Barangaroo Remediation
Lend Lease (Millers Point) Pty Ltd
27-Jun-2014

Acid Sulfate Soils Management Plan

Remediation Development Application, Barangaroo Block 5, EPA Declaration Area Number 21122, Hickson Road, Millers Point, NSW

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27-Jun-2014

Job No.: 60321826_ASS_20140516_RevC_Final

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Quality Information

Document Acid Sulfate Soils Management Plan

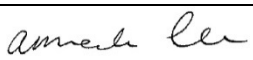
Ref 60321826_ASS_20140516_RevC_Final

Date 27-Jun-2014

Prepared by Anthony Davis

Reviewed by Amanda Lee

Revision History

Revision	Revision Date	Details	Authorised	
			Name/Position	Signature
A	16-May-2014	Rev A	Michael Jones Technical Director	
B	23-May-2014	Rev B	Amanda Lee Associate Director	
0	27-Jun-2014	Rev C	Amanda Lee Associate Director	

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Glossary of Terms

Term	Description
ABA	Acid-Base Accounting - An ABA approach is widely used for predicting net acidity from sulfide oxidation of ASS. While several ABA models have been used for ASS, they all share a common underlying principle/approach, encapsulated in the following equation: **Net Acidity = Potential Sulfidic Acidity + Existing Acidity – Acid Neutralising Capacity**
ANC	The acid neutralising capacity (ANC) is a measure of the inherent ability of a soil to buffer acidity and resist the lowering of the soil pH. Acid buffering in the soil may be provided by dissolution of calcium and/or magnesium carbonates (e.g. shell), cation exchange reactions, and by reaction with the organic and clay fractions.
ARI	Average Recurrence Interval - The average, or expected, value of the periods between exceedences of a given rainfall total accumulated over a given duration.
ASS	Acid Sulfate Soils include actual acid sulfate soils (AASS) or potential acid sulfate soils (PASS). Actual and potential acid sulfate soils are often found in the same soil profile, with actual acid sulfate soils generally overlying potential acid sulfate soil horizons.
AASS	Actual Acid Sulfate Soils are soils containing highly acidic soil horizons or layers resulting from the aeration of soil materials that are rich in iron sulfides, primarily sulfide. This oxidation produces hydrogen ions in excess of the sediment's capacity to neutralise the acidity resulting in soils of pH of 4 or less, when measured in dry season conditions. These soils can usually be identified by the presence of pale yellow mottles and coatings of jarosite.
ASSMP	Acid Sulfate Soil Management Plan
ASSMAC	Acid Sulfate Soil Management Advisory Committee
Aglime	Finely crushed limestone
Block 4 Remediation Area	Portion of the Declaration Area situated within Barangaroo South
Block 5 Remediation Area	Portion of the Declaration Area located within Barangaroo Central (including remediation of some land adjacent to the Declaration Area on the west)
BP	Before (the) present (day)
CRS	Chromium Reducible Sulfur - A commonly used, low cost method of determining reducible inorganic sulfur compounds. It does not suffer from interferences from organic sulfur compounds or sulfates. Often used where results are close to trigger values and where significant organics are present although does not quantify the actual acidity resulting from AASS.
CRS Suite	The Chromium suite is a collection of independent analytical methods, each of which determines a component of the acid base account.
DECCW	NSW Department of Environment, Climate Change and Water (now EPA)
EPA	Environment Protection Authority
EPA Declaration Area	Remediation Site Declaration 21122
DO	Dissolved oxygen
Dolomite	Calcium magnesium carbonate
EPA	Environment Protection Authority, and the legal entity with whom the Barangaroo Delivery Authority has entered into a Voluntary Management Proposal for the remediation of the site

Term	Description
Ex-situ Remediation Methodology	Excavation of contamination and off-site disposal (with off-site pre-treatment, where required)
Hickson Road Remediation Area	Portion of the Declaration Area situated within the Hickson Road reserve
Jarosite	Hydrous sulfate of potassium and iron with a chemical formula of $KFe(III)_3(OH)_6(SO_4)_2$; it is commonly present in oxidised acid sulfate soils.
Lend Lease	Lend Lease (Millers Point) Pty Ltd
Magnesite	Magnesium carbonate
MSDS	Material Safety Data Sheets
Natrojarosite	Hydrous sulfate of sodium and iron with a chemical formula of $NaFe(III)_3(OH)_6(SO_4)_2$; it is commonly present in oxidised acid sulfate soils
PASS	Potential Acid Sulfate Soils are soils which contain iron sulfides or sulfidic material which have not been exposed to air and oxidised. The field pH of these soils in their undisturbed state is pH 4 or more and may be neutral or slightly alkaline; however, they pose a considerable environmental risk when disturbed.
PDA	Project Development Agreement
RAP	Remedial Action Plan
RWP	Remedial Works Plan
Schwermantite	Iron-oxyhydroxysulfate mineral with an ideal chemical formula of $Fe_8O_8(OH)_{6(}SO_4)\cdot nH_2O$ or $Fe^{3+}16O16(OH,SO_4)_{12\text{-}13}\cdot 10\text{-}12H_2O$ found in oxidised acid sulfate soils.
S_{CR}	Chromium reducible sulfur
Site	Area required for the purpose of the Block 5 Remediation Development Application identified as: Block 5 Remediation Area Any other areas of Barangaroo or Hickson Road required for staging and undertaking the remediation and stormwater diversion works
Site Remediation Area	The Block 5 Remediation Area (including remediation of some land adjacent to the Declaration Area on the west)
sPOCAS	Suspension Peroxide Oxidation Combined Acidity & Sulfur
SROH	significant risk of harm
TAA	Total Actual Acidity
TPA	Total Potential Acidity
TSS	Total Suspended Solids
VMP	Voluntary Management Proposal

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) has been engaged by Lend Lease (Millers Point) Pty Ltd (Lend Lease) to prepare this Acid Sulfate Soils Management Plan (ASSMP) to accompany a Development Application (SSD 6533-2014) for Remediation of **Block 5** at Barangaroo Central to be submitted to the Minister for Planning pursuant to the Part 4 of the *Environmental Planning and Assessment Act, 1979*. The ASSMP has been prepared at the request of Lend Lease to address the issues associated with the potential presence of Acid Sulfate Soils (ASS).

