<1	0.00	No Limit	
		EP080: Benzene	71-43-2	0.2	mg/kg	<0.2	<0.2	0.00	No Limit	
		EP080: Toluene	108-88-3	0.5	mg/kg	<0.5	<0.5	0.00	No Limit	
		EP080: Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	<0.5	0.00	No Limit	
		EP080: meta- & para-Xylene	108-38-3	0.5	mg/kg	<0.5	<0.5	0.00	No Limit	
			106-42-3							
	95-47-6	0.5	mg/kg	<0.5	<0.5	0.00	No Limit			
	91-20-3	1	mg/kg	<1	<1	0.00	No Limit			
EP090: Organotin Compounds (QC Lot: 3379944)										
EB2030240-001	Anonymous	EP090: Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	<0.5	0.00	No Limit	
Sub-Matrix: WATER										
Sub-Matrix: WATER				Laboratory Duplicate (DUP) Report						
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)	
EG020T: Total Metals by ICP-MS (QC Lot: 3376558)										
ES2040568-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit	
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit	
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit	
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.003	0.003	0.00	No Limit	
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit	
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.001	0.001	0.00	No Limit	
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.006	22.6	No Limit	
ES2040616-010	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit	
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.016	0.016	0.00	0% - 50%	
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit	
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit	
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit	
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit	
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit	
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 3377647)										
ES2040354-012	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit	
ES2041287-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit	



Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report				
				Result	Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3379343)									
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	121.1 mg/kg	106	88.0	113	
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	0.74 mg/kg	84.4	70.0	130	
EG005T: Chromium	7440-47-3	2	mg/kg	<2	20.2 mg/kg	96.8	68.0	132	
EG005T: Copper	7440-50-8	5	mg/kg	<5	52.9 mg/kg	107	89.0	111	
EG005T: Lead	7439-92-1	5	mg/kg	<5	62.1 mg/kg	95.8	82.0	119	
EG005T: Nickel	7440-02-0	2	mg/kg	<2	15.4 mg/kg	96.9	80.0	120	
EG005T: Zinc	7440-66-6	5	mg/kg	<5	162 mg/kg	78.2	66.0	133	
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3380688)									
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	121.1 mg/kg	106	88.0	113	
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	0.74 mg/kg	112	70.0	130	
EG005T: Chromium	7440-47-3	2	mg/kg	<2	20.2 mg/kg	118	68.0	132	
EG005T: Copper	7440-50-8	5	mg/kg	<5	52.9 mg/kg	106	89.0	111	
EG005T: Lead	7439-92-1	5	mg/kg	<5	62.1 mg/kg	106	82.0	119	
EG005T: Nickel	7440-02-0	2	mg/kg	<2	15.4 mg/kg	107	80.0	120	
EG005T: Zinc	7440-66-6	5	mg/kg	<5	162 mg/kg	82.8	66.0	133	
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3379342)									
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.073 mg/kg	127	70.0	130	
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3380689)									
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.073 mg/kg	118	70.0	130	
EG048G: Hexavalent Chromium (Alkaline Digest) (QCLot: 3374174)									
EG048G: Hexavalent Chromium	18540-29-9	0.5	mg/kg	<0.5	20 mg/kg	102	68.0	114	
EK055: Ammonia as N (QCLot: 3383786)									
EK055: Ammonia as N	7664-41-7	20	mg/kg	<20	125 mg/kg	98.0	84.0	104	
EK057G: Nitrite as N by Discrete Analyser (QCLot: 3380303)									
EK057G: Nitrite as N (Sol.)	14797-65-0	0.1	mg/kg	<0.1	2.5 mg/kg	101	85.0	111	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 3380304)									
EK059G: Nitrite + Nitrate as N (Sol.)	----	0.1	mg/kg	<0.1	2.5 mg/kg	104	88.0	118	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 3374216)									
EK061G: Total Kjeldahl Nitrogen as N	----	20	mg/kg	<20	1000 mg/kg	91.6	72.0	106	
				<20	100 mg/kg	99.8	70.0	122	
				<20	500 mg/kg	85.6	70.0	130	
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 3374215)									



Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report				
					Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EP067G: Total Phosphorus as P by Discrete Analyser (QCLot: 3374215) - continued									
EP067G: Total Phosphorus as P	----	2	mg/kg	<2	442 mg/kg	95.1	76.0	108	
				<2	44.2 mg/kg	92.0	70.0	118	
				<2	100 mg/kg	81.5	70.0	130	
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3374836)									
EP071: C10 - C14 Fraction	----	50	mg/kg	<50	300 mg/kg	103	75.0	129	
EP071: C15 - C28 Fraction	----	100	mg/kg	<100	450 mg/kg	101	77.0	131	
EP071: C29 - C36 Fraction	----	100	mg/kg	<100	300 mg/kg	107	71.0	129	
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3377526)									
EP080: C6 - C9 Fraction	----	10	mg/kg	<10	26 mg/kg	98.8	68.4	128	
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3374836)									
EP071: >C10 - C16 Fraction	----	50	mg/kg	<50	375 mg/kg	99.9	77.0	125	
EP071: >C16 - C34 Fraction	----	100	mg/kg	<100	525 mg/kg	104	74.0	138	
EP071: >C34 - C40 Fraction	----	100	mg/kg	<100	225 mg/kg	103	63.0	131	
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3377526)									
EP080: C6 - C10 Fraction	C6_C10	10	mg/kg	<10	31 mg/kg	101	68.4	128	
EP080: BTEXN (QCLot: 3377526)									
EP080: Benzene	71-43-2	0.2	mg/kg	<0.2	1 mg/kg	98.6	62.0	116	
EP080: Toluene	108-88-3	0.5	mg/kg	<0.5	1 mg/kg	102	67.0	121	
EP080: Ethylbenzene	100-41-4	0.5	mg/kg	<0.5	1 mg/kg	102	65.0	117	
EP080: meta- & para-Xylene	108-38-3 106-42-3	0.5	mg/kg	<0.5	2 mg/kg	104	66.0	118	
EP080: ortho-Xylene	95-47-6	0.5	mg/kg	<0.5	1 mg/kg	104	68.0	120	
EP080: Naphthalene	91-20-3	1	mg/kg	<1	1 mg/kg	99.9	63.0	119	
EP090: Organotin Compounds (QCLot: 3379944)									
EP090: Tributyltin	56573-85-4	0.5	µgSn/kg	<0.5	1.25 µgSn/kg	97.1	52.0	139	

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report				
					Spike Concentration	Spike Recovery (%)		Recovery Limits (%)	
						LCS	Low	High	
EG020T: Total Metals by ICP-MS (QCLot: 3376558)									
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.1	82.0	114	
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	94.9	84.0	112	
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	94.9	86.0	116	
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	95.4	83.0	118	
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	97.7	85.0	115	
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	97.6	84.0	116	
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	94.0	79.0	117	
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3377647)									



Sub-Matrix: WATER

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report			
					Spike Concentration	Spike Recovery (%)	Recovery Limits (%)	
						LCS	Low	High
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3377647) - continued								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	101	77.0	111

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: SOIL

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike Concentration	Spike Recovery(%) MS	Recovery Limits (%)	
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3379343)							
ES2040445-001	SS001_201118	EG005T: Arsenic	7440-38-2	50 mg/kg	95.5	70.0	130
		EG005T: Cadmium	7440-43-9	50 mg/kg	95.4	70.0	130
		EG005T: Chromium	7440-47-3	50 mg/kg	80.8	68.0	132
		EG005T: Copper	7440-50-8	250 mg/kg	# Not Determined	70.0	130
		EG005T: Lead	7439-92-1	250 mg/kg	90.2	70.0	130
		EG005T: Nickel	7440-02-0	50 mg/kg	94.7	70.0	130
		EG005T: Zinc	7440-66-6	250 mg/kg	# Not Determined	66.0	133
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 3380688)							
ES2040445-007	SS007_201118	EG005T: Arsenic	7440-38-2	50 mg/kg	91.4	70.0	130
		EG005T: Cadmium	7440-43-9	50 mg/kg	94.4	70.0	130
		EG005T: Chromium	7440-47-3	50 mg/kg	111	68.0	132
		EG005T: Copper	7440-50-8	250 mg/kg	99.0	70.0	130
		EG005T: Lead	7439-92-1	250 mg/kg	94.9	70.0	130
		EG005T: Nickel	7440-02-0	50 mg/kg	94.8	70.0	130
		EG005T: Zinc	7440-66-6	250 mg/kg	99.2	66.0	133
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3379342)							
ES2040445-001	SS001_201118	EG035T: Mercury	7439-97-6	5 mg/kg	81.6	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3380689)							
ES2040445-007	SS007_201118	EG035T: Mercury	7439-97-6	5 mg/kg	91.0	70.0	130
EG048: Hexavalent Chromium (Alkaline Digest) (QCLot: 3374174)							
ES2040420-002	Anonymous	EG048G: Hexavalent Chromium	18540-29-9	20 mg/kg	80.3	70.0	130
ES2040420-002	Anonymous	EG048G: Hexavalent Chromium	18540-29-9	20 mg/kg	82.9	70.0	130
EK055: Ammonia as N (QCLot: 3383786)							
ES2041011-001	Anonymous	EK055: Ammonia as N	7664-41-7	125 mg/kg	96.5	70.0	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 3380303)							



Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report				
				Spike	SpikeRecovery(%)	Recovery Limits (%)		
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High	
EK057G: Nitrite as N by Discrete Analyser (QCLot: 3380303) - continued								
ES2040445-007	SS007_201118	EK057G: Nitrite as N (Sol.)	14797-65-0	2.5 mg/kg	90.4	70.0	130	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 3380304)								
ES2040445-007	SS007_201118	EK059G: Nitrite + Nitrate as N (Sol.)	----	2.5 mg/kg	# Not Determined	70.0	130	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 3374216)								
ES2040445-007	SS007_201118	EK061G: Total Kjeldahl Nitrogen as N	----	500 mg/kg	85.0	70.0	130	
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 3374215)								
ES2040445-007	SS007_201118	EK067G: Total Phosphorus as P	----	100 mg/kg	120	70.0	130	
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3374836)								
ES2040445-001	SS001_201118	EP071: C10 - C14 Fraction	----	523 mg/kg	89.6	73.0	137	
		EP071: C15 - C28 Fraction	----	2319 mg/kg	102	53.0	131	
		EP071: C29 - C36 Fraction	----	1714 mg/kg	121	52.0	132	
EP080/071: Total Petroleum Hydrocarbons (QCLot: 3377526)								
ES2040955-005	Anonymous	EP080: C6 - C9 Fraction	----	65 mg/kg	117	70.0	130	
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3374836)								
ES2040445-001	SS001_201118	EP071: >C10 - C16 Fraction	----	860 mg/kg	104	73.0	137	
		EP071: >C16 - C34 Fraction	----	3223 mg/kg	106	53.0	131	
		EP071: >C34 - C40 Fraction	----	1058 mg/kg	120	52.0	132	
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 3377526)								
ES2040955-005	Anonymous	EP080: C6 - C10 Fraction	C6_C10	75 mg/kg	122	70.0	130	
EP080: BTEXN (QCLot: 3377526)								
ES2040955-005	Anonymous	EP080: Benzene	71-43-2	5 mg/kg	107	70.0	130	
		EP080: Toluene	108-88-3	5 mg/kg	104	70.0	130	
		EP080: Ethylbenzene	100-41-4	5 mg/kg	106	70.0	130	
		EP080: meta- & para-Xylene	108-38-3	5 mg/kg	104	70.0	130	
			106-42-3					
		EP080: ortho-Xylene	95-47-6	5 mg/kg	105	70.0	130	
EP080: Naphthalene	91-20-3	5 mg/kg	98.9	70.0	130			
EP090: Organotin Compounds (QCLot: 3379944)								
EB2030240-002	Anonymous	EP090: Tributyltin	56573-85-4	1.25 µgSn/kg	116	20.0	130	