The ASSMP addresses proposed remediation works within Block 5 of the NSW Environment Protection Agency (EPA) Declaration Area 21122 (Declaration Area) and some adjoining land, which includes part of the Barangaroo redevelopment site and part of the adjoining Hickson Road, located at Millers Point, NSW (refer to **Appendix B**). It is noted that remediation of remaining parts of the Declaration area (Block 4 and Hickson Road) form the subject of a separate Development Application, and are not considered further in this report. A Remedial Action Plan (RAP) has been prepared (AECOM, 2013) to detail the remediation works which are required to enable the NSW EPA's declaration of the Site as a remediation site to be revoked (refer to **Section 1.3** for further detail).

The proposed remediation method will be included within the Development Application and are summarised in **Section 1.7**.This ASSMP is specific to ex-situ works undertaken in Block 5 which involve disturbance of the subsurface where potential or actual acid sulfate soils (PASS/AASS) are present.

This ASSMP provides the control measures for management of PASS and AASS which may be identified during the proposed ex-situ remediation works.

The location of the Declaration Area is pre**s**ented on **Figure F1** and the layout of Block 5 and the Declaration Area is presented in **Figure F2** (refer to **Appendix A**).

1.1 Barangaroo

Barangaroo is located on the north western edge of the Sydney Central Business District, bounded by Sydney Harbour to the west and north, the historic precinct of Millers Point (for the northern half), The Rocks and the Sydney Harbour Bridge approach to the east; and bounded to the south by a range of new development dominated by large CBD commercial tenants.

The 22 ha Barangaroo Site is roughly rectangular in shape and has frontage to the harbour foreshore of 1.4km. Hickson Road delineates the eastern boundary.

The NSW Government held an international urban design competition for the site in 2005 and the winning entry was used as the basis for the original Barangaroo Concept Plan which was approved in February 2007 and sets out the urban design and policy initiatives to be employed in the redevelopment of the site.

The Concept Plan (as modified) is the statutory planning approval to guide the urban renewal of Barangaroo and currently provides for the development of mixed use precinct comprising commercial, retail, residential and community development and new public open space / public domain.

The Barangaroo Delivery Authority is the state government authority that manages and delivers the development of Barangaroo.

1.2 EPA Declaration Area (#21122)

In May 2009, the NSW Environment Protection Authority (EPA) determined that a portion of land at Millers Point (part of the Barangaroo Site and an adjacent portion of Hickson Road), was contaminated in such a way as to present a significant risk of harm (SROH) to human health and the environment. As a consequence the EPA declared the area to be a remediation site (Declaration Number 21122; Area Number 3221) under the Contaminated Land Management Act 1997.

The Remediation Site Declaration 21122 indicates that the area of the declaration coincides with the known footprint of the former Millers Point gasworks facilities. This area is located on part of Barangaroo and part of Hickson Road adjacent to Barangaroo.

In accordance with Declaration Number 21122, the Declaration Area comprises:

- Part Lot 5 and Part Lot 3 DP 876514, Hickson Road, Millers Point, NSW 2000
- Part of Hickson Road adjacent to:
    - 30-34 Hickson Road (Lot 11, DP1065410)
    - 36 Hickson Road (Lot 5, DP873158)
    - 38 Hickson Road (SP72797) Millers Point

The Barangaroo Delivery Authority has entered into a Voluntary Management Proposal (VMP) with the EPA associated with EPA Declaration Area (Approval No. 20101719). Phase 1 of this VMP involves investigative works and undertaking remedial design to determine and obtain agreement on a proposed remediation methodology. Phase 2 of the VMP will involve the implementation of the agreed remediation works.

An independent, EPA-accredited Site Auditor has been appointed to undertake review of proposed remediation works, and prepare statutory audit statements prior to and following completion of remediation.

For the purposes of planning and staging works, the EPA Declaration Area is divided into 3 areas as follows:

- Block 4 Remediation Area - the part of the Declaration Area on Barangaroo South
- Block 5 Remediation Area - the part of the Declaration Area on Barangaroo Central (including remediation of some land adjacent to the Declaration Area on the west)
- Hickson Road Remediation Area - the part of the Declaration Area located on Hickson Road.

1.3 Summary Site History and Key Contaminants

The Millers Point gasworks operated on the Declaration Area between 1840 and 1921. The Site has subsequently been used for various activities, but predominantly a commercial port facility and public road.

When EPA declared parts of Barangaroo and Hickson Road a “Remediation Site”, it described the nature of contamination as gasworks waste, with the following particular substances: polycyclic aromatic hydrocarbons (PAHs); benzene, toluene, ethylbenzene and total xylenes (BTEX); total petroleum hydrocarbons (TPH); ammonia and cyanide.

The AECOM VMP / Block 4 Remedial Action Plan (AECOM, 2013) (RAP) provides more specific details regarding the type, magnitude and location of ground contamination as identified in previous site investigations.

1.4 Definition of Site for Block 5 Remediation DA

For the purposes of the Development Application for the remediation of Block 5, the Site includes the area of land to be remediated (Site Remediation Area), plus any adjacent land used for the staging and undertaking of the proposed remediation works and stormwater diversion works (refer to **Section 1.6**).

The Site Remediation Area comprises the Block 5 part of the Declaration Area (including some land adjacent to the Declaration Area on the west). Refer to **Appendix A** for location of the Site and Site Remediation Area.

This ASSMP refers specifically to the remediation of **Block 5** at Barangaroo Central (Refer to **Figure 3** in **Appendix A**).

1.5 Role of Lend Lease

Lend Lease has been contracted by the Barangaroo Delivery Authority to undertake remediation of the Declaration Area, which includes Block 5.

1.6 Remediation Action Plan and Methodology

The proposed remediation of the Site is detailed in the AECOM RAP (2013).

The RAP included two potential methodology options for Block 5:

- In-situ remediation; or
- Ex-situ remediation.

The Development Application for Block 5 Remediation includes for the **ex-situ remediation** methodology as detailed in the AECOM RAP.

If required, the works proposed also include the diversion of existing stormwater drainage infrastructure within the Site, involving decommissioning existing pipes, and construction of a new pipe network.

For the purposes of this plan, reference to remediation works includes stormwater diversion works on the Site.