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 3376558)							
ES2040445-011	QC003_201118	EG020A-T: Arsenic	7440-38-2	1 mg/L	94.5	70.0	130



Sub-Matrix: WATER

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 3376558) - continued							
ES2040445-011	QC003_201118	EG020A-T: Cadmium	7440-43-9	0.25 mg/L	95.4	70.0	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	95.0	70.0	130
		EG020A-T: Copper	7440-50-8	1 mg/L	92.9	70.0	130
		EG020A-T: Lead	7439-92-1	1 mg/L	93.5	70.0	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	95.9	70.0	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	93.5	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 3377647)							
ES2040354-013	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	95.2	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: ES2040445	Page	: 1 of 9
Client	: AECOM Australia Pty Ltd	Laboratory	: Environmental Division Sydney
Contact	: MR CAMERON RITCHIE	Telephone	: +61 2 8784 8555
Project	: 60633505 SLAMI	Date Samples Received	: 19-Nov-2020
Site	: ----	Issue Date	: 27-Nov-2020
Sampler	: JACE EMBERG	No. of samples received	: 14
Order number	: 60633505	No. of samples analysed	: 11

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO** Method Blank value outliers occur.
- **NO** Duplicate outliers occur.
- **NO** Laboratory Control outliers occur.
- Matrix Spike outliers exist - please see following pages for full details.
- Surrogate recovery outliers exist for all regular sample matrices - please see following pages for full details.

Outliers : Analysis Holding Time Compliance

- **NO** Analysis Holding Time Outliers exist.

Outliers : Frequency of Quality Control Samples

- Quality Control Sample Frequency Outliers exist - please see following pages for full details.



Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EG005(ED093)T: Total Metals by ICP-AES	ES2040445--001	SS001_201118	Copper	7440-50-8	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EG005(ED093)T: Total Metals by ICP-AES	ES2040445--001	SS001_201118	Zinc	7440-66-6	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Ar	ES2040445--007	SS007_201118	Nitrite + Nitrate as N (Sol.)	----	Not Determined	----	MS recovery not determined, background level greater than or equal to 4x spike level.

Regular Sample Surrogates

Sub-Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Samples Submitted							
EP090S: Organotin Surrogate	ES2040445-001	SS001_201118	Tripopyltn	----	4.70 %	35.0-130 %	Recovery less than lower data quality objective

Outliers : Frequency of Quality Control Samples

Matrix: **SOIL**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Moisture Content	2	22	9.09	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for VOC in soils vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
Container / Client Sample ID(s)							