1.7 Summary of Proposed Works for the Block 5 Remediation DA

The works proposed as part of the Block 5 Remediation DA includes the following:

a) Temporary diversion of existing stormwater, where required.

b) Installing temporary retention structures (eg. sheet piling in bentonite slurry, secant piles) to facilitate proposed excavation, where required, including:
   - temporary ground anchors or other restraint system as required into adjoining blocks and road reserve.
   - Support/retain the existing Sewer Pumping Station 1129 and associated infrastructure.

c) Installation of temporary odour structure(s) over proposed excavation area.

d) Dewatering and water treatment in an on-site water treatment plant

e) Excavation of contaminated soil beneath odour structures, with appropriate air emission controls/monitoring

f) Transfer of contaminated material directly off-site for landfill disposal, including where required to a licensed off-site treatment facility for pre-treatment (eg. for hazardous waste).

g) Backfilling of Block 5 excavation with suitable fill (imported and/or won from site)

2.0 Objectives of the ASSMP

The objective of this ASSMP is to consider both the existing and potential future environmental impacts relating to ASS material in and around Block 5 and to detail mitigation measures to minimise the potential impacts on the environment, including Darling Harbour located to the west of Block 5.

The control measures outlined in this ASSMP are designed to mitigate the environmental impacts of the proposed excavations to acceptable levels and have been developed to achieve the following objectives:

- Control and, where possible, minimisation of disturbance of acid sulfate soils (if present);
- Confirmation of the success of impact control measures by the means of validation monitoring;
- Compliance with statutory requirements; and
- Preservation of water quality on an ongoing basis.

Each environmental protection measure is based upon a proven and Industry Best Practice methodology.

The ASSMP is designed for the excavation phase of the remedial works only and is not required for material remaining *in situ,* which will not be disturbed. It is based on tabulated checklists for management measures, maintenance, reporting, failure identification and corrective action for each identified issue.

The control measures proposed in this ASSMP include:

- Assessment procedures for PASS utilising a sampling protocol, set criteria to measure and agreed standards for those criteria to evaluate acid potential;
- Treatment of water accumulating within the Block 5 to an acceptable water quality for discharge;
- Ongoing Monitoring Programme, if required; and
- Treatment of PASS if encountered and control structures to prevent leachate discharge off-site without meeting specified target water quality criteria.

2.1 Description of Acid Sulfate Soils

ASS is the common name given to a range of soil types containing iron sulphides, the most common being pyrite. When exposed to air due to drainage or disturbance, these soils produce sulfuric acid, often releasing toxic quantities of iron, aluminium and heavy metals. ASS formed on coastal lowlands are generally found less than 2.5 to 3 m Above Sea Level (ASL), which corresponds with the highest point of sea level rise following ice shelf melt during the mid Holocene (~6000y BP). The sea level has been dropping ever since due to isostatic adjustment of the lithosphere. For the purposes of discussion herein ASL is equivalent to AHD.

NSW regulatory requirement assumes that all coastal soils less than 5 m AHD likely to be disturbed by excavation or water table draw-down be assessed for their acid ASS properties. Where their presence is identified a management plan for minimising impacts must be developed.

In coastal lowlands ASS may be present as actual ASS (AASS) or PASS. PASS are sulfidic soils formed in coastal lowlands subject to tidal inundation or saline groundwater where conditions are conducive for accumulation of iron sulfides in soils (e.g. source of sulfate, source of iron, reducing conditions (organic rich), and stable low energy environment. AASS occur where natural (e.g. draught impacts on groundwater levels, or regular rise and fall of groundwater) or anthropogenic (e.g. land development, drainage works, etc.) activity has disturbed and subjected ASS (PASS) to oxidation releasing acidity and reaction products (iron, sulfate, calcium, magnesium, aluminium etc.).

Mapping of ASS by the former NSW Department of Land and Water Conservation (DLWC) shows the Declaration Area is identified within an area described as '*disturbed terrain, may include filled areas which often occur during reclamation of low lying swamps for urban development. Other disturbed terrain includes areas which have been mined or dredged, or have undergone heavy ground disturbance through general urban development…Soil investigations are required to assess these areas for acid sulfate potential*'.

2.2 Supporting Documents

The following investigation reports provided the dataset related to the presence of ASS within Block 5:

- AECOM. 2010a. Sampling Analysis and Quality Plan, Declaration Area – Issue 2 VMP and PDA Works, NSW EPA Declaration Area 21122, former Millers Point Gasworks. 4 March.
- AECOM. 2010b. Data Gap Investigation. EPA Declaration Area (Parts of Barangaroo Site and Hickson Road, Millers Point, NSW. 23 September.
- AECOM Australia Pty Ltd, 2010c. Data Gap Investigation, Other Remediation Works (South) Area (Parts of Barangaroo Site, Hickson Road, Millers Point, NSW. 14 May.
- AECOM Australia Pty Ltd, 2010d. Data Gap Investigation, Other Remediation Works North, Hickson Road, Millers Point, NSW. 20 October.

2.3 Changing the ASSMP Provision

This ASSMP contains provisions that may be changed. If any of the provisions are considered impractical, too costly or not thorough enough, then they should be changed to reflect the conditions on site.

This ASSMP has been prepared with consultation of the NSW Acid Sulfate Soils Manual (Stone et al., 1998).

In addition, and in line with best practice, more recent guidelines were also consulted in formulating this ASSMP including publications by QASSIT ASS Guidelines (Ahern et al., 1998), Laboratory Methods Guidelines (Ahern et al., 2004) and Management Guidelines (Dear et al., 2002).

2.4 Management

It is noted that contracting arrangements with respect to the ASSMP implementation works are still to be determined. Lend Lease and/or the nominated contractor/consultant undertaking implementation of the ASSMP have clearly defined responsibilities under the Protection of Environment Operations Act, 1997, to report any incidents likely to cause environmental harm. It is noted that this ASSMP is a live document, which should be updated (or an addendum documenting any changes issued) following confirmation of the responsible person/contractor. If there is any doubt over any particular incident, advice should be sought from the NSW EPA or other relevant statutory authorities.

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3.0 Site Description

3.1 Site Condition and Surrounding Environment

3.1.1 Current Land use

The location of Block 5 is presented on **Figure F1** and Block 5 layout is illustrated in **Figure F2** of **Appendix A**.

The Declaration Area (of which Block 5 forms part) is used as a public road or open space, is currently used for temporary construction staging and variably paved with concrete and asphalt. The concrete ground surface was observed to be in generally good condition with some cracking noted on the surface of the asphalt. A sewage pumping station is located within Block 5 on the eastern portion of the Declaration Area adjacent to Hickson Road. Access to Block 5 is restricted by the presence of a cyclone wire fence on the eastern side.

3.1.2 Surrounding Land use

Block 5 is surrounded by the following land use:

- North: Barangaroo, including material and equipment storage associated with Barangaroo construction);
- South: Barangaroo Block 4 (under development), and the southern portion of Hickson Road followed by Sussex Street (public roads);
- East : Hickson Road, commercial and high density residential buildings with Jenkins Street beyond; and
- West: Public waterfront walkway and Darling Harbour.

3.2 Topography and Drainage

The topography of the Site is relatively flat having undergone significant historical cut and fill works. The Site is predominantly covered in hardstand (concrete and bitumen).

The majority of stormwater runoff would be captured by the various stormwater drains on and in the vicinity of the Site, which drain into Darling Harbour.

3.3 Geology

Reference to the *1:100, 000 Geological Survey of NSW (Sydney) Sheet 9130 (Ed 1) (*Herbert 1983*)* indicates that the stratigraphy of the Block 5 Remediation Area comprises man-made fill material, marine clays and Hawkesbury Sandstone. The Pittman LIV dyke geological feature has been identified running in a general east west direction across the southern portion of the Declaration Area.

Information from previous investigations indicates that the former 1880s shoreline ran approximately along the western edge of Hickson Road (i.e. along the eastern edge of the proposed Stage 1 Development). The area to the west of Hickson Road is understood to have been progressively reclaimed. Aerial photographs from the 1950s indicate that the area between Hickson Road and the current shoreline was occupied by a number of finger wharves, extending from Hickson Road. It is understood that the space between the historical finger wharfs and seawalls were in filled in several stages between the 1960s and 1980s with various types of material. The former Southern Cove is understood to have been filled in 1988.

ERM (2007) identified and summarised the following subsurface conditions across the wider Barangaroo precinct:

- Hardstand (0 to 0.46 m bgs): consisting of concrete, asphalt and bitumen, generally in good condition with minimal staining;
- Road Base Fill (0 to 0.5 m bgs);
- Fill (0 to 18 m bgs): Fill materials consisting of sandstone, building rubble, bricks and concrete, silty gravelly sand. Black staining and odours (particularly around the former gasworks);
- Marine Clay/Sand (3.0 to 18.4 m bgs): Interbedded Clayey Sand and Sandy Clay, dark greyish brown, saturated, some shell fragments and organic matter, Sandy Clay (soft, high plasticity), Clayey Sand and Sand (loose to dense, low plasticity, fine to coarse grained, low to no plasticity);

- Marine Clay/Sand (4.9 to 32.75 m bgs): Interbedded Clayey Sand, Sandy Clay and Sand, pale yellowish brown, white, reddish brown or dark greyish brown. Sandy Clay-stiff to hard, medium to high plasticity. Clayey Sand and Sand – loose to dense, fine to coarse grained, low or no plasticity; and
- Bedrock (1.3 to 32.75 m bgs): Weathered Sandstone, white, light yellowish, brown, olive brown and reddish brown, white, wet, fine to coarse grained, some fracturing noted.

Recent intrusive investigations undertaken by AECOM (2010b) described the following lithological profile:

- Encountered stratigraphic conditions were variable across the Declaration Area, but generally comprised fill material overlying natural weathered sandstone with clay components. Sandstone bedrock was generally present underlying natural weathered bedrock materials or in some instances directly underneath fill materials.
- Observations of odours, staining and sheen were generally more common in the overlying fill materials, although they were also noted at eight locations within the natural soil and bedrock present on the Declaration Area.
- The depth of fill materials encountered during the AECOM DGI (2010b) was variable across the Declaration Area, with fill depths ranging from 0.43 m bgs (AECOM BH67) to 17.5 m bgs (AECOM BH56).
- Fill materials were generally shallower in the eastern portion of the Declaration Area closest to Hickson Road and deeper in the western portion of the Declaration Area. The thickness of fill material generally increased from east to west across the Declaration Area; and
- Observations during the test pitting and drilling works identified unconsolidated, highly variable fill materials, which generally comprised unconsolidated gravels, sand, bricks, sandstone, timber, slag and steel. Visual signs of contamination including black staining, tar and surface sheen (where groundwater was present) were noted in several test pits, predominantly located in the footprint of the former Retort House and Purifying Beds within Block 4 within a variable gravelly sand to clayey sand matrix.
- Natural soils encountered across the Declaration Area comprised silty sands, gravelly sands, clays, weathered sandstone and sand with components of clay overlying sandstone bedrock
- The depth to bedrock encountered during the DGI was variable across the Declaration Area, with depths to sandstone ranging from 0.43 m bgs (AECOM BH67) to 25.0 m bgs (AECOM BH60/MW60). Bedrock was generally shallower in the eastern portion of the Declaration Area closest to Hickson Road and deeper in the western portion of the Declaration Area. The depth to sandstone bedrock generally increased from east to west across the Declaration Area.

Based on the natural soil materials encountered by AECOM during the DGI (2010b), the presence of PASS or ASS soils is likely to be primarily associated with the presence of naturally occurring silty sands and marine clays, however may be encountered within other natural soil and fill materials underlying the Declaration Area and Block 5.

3.4 Hydrogeology

The AECOM DGI (2010b) investigation made the following summary of groundwater conditions within Block 5:

- Groundwater beneath Block 5 is present as an unconfined, shallow aquifer within the fill materials and the underlying natural sediments. Groundwater is also likely to occur as a deeper bedrock aquifer within the underlying sandstone bedrock. Groundwater within the bedrock would occur as a fractured bedrock aquifer, potentially confined by an overlying clay unit in some areas of the Declaration Area.
- Due to the proximity of Block 5 to Darling Harbour, the depth to groundwater is shallow and the overall direction of groundwater flow is expected to be towards Darling Harbour.
- Groundwater within Block 5 is tidally influenced, resulting in the fluctuation of groundwater levels within the fill materials and natural sediments. Groundwater chemistry within Block 5 is dominated by sodium and chloride ions, indicative of a saline environment. Variability in the groundwater chemistry and hardness was present in some areas of Block 5 and the wider Declaration Area, which is attributed to the presence of the fill materials.