Matrix: SOIL

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA055: Moisture Content							
Soil Glass Jar - Unpreserved (EA055) SS007_201118	18-Nov-2020	----	----	----	20-Nov-2020	02-Dec-2020	✓
Soil Glass Jar - Unpreserved (EA055) SS001_201118, SS002_201118, SS003_201118, SS004_201118, SS005_201118, SS006_201118, SS008_201118, QC001_201118	18-Nov-2020	----	----	----	23-Nov-2020	02-Dec-2020	✓
EG005(ED093)T: Total Metals by ICP-AES							
Soil Glass Jar - Unpreserved (EG005T) SS001_201118, SS002_201118, SS003_201118, SS004_201118, SS005_201118, SS006_201118, SS008_201118, QC001_201118	18-Nov-2020	23-Nov-2020	17-May-2021	✓	26-Nov-2020	17-May-2021	✓
Soil Glass Jar - Unpreserved (EG005T) SS007_201118	18-Nov-2020	24-Nov-2020	17-May-2021	✓	24-Nov-2020	17-May-2021	✓
EG035T: Total Recoverable Mercury by FIMS							
Soil Glass Jar - Unpreserved (EG035T) SS001_201118, SS002_201118, SS003_201118, SS004_201118, SS005_201118, SS006_201118, SS008_201118, QC001_201118	18-Nov-2020	23-Nov-2020	16-Dec-2020	✓	26-Nov-2020	16-Dec-2020	✓
Soil Glass Jar - Unpreserved (EG035T) SS007_201118	18-Nov-2020	24-Nov-2020	16-Dec-2020	✓	25-Nov-2020	16-Dec-2020	✓
EG048: Hexavalent Chromium (Alkaline Digest)							
Soil Glass Jar - Unpreserved (EG048G) SS001_201118, SS003_201118, SS006_201118	18-Nov-2020	20-Nov-2020	16-Dec-2020	✓	20-Nov-2020	27-Nov-2020	✓
EK055: Ammonia as N							
Soil Glass Jar - Unpreserved (EK055) SS007_201118	18-Nov-2020	----	----	----	25-Nov-2020	16-Dec-2020	✓
EK057G: Nitrite as N by Discrete Analyser							
Soil Glass Jar - Unpreserved (EK057G) SS007_201118	18-Nov-2020	24-Nov-2020	25-Nov-2020	✓	25-Nov-2020	26-Nov-2020	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Soil Glass Jar - Unpreserved (EK059G) SS007_201118	18-Nov-2020	24-Nov-2020	16-Dec-2020	✓	25-Nov-2020	26-Nov-2020	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Soil Glass Jar - Unpreserved (EK061G) SS007_201118	18-Nov-2020	20-Nov-2020	16-Dec-2020	✓	20-Nov-2020	18-Dec-2020	✓



Matrix: SOIL

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK067G: Total Phosphorus as P by Discrete Analyser							
Soil Glass Jar - Unpreserved (EK067G) SS007_201118	18-Nov-2020	20-Nov-2020	16-Dec-2020	✓	20-Nov-2020	18-Dec-2020	✓
EP080/071: Total Petroleum Hydrocarbons							
Soil Glass Jar - Unpreserved (EP080) SS001_201118, SS002_201118, SS003_201118, SS004_201118, SS005_201118, SS006_201118, SS007_201118, SS008_201118, QC001_201118	18-Nov-2020	23-Nov-2020	02-Dec-2020	✓	25-Nov-2020	02-Dec-2020	✓
Soil Glass Jar - Unpreserved (EP071) SS001_201118, SS002_201118, SS003_201118, SS004_201118, SS005_201118, SS006_201118, SS007_201118, SS008_201118, QC001_201118	18-Nov-2020	23-Nov-2020	02-Dec-2020	✓	26-Nov-2020	02-Jan-2021	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Soil Glass Jar - Unpreserved (EP080) SS001_201118, SS002_201118, SS003_201118, SS004_201118, SS005_201118, SS006_201118, SS007_201118, SS008_201118, QC001_201118	18-Nov-2020	23-Nov-2020	02-Dec-2020	✓	25-Nov-2020	02-Dec-2020	✓
Soil Glass Jar - Unpreserved (EP071) SS001_201118, SS002_201118, SS003_201118, SS004_201118, SS005_201118, SS006_201118, SS007_201118, SS008_201118, QC001_201118	18-Nov-2020	23-Nov-2020	02-Dec-2020	✓	26-Nov-2020	02-Jan-2021	✓
EP080: BTEXN							
Soil Glass Jar - Unpreserved (EP080) SS001_201118, SS002_201118, SS003_201118, SS004_201118, SS005_201118, SS006_201118, SS007_201118, SS008_201118, QC001_201118	18-Nov-2020	23-Nov-2020	02-Dec-2020	✓	25-Nov-2020	02-Dec-2020	✓
EP090: Organotin Compounds							
Soil Glass Jar - Unpreserved (EP090) SS001_201118, SS003_201118, SS006_201118	18-Nov-2020	23-Nov-2020	02-Dec-2020	✓	24-Nov-2020	02-Jan-2021	✓