- The hydraulic conductivities reported for Block 5 were variable due to the inconsistent nature and distribution of fill materials. This variability in conductivity results in inconsistent lag times for tidal influence across Block 5 and creates a tortuous flow path for groundwater and associated contamination.
- Based on the preliminary results reported in AECOM (2010b) there appears to be an efficient hydraulic connection between the saturated fill material and Darling Harbour down gradient of Block 5 in the Public Domain area indicating a significant exchange of water during tidal cycles. However groundwater flux in the underlying natural material was determined to be negligible.

3.5 Potentially Sensitive Receptors

The nearest receptor for groundwater and surface water coming from Block 5 is Darling Harbour, which forms part of the larger Sydney Harbour and based on the definitions outlined in ANZECC (2000) would likely meet the classification of a '*highly disturbed system'*. It is however noted that the level of protection for the proposed remedial action is to protect Darling Harbour as a "*slightly to moderately disturbed system*".

Block 5 is situated to the west of Hickson Road and a mixed commercial and residential area. Construction Worker Site Accommodation associated with the development of Barangaroo South may be located in the vicinity of the Block 5 Remediation Area.

4.0 Existing Acid Sulfate Soil Data

4.1 Summary of Previous Results

A total of 12 samples were previously analysed for Suspension Peroxide Oxidation Combined Acidity and Sulfur (sPOCAS) during the AECOM (2010b, c and d) investigations to evaluate the potential for potential or actual acid sulfate soils to be present.

Of the 12 samples analysed, one sample was collected within The Block 5 Remediation Area, with the remaining samples from adjacent areas. The reported results indicate there is a low potential for acid sulfate soils to be present.

Table 1 Sample Sulfur Trail, Acid Trail and Lime Calculation

No	Sample ID	Area	Material Type	Depth interval (m)	Sulfur Trail %S oxidisable (S_{POS})	Acid Trail Titratable Peroxide Acidity (m H^+/t)	Lime calculation Kg $CaCO_3/m^3$
1	AECOM BH49	Block 4	Sandy Gravelly Clay FILL (stiff)	6.2-6.4	1.21	<2	<1
2	AECOM BH68	Block 5	Sandy Gravel FILL (loose to medium dense	7.3-7.5	0.04	83	5
3	AECOM BH01	Public Domain Blocks 1-3	CLAY (very stiff)	17.65-17.75	<0.02	25	2
4	AECOM BH14	Block 3	Sandy CLAY (stiff to very stiff)	16.0-16.2	0.02	35	4
5	AECOM BH25	Block 2	Gravelly Clay FILL (medium stiff)	12.0-12.3	0.7	<2	<1
6	AECOM BH30	Public Domain Blocks 1-3	Gravelly Sandy Clay FILL (soft)	13.0-13.4	0.04	<2	1
7	AECOM BH32	Block 2	SAND (dense)	14.5-14.7	0.41	<2	1
8	AECOM BH60_16.0-16.4	Public Domain	Sandy Clay FILL	<0.02	82	4	4
9	AECOM BH63_11.5-11.9	Public Domain	Sandy Clay FILL (medium stiff)	0.04	<2	<1	<1
10	AECOM BH71_7.0-7.2	Public Domain	Sandy Clay FILL (medium stiff to stiff)	0.02	<2	<1	<1
11	AECOM BH71_17.5-17.7	Public Domain	Clayey SAND (dense)	0.02	25	2	2
12	AECOM BH72_19.0-19.2	Public Domain	CLAY (very stiff)	<0.02	26	2	2

The data indicated the following:

- Although the sampling program was limited and reported results were low there is potential for PASS to be present in the fill and natural materials at the Declaration Area (including Block 5).
- Based on Table 4.4 of the ASSMAC (1998) Assessment Guidelines, the reported sulfur trail (% sulfur oxidisable) and Acid trail (mol H^+/tonne) exceeds the Action criteria (0.03% and 18 mol H^+/tonne respectively) **if more than 1000 tonnes of soils** are to be disturbed triggering the need for an ASSMP.
- In the absence of additional data it is assumed that prior to any land disturbance the PASS layer is likely to be contained primarily within the natural sands and clays within Block 5. Additional field sampling is required to evaluate the presence and distribution of ASS within Block 5.
- Further sampling will refine the geometry and distribution of PASS materials (if present) within fill and natural soils and may provide a better definition of liming requirements.

5.0 Sampling and Analytical Program

5.1 Field Assessment to Evaluate the Presence of ASS

Based on the low probability of ASS material being present within The Block 5 Remediation Area, a preliminary ASS field assessment is not considered necessary. However, in the event that PASS or AASS are identified, they should be managed in accordance with the unexpected finds procedure previously adopted for Blocks 1-3 excavation program. Management of any ASS impacted soils identified during the Block 5 ex situ works should include consideration of the following:

- Soil characterisation, including a detailed description of the profiles for the major soil horizons present within the area of identified ASS.
- Field testing to screen for the presence of ASS will be completed for Field pH (pH_F[1]) and Field pH Peroxide Test (pH_{FOX}[2]).
- Collection of samples at regular intervals in accordance with the ASSMAC Guidelines.
- Field tests for ASS screening will be conducted at regular intervals to confirm the area of ASS impact.
- Testing will follow QASSIT methodology (QASSIT Guidelines, Ahern et al 1998; Soil Management Guidelines v3.8 Dear et al 2002; and Acid Sulfate Soils Laboratory Methods Guidelines Ahern et al 2004) or an appropriate equivalent methodology.

5.2 Identification of Field Sulfide

A number of factors need to be considered in arriving at positive field sulfide identification:

- Conventionally a field pH_F <5.5 is indicative of actual acidity and pH_{FOX} <4.5 is indicative of potential acid sulfate soils.
- A pH_{FOX} value at least one unit below field pH_F may indicate acid generating material requiring further testing. The greater the difference between the two measures (ΔpH), the more indicative the value is of a potentially acidic soil material. The lower the final pH_{FOX} value is, the better the indication of a positive result.
- If the pH_{FOX} < 3, and the above condition applies, then it strongly indicates a PASS. The more the PH_{FOX} drops below 3, the more positive the presence of sulfides.
- A pH_{FOX} of 3-4 is less positive and laboratory analysis is needed to confirm if sulfides are present.
- For pH_{FOX} 4-5 the test is neither negative nor positive. However further testing is required. Sulfides may be present either in small quantities and be poorly reactive under the quick field test conditions or the sample may contain carbonate, which neutralises some or all of the acid produced by oxidation. Equally the pH_{FOX} may be produced by organic acids and there may be no sulfides present in this situation.
- For pH_{FOX} > 5 and little or no drop in pH from the field value, little net acidification ability is indicated.

The field pH (pH_F) and field pH peroxide (pH_{FOX}) tests have been developed for a rapid assessment in the field of the likelihood of acid sulfate soils. These tests are easy to conduct, quick, and have a minimum set-up cost. The field tests have been developed to give reasonable prediction for many soils (provided the tests are performed properly) whilst at the same time being relatively easy to perform with a minimal amount of equipment. Soil field pH tests provide a useful indication of the existing and potential acidity levels in the soil. Although these field tests may provide an indication of ASS presence, they are purely qualitative and do not give any quantitative measure of the amount of acid that has been or could be produced through the oxidation process.

Field staff will be provided with Table 2 that provides a summary of field test responses to assess whether further action is required.

[1] pH_F is pH of ASS measured in the field on a mixture of soil and water.
[2] pH_{FOX} is pH of ASS measured in the fields on a mixture of soil and 15% hydrogen peroxide.

Table 2 Field Peroxide Test Result Interpretation

pH1:5	pHFOX	ΔpH	ΔTemp (ºC)	Effervescence*	Action Required
≥5.0	≥4.5	≤2.0	<5ºC	None-Mild	None
<5.0	<4.5	>2.0	>5ºC	Mild-Strong	Preliminary lab assessment
<5.0	<2.5	>2.0	>10ºC	Strong-Extreme	Detailed assessment

Source: Victorian Government Department of Sustainability and Environment (2008)
Note(s): 1. levels of effervescence are: none; mild; strong; extreme
2. * also includes iron precipitation

It should be noted that the method is a field based method used for screening actual and potential acid sulfate soils that also captures acidity generated by non-sulfidic soils e.g. organosols etc.

If it is concluded by the appropriately qualified soil scientist that (based on application of the Phase 1 *Preliminary risk assessment guidelines*) the Block 5 Remediation Area does not pose a potential for either the occurrence or oxidation of ASS, then a report will be prepared to this effect. The report will justify why further assessment is not warranted and include maps of Block 5 showing features, any sample locations and areas of potential ASS occurrence (if these are present).

If it is concluded by the appropriately qualified soil scientist that (based on application of the Phase 1 *Preliminary risk assessment guidelines*) The Block 5 Remediation Area does pose a potential for either the occurrence or oxidation of ASS, then samples collected during the field investigation will be subject to further laboratory testing.

5.3 Laboratory Analysis

The laboratory analytical program requires consideration of handling and storage. Due to the potentially volatile nature of the sulfur compounds being assessed and the act of removing them from an anoxic environment, collected samples will be sealed to minimise oxygen exchange, placed in the dark and kept cool to frozen (preferably <4ºC) until received at the laboratory.

If samples cannot be deliver to a NATA accredited laboratory within 24 hours the following options will be employed:

- Freezing the samples and/or transporting to the laboratory with dry ice; or
- Oven drying to 80-85ºC forced convection as quickly as possible and transporting/ storing in a low humidity environment.

Laboratory testing will involve the following:

- Titratable Actual Acidity (TAA)
- Chromium Reducible Sulfur (CRS) and
- Acid Neutralising Capacity (ANC)

Tests will be completed at NATA accredited laboratory from delivered sub-samples prepared by qualified field staff. Testing will follow QASSIT methodology (Ahern et al, 1998, 2004). QASSIT (1998) recommending sampling at 0.5 m intervals, with tests completed at the top and bottom of each distinct horizon.

The potential for samples to produce acid will be assessed against the screening criteria presented in **Table 3.**

Table 3 Action Criteria to Trigger Further Testing

Type of Material	≤1000 T (≤600 m3) disturbed	>1000 T (>600 m3) disturbed	Type of Material	≤1000 T (≤600 m3) disturbed	>1000 T (>600 m3) disturbed	Type of Material	≤1000 T (≤600 m3) disturbed
Texture	Clay	Sulfur Trail	Texture	Clay	Sulfur Trail	Texture	Clay
Units	%	%S	Units	%	%S	Units	%
Coarse	≤5	0.03	Coarse	≤5	0.03	Coarse	≤5
Medium	5-40	0.06	Medium	5-40	0.06	Medium	5-40
Fine	≥40	0.1	Fine	≥40	0.1	Fine	≥40

Note(s): 1. disturbed' refers to excavation, dewatering, dredging, etc.
2. Coarse = sands; Medium = sandy loams/silts to light clays/silts; Fine = medium to heavy clays, silty clays
3. NAGP net acid generation potential – requires %S and acid neutralizing capacity (ANC) to determine

6.0 Management Strategies

Based on the dataset reported following the additional investigations, there is a low possibility that ASS material may be encountered across the proposed excavation areas of The Block 5 Remediation Area (**Appendix A**, **Figure F2**).

In general the excavated PASS material should be placed into an appropriately bunded treatment area (pads) and treated with a neutralising agent (e.g. lime). The treatment pad design details are presented in **Section 6.5**.

Leachate water from the PASS material will also need to be managed and treated to ensure no acid is released to the environment.

An alternative to on-site treatment and beneficial reuse would involve direct off-site disposal of suitably classified impacted soils to an appropriate landfill licensed to received such materials in accordance with the requirements of DECC (2008). The strategy for off-site disposal is detailed in **Sections 6.9** and **6.10**. It is noted that consideration must be given to the potential presence and management of ACM within excavated material. If asbestos is encountered during ASS management works, the material must be managed in conjunction with an asbestos management plan (AMP) prepared in accordance with the recommendations of the RAP (AECOM, 2013d).

6.1 Site Management

PASS materials should be kept separate from non-PASS materials at all times to reduce the volume of material requiring treatment. Acid is transported by water; therefore, excavation works in PASS should be conducted during dry periods (where practical) to minimise the risk of overflow associated with sudden or heavy rain and to allow better control of treated waters for discharge.

6.2 Leachate Control

Based on the information provided to AECOM at the time of preparation of this ASSMP, groundwater and surface runoff during storm events will accumulate within excavations or constructed collection ponds/sumps within the Block 5 Remediation Area, including water generated from ASS treatment, during the proposed excavation works. This water will require collection and management.

Any leachate generated during the ASS treatment operations must be directed to the Block 5 Remediation Area water treatment plant and treated to a prescribed discharge water quality (refer to Procedure 2 – Performance Criteria). In addition, a truck wash down area comprising a hardstand of base coarse with drainage should be constructed adjacent to a leachate pond so that truck wash down water can be collected for treatment.

Disposal of water from ASS treatment should be undertaken in accordance with the Environment Protection License (EPL) relevant to Block 5. Water should be tested for the following parameters/analytes in addition to the analytes specified in a Construction Environmental Management Plan (CEMP) produced separately to this document.

- pH;
- Total Suspended Solids (TSS);
- Turbidity;
- Dissolved Oxygen; and
- Oil and Grease

Prior to disposal of water, appropriate treatment should be undertaken in accordance with any licences/ relevant regulation to be specified in a CEMP prepared separately to this document.

Treatment measures may include but not limited to the following:

- pH adjustment of the ponded water with a calcium hydroxide solution (e.g. hydrated/slaked lime); and
- Removal through flocculation.

6.3 Liming Rates

A technique commonly used in ASS treatment is neutralisation where alkaline materials are physically incorporated into the soil. Sufficient neutralising agent(s) needs to be used to ensure that there is the capacity to neutralise all existing acidity that may be present and all potential acidity that could be generated from complete oxidation of the sulfides over time. Note: if there is existing acidity, limited effective natural buffering capacity remains. Finely crushed limestone or Aglime is commonly used as the neutralisation agent.

Note: Aglime is calcium carbonate and should not be confused with hydrated lime or calcium hydroxide.

The liming rate is the amount of Aglime required to neutralise existing and potential acidity in the soil material that has been disturbed by the development activity.

The formula to calculate liming rates is:

%S x 30.59 x 1.02 x 1.5 = kg $CaCO_3$/tonne of soil

Note: 30.59 converts S% to kg of H_2SO_4 per tonne; 1.02 converts kg of H_2SO_4 per tonne to kg of $CaCO_3$ per tonne; and 1.5 is the safety factor

To convert units from tonnes to cubic metres, multiply the kg $CaCO_3$/tonne of soil by the bulk density of the soil

Handling options for excavated PASS material should use Industry best practice to mitigate acid generation.

The options for treatment include:

- Neutralisation of PASS/AASS material with finely crushed limestone (Aglime) at a predetermined rate including a safety factor of 1.5 to allow for mixing inconsistencies; this is the preferred option for on-site beneficial reuse of excavated PASS;
- Over-excavation and burial below water table;
- Preloading and burial below water table; or
- Disposal off-site – refer to **Sections 6.9** and **6.10**.

Neutralisation with Aglime treatment will be undertaken progressively in designated treatment areas in accordance with the excavation program. The action levels for excavations larger than 1000 t is 0.03% oxidisable sulfur. Treatment areas should be bunded and the bund walls lined with an anchored geotextile or plastic sheeting liner, so as to minimise erosion and direct impact by the PASS. The bunds will also minimise surface water runoff entering or leaving the treatment areas. A guard layer of Aglime as described in **Section 6.5.1** should be placed over the underlying soil at the base of each treatment area, so as to provide further safeguard against any acidic leachate generated during treatment which is not fully neutralised by the Aglime treatment. The division of each treatment area into cells may expedite the treatment process as material can be allocated to different cells as excavation works progress, resulting in a staged treatment process.

Once PASS material has been placed in the treatment areas it should be allowed to drain (with leachate directed into the leachate management pond) and then dosed with a neutralising agent (e.g. Aglime) in accordance with the required dosing rate (calculated based on assessment findings, as per **Section 6.3**).

The application rate for the neutralising agent (liming rate) will depend on the agent used. It is recommended that fine grained Aglime with a neutralising value (NV) of at least 95% is used.

The lime should be thoroughly mixed through the soil with suitable site machinery. Additional quantities of Aglime above the calculated dosing rate may be required to allow for difficulties in mixing and to act as a backup buffer under such circumstances. The effectiveness of the adopted dosing rate should be confirmed by the regular sample screening of the treated material using pH and peroxide pH field tests, with additional lime added as required.

It should be noted that as a precautionary measure, treatment works involving Aglime should not be conducted during windy conditions, unless the material can be appropriately conditioned to prevent dust generation. When the field screening indicates that the material has been suitably treated, the PASS should be disposed of to an appropriately licensed facility in accordance with the appropriate waste classification.

6.4 Limestone Neutralisation

The following management protocols should be followed:

- Soils selected for this method of treatment will be treated with limestone or equivalent neutralising agent to neutralise the net acidity based on Total Potential Acidity (TPA) or equivalent oxidisable sulfur (S_{CR}), TAA, and retained acidity, if present (derived from S_{NAS});
- Treatment will be verified using field pH after oxidation, ANC by C_{IN} or ANC_{BT} and Lab TPA or oxidisable sulfur based on verification sample testing at a specified rate (usually one sample per 500 m^3 of excavated material);
- Aglime (finely crushed limestone or suitable and approved alternative) application rate will include a safety factor for mixing of 1.5, unless it can be demonstrated that this factor can be reduced to the satisfaction of the local governing authority;
- Excavated PASS material will be placed in spatially tracked, prepared pads (i.e. bunded using non-PASS material) and limed;
- Suitable quantities of treatment additives will be stockpiled on The Block 5 Remediation Area for emergency treatment;
- Stockpiles of lime will be "dampened down" or covered to minimise dust emission;
- Utilisation of safe handling and storage procedures for alkaline treatment substances, including training of project staff in health and safety procedures relating to their use;
- The treatment areas will be constructed with a guard layer base and fully bunded to contain any runoff during rain events – the bund should be constructed from non-acid sulfate soil material;
- The guard layer installed will have a surface treatment of lime added at a minimum rate of 5kg/m^2/metre depth of material (or part thereof) to be placed. This is to provide a layer of neutralising treatment for any acidic runoff or leachate from the treatment areas.

6.5 Treatment Pad Design

For treatment of material in an open area, neutralisation should be carried out on a treatment or liming pad. The following issues should be considered in the treatment pad design.

6.5.1 Guard Layers

A guard layer of neutralising agent should be spread onto the soil surface of the treatment pad prior to the placement of soils. This will reduce risk by neutralising acidic leachate generated in the treatment pile and not neutralised during the treatment process. This is especially relevant to the first layer of PASS that is placed for treatment prior to application of the neutralising agent. The guard layer will assist in protecting groundwater quality.

6.5.1.1 Guard layer rate

The rate of neutralising agent used in the guard layer (per square metre) should be based on 0.2 times the average of the potential and existing acidity for every metre depth of the soil to be treated (i.e. if 2 metres of soil are to be treated in the treatment pad, then twice 0.2 times the neutralising agent required to neutralise the acidity should be spread as a guard layer). The safety factor of 1.5 to 2 is recommended for all guard layers. The safety factor may need to be increased for sands and for treatment pads that are adjacent to environmentally sensitive areas. For example:

- SCR = 1.9%
- TAA = 125 mol H+/tonne
- Existing + Potential Acidity = (125 ÷ 623.7) + 1.9 = 2.1%
- 0.2 times the average of the potential and existing acidity = 0.2 x 2.1% = 0.42 %S
- Thickness of soil on treatment pad = 2 m
- The situation would require 39 kg $CaCO_3/m^2$ of soil as the guard layer for 2m (vertical) of fill

In all cases a minimum of 5 kg fine Aglime per m^2 per vertical metre of fill should be used in the guard layer.

6.6 Monitoring of Treatment

Treated layers will be monitored regularly for success using a combination of field based tests (*ASS Laboratory Methods Guidelines* for pH before and after peroxide oxidation, Ahern et al, 2004) and acid neutralising capacity or equivalent parameter on representative samples of material being treated, before placement of subsequent layers upon same site with reference to the action levels listed in **Table 2**, verification sampling will be tested at a rate of one sample per 500m^3;

Monitoring of surface water around the treatment site to detect temporary failures;

Any leachate generated within the Block 5 Remediation Area will be collected and treated within a bunded area if high acidities persist; the collected leachate will be treated using hydrated lime or equivalent to raise pH to 6.5-9.0, Suspended Solids to <50 mg/l. These parameters should be tested on a daily basis;

Records will be kept of lime dosing rate and water quality monitoring results.

During treatment of PASS, soil pH should be regularly measured. Soil pH will be used as a measure of the effectiveness of neutralisation, and the material will only be considered to have been suitably treated when a pH value in excess of 6.5 and a peroxide pH value in excess of 6 have been attained consistently throughout the batch of material being treated.

If treated soils are to be stockpiled on-site prior to disposal, the field pH and peroxide pH of the stockpiled materials should be determined immediately prior to disposal. If material fails the pH and peroxide pH testing, further dosing with Aglime should be conducted as required prior to disposal.

During PASS treatment, if soil sampling for laboratory analysis of acid sulfate soil parameters is required, soil sampling, transport and laboratory analysis should be undertaken as detailed in **Section 5.3**.

6.7 Handling Potential Acid Sulfate Soils Prior to Disposal

In accordance with the Waste Classification Guideline: Part 4 - Acid Sulfate Soils (DECC, 2008), untreated PASS must be kept wet at all time during excavation and subsequent handling, transport and storage until they can be disposed of safely. The material must be received at the proposed pick up point within 16 hours of being excavated.

6.8 Transportation of Acid Sulfate Soils

Untreated PASS material requiring transport should be loaded into sealed trucks and immediately transferred to a regulated landfill as per **Sections 6.9 and 6.10**. All vehicles must be covered and sealed where practical to prevent the loss/leakage of PASS material, including leachate, during transport. Similarly, wheels and external surface of all trucks will require appropriate cleaning prior to leaving the Block 5 Remediation Area to remove any PASS material that may be clinging to exterior surfaces.

6.9 PASS Off-site Disposal (below the water table)

In accordance with the Waste Classification Guideline: Part 4 - Acid Sulfate Soils (DECC, 2008), untreated PASS may be disposed off-site to a suitably licensed landfill (such as Kurnell Landfill Company) in water below the permanent water table, provided:

- This occurs before the material has had a chance to oxidise (that is within 24 hours of excavation); and
- The material meets the meets the definition of 'virgin excavated natural material' (VENM) under the *Protection of the Environment Operations Act 1997*, even though they contain sulfidic ores or soils.

Off-site disposal of un-treated PASS materials for treatment and disposal must occur within 24 hours of excavation and contractors accepting the material must be appropriately licensed and notified in advance. If soils are to be stockpiled within the Block 5 Remediation Area for more than 24 hours then further testing will be required directly prior to disposal to evaluate any changes in pH and the possible oxidation of PASS before disposal. All excavated PASS soil must be kept saturated at all times.

PASS must be disposed of within 8 hours of receipt at a landfill and kept wet until burial at least 2 metres below the lowest historical level of the water table at the disposal site. Documentation must be provided to the occupier

of the landfill for each truckload of potential ASS received, indicating that the soil's excavation, transport and handling have been in accordance with the Acid Sulfate Soil Manual, thus preventing the generation of acid.

The occupier of the disposal site must also test the pH of each load of soil received immediately prior to its placement under water using the test method(s) in the Acid Sulfate Soil Manual (Methods 21A and/or 21Af). These details, together with the pH of the soil recorded at the time of its extraction, must be retained by the occupier of the landfill site.

6.10 PASS Off-site Disposal (above the water table)

Where PASS cannot be classified as VENM or a suitable underwater disposal site at a landfill is not available, the soil should be treated in accordance with the neutralising techniques in ASSMAC (1998) and as outlined in **Section 6.0**. After treatment the soil should be disposed in accordance with the appropriate waste classification for that material.

6.11 Alternative Treatment Options

6.11.1 Over-excavation Option

This option may be utilised where low or non-PASS material is located at depth in the excavated site below the water table. The process involves placing high PASS material below the water table and treating the lower PASS material if necessary.

Stockpiling of high PASS material should be minimised where practical and located in temporary treated sites (bunded and limed).

If this option is selected the actual acid sulfate value of the soil to be excavated will be assessed as per ASS Laboratory Methods Guidelines (Ahern et al., 2004) and any actual acid sulfate soil identified will be treated using a pre-determined lime application rate (including the 1.5 factor) as described previously.

6.11.2 Preloading Option

This option may be utilised where sufficient non-PASS material is available for use. Non-PASS material is placed over compressible PASS material and compresses