Matrix: **SOIL**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
MM868: Coliforms & E.coli by MPN using Aquachrom ECC							
Soil Glass Jar - Unpreserved (MM868) SS007_201118	18-Nov-2020	----	----	----	20-Nov-2020	22-Nov-2020	✓

Matrix: **WATER**

Evaluation: * = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Unspecified; Lab-acidified (EG020A-T) QC002_201118, QC003_201118	18-Nov-2020	21-Nov-2020	17-May-2021	✓	21-Nov-2020	17-May-2021	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Unspecified; Lab-acidified (EG035T) QC002_201118, QC003_201118	18-Nov-2020	----	----	----	23-Nov-2020	16-Dec-2020	✓



Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: ✖ = Quality Control frequency not within specification ; ✔ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Analytical Methods							
Laboratory Duplicates (DUP)							
Buchi Ammonia	EK055	1	9	11.11	10.00	✔	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Alkaline Digestion and DA Finish	EG048G	1	6	16.67	10.00	✔	NEPM 2013 B3 & ALS QC Standard
Moisture Content	EA055	2	22	9.09	10.00	✖	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	1	100.00	10.00	✔	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	1	100.00	10.00	✔	NEPM 2013 B3 & ALS QC Standard
Organotin Analysis	EP090	1	8	12.50	10.00	✔	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	1	1	100.00	9.52	✔	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	4	39	10.26	10.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	5	40	12.50	10.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	2	19	10.53	10.00	✔	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	9	11.11	10.00	✔	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	20	10.00	10.00	✔	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Buchi Ammonia	EK055	1	9	11.11	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Alkaline Digestion and DA Finish	EG048G	2	6	33.33	10.00	✔	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	1	100.00	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	1	100.00	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Organotin Analysis	EP090	1	8	12.50	5.00	✔	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	3	1	300.00	14.29	✔	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	39	5.13	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	40	5.00	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	3	19	15.79	15.00	✔	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	9	11.11	5.00	✔	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	5.00	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Buchi Ammonia	EK055	1	9	11.11	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Alkaline Digestion and DA Finish	EG048G	1	6	16.67	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	1	100.00	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	1	100.00	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Organotin Analysis	EP090	1	8	12.50	5.00	✔	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	1	1	100.00	4.76	✔	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	39	5.13	5.00	✔	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	40	5.00	5.00	✔	NEPM 2013 B3 & ALS QC Standard



Matrix: **SOIL** Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Analytical Methods							
Method Blanks (MB) - Continued							
Total Phosporus By Discrete Analyser	EK067G	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	9	11.11	5.00	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Buchi Ammonia	EK055	1	9	11.11	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Alkaline Digestion and DA Finish	EG048G	2	6	33.33	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx)- Soluble by Discrete Analyser	EK059G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Soluble by Discrete Analyser	EK057G	1	1	100.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Analysis	EP090	1	8	12.50	5.00	✓	NEPM 2013 B3 & ALS QC Standard
TKN as N By Discrete Analyser	EK061G	1	1	100.00	4.76	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	39	5.13	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	40	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosporus By Discrete Analyser	EK067G	1	19	5.26	5.00	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	9	11.11	5.00	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER** Evaluation: * = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type	Method	Count		Rate (%)			Quality Control Specification
		QC	Reaular	Actual	Expected	Evaluation	
Analytical Methods							
Laboratory Duplicates (DUP)							
Total Mercury by FIMS	EG035T	2	14	14.29	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	20	10.00	10.00	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Total Mercury by FIMS	EG035T	1	14	7.14	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Total Mercury by FIMS	EG035T	1	14	7.14	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Total Mercury by FIMS	EG035T	1	14	7.14	5.00	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	5.00	5.00	✓	NEPM 2013 B3 & ALS QC Standard



Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Moisture Content	EA055	SOIL	In house: A gravimetric procedure based on weight loss over a 12 hour drying period at 105-110 degrees C. This method is compliant with NEPM Schedule B(3).
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂) (Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM Schedule B(3)
Hexavalent Chromium by Alkaline Digestion and DA Finish	EG048G	SOIL	In house: Referenced to USEPA SW846, Method 3060. Hexavalent chromium is extracted by alkaline digestion. The digest is determined by photometrically by automatic discrete analyser, following pH adjustment. The instrument uses colour development using dephenylcarbazide. Each run of samples is measured against a five-point calibration curve. This method is compliant with NEPM Schedule B(3)
Trivalent Chromium by Alkaline Digestion and DA Finish	EG049G-AIk	SOIL	In house: Referenced to APHA 3500 Cr-A&B & 3120 and USEPA USEPA SW846, Method 3060. The difference between Total and Hexavalent Chromium. The total Chromium is determined by ICPAES and the Hexavalent chromium is extracted by alkaline digestion and the digest is determined by photometrically by automatic discrete analyser. The instrument uses colour development using dephenylcarbazide. This method is compliant with NEPM Schedule B(3)
Buchi Ammonia	EK055	SOIL	In house: Referenced to APHA 4500-NH ₃ B&G, H Samples are steam distilled (Buchi) prior to analysis and quantified using titration, FIA or Discrete Analyser.
Nitrite as N - Soluble by Discrete Analyser	EK057G	SOIL	In house: Referenced to APHA 4500-NO ₃ - B. Nitrite in a water extract is determined by direct colourimetry by Discrete Analyser.
Nitrate as N - Soluble by Discrete Analyser	EK058G	SOIL	In house: Referenced to APHA 4500-NO ₃ - F. Nitrate in the 1:5 soil:water extract is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results.
Nitrite and Nitrate as N (NO _x)- Soluble by Discrete Analyser	EK059G	SOIL	In house: Thermo Scientific Method D08727 and NEMI (National Environmental Method Index) Method ID: 9171. This method covers the determination of total oxidised nitrogen (NO _x -N) and nitrate (NO ₃ -N) by calculation, Combined oxidised Nitrogen (NO ₂ +NO ₃) in a water extract is determined by direct colourimetry by Discrete Analyser.
TKN as N By Discrete Analyser	EK061G	SOIL	In house: Referenced to APHA 4500-Norg-D Soil samples are digested using Kjeldahl digestion followed by determination by Discrete Analyser.
Total Nitrogen as N (TKN + NO _x) By Discrete Analyser	EK062G	SOIL	In house: Referenced to APHA 4500 Norg/NO ₃ - Total Nitrogen is determined as the sum of TKN and Oxidised Nitrogen, each determined seperately as N.
Total Phosporus By Discrete Analyser	EK067G	SOIL	In house: Referenced to APHA 4500 P-B&F This procedure involves sulfuric acid digestion and quantification using Discrete Analyser.



Analytical Methods	Method	Matrix	Method Descriptions
TRH - Semivolatile Fraction	EP071	SOIL	In house: Referenced to USEPA SW 846 - 8015 Sample extracts are analysed by Capillary GC/FID and quantified against alkane standards over the range C10 - C40. Compliant with NEPM Schedule B(3).
TRH Volatiles/BTEX	EP080	SOIL	In house: Referenced to USEPA SW 846 - 8260. Extracts are analysed by Purge and Trap, Capillary GC/MS. Quantification is by comparison against an established 5 point calibration curve. Compliant with NEPM Schedule B(3) amended.
Organotin Analysis	EP090	SOIL	In house: Referenced to USEPA SW 846 - 8270 Prepared sample extracts are analysed by GC/MS coupled with high volume injection, and quantified against an established calibration curve.
Coliforms & E.coli in Soils by MPN using Aquachrom ECC	MM868	SOIL	Microbiological analysis subcontracted to ALS Scoresby (NATA Accredited Laboratory No. 992).
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl ₂)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl ₂ which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM Schedule B(3).

Preparation Methods	Method	Matrix	Method Descriptions
Alkaline digestion for Hexavalent Chromium	EG048PR	SOIL	In house: Referenced to USEPA SW846, Method 3060A.
TKN/TP Digestion	EK061/EK067	SOIL	In house: Referenced to APHA 4500 Norg- D; APHA 4500 P - H. Macro Kjeldahl digestion.
1:5 solid / water leach for soluble analytes	EN34	SOIL	10 g of soil is mixed with 50 mL of reagent grade water and tumbled end over end for 1 hour. Water soluble salts are leached from the soil by the continuous suspension. Samples are settled and the water filtered off for analysis.
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM Schedule B(3).
Methanolic Extraction of Soils for Purge and Trap	ORG16	SOIL	In house: Referenced to USEPA SW 846 - 5030A. 5g of solid is shaken with surrogate and 10mL methanol prior to analysis by Purge and Trap - GC/MS.
Tumbler Extraction of Solids	ORG17	SOIL	In house: Mechanical agitation (tumbler). 10g of sample, Na ₂ SO ₄ and surrogate are extracted with 30mL 1:1 DCM/Acetone by end over end tumble. The solvent is decanted, dehydrated and concentrated (by KD) to the desired volume for analysis.
Organotin Sample Preparation	ORG35	SOIL	In house: 20g sample is spiked with surrogate and leached in a methanol:acetic acid:UHP water mix and vacuum filtered. Reagents and solvents are added to the sample and the mixture tumbled. The butyltin compounds are simultaneously derivatised and extracted. The extract is further extracted with petroleum ether. The resultant extracts are combined and concentrated for analysis.
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM Schedule B(3)

Appendix E

Photo Logs

Site Sampling Photo log

Sampling completed on 18 November 2020



SS001 (1)



SS001 (2)



SS001 (3)



SS001 (4)



SS002 (1)



SS002 (2)



SS003 (1)



SS003 (2)



SS004 (1)



SS004 (2)



SS004 (3)



SS005 (1)



SS005 (2)



SS005 (3)



SS006 (1)



SS006 (2)



SS006 (3)



SS007 (1)



SS007 (2)



SS007 (3)



SS008 (1)



SS008 (2)

Site Walkover Photo Log

Walkover completed on 17 September 2020



Waypoint 117 (1)



Waypoint 117 (2)



Waypoint 118 (1)



Waypoint 118 (2)



Waypoint 118 (3)



Waypoint 118 (4)



Waypoint 118 (5)



Waypoint 119



Waypoint 121



Waypoint 123 (1)



Waypoint 123 (2)



Waypoint 124



Waypoint 125 (1)



Waypoint 125 (2)



Waypoint 126 (1)



Waypoint 126 (2)



Waypoint 126 (3)



Waypoint 127



Waypoint 129 (1)



Waypoint 129 (2)



Waypoint 129 (2)



Waypoint 129 (4)



Waypoint 129 (5)



Waypoint 129 (6)



Waypoint 130 (1)



Waypoint 130 (2)



Waypoint 131 (1)



Waypoint 131 (2)



Waypoint 132 (1)



Waypoint 132 (2)



Waypoint 133 (1)



Waypoint 133 (2)



Waypoint 133 (3)



Waypoint 133 (4)



Waypoint 133 (5)



Waypoint 133 (6)



Waypoint 133 (7)



Waypoint 134 (1)



Waypoint 134 (2)



Waypoint 134 (3)



Waypoint 135 (1)



Waypoint 135 (2)



Waypoint 135 (3)



Waypoint 135 (4)



Waypoint 135 (5)



Waypoint 135 (6)



Waypoint 137 (1)



Waypoint 137 (2)



Waypoint 137 (3)



Waypoint 137 (4)



Waypoint 137 (5)



Waypoint 137 (6)



Waypoint 137 (7)



Waypoint 137 (8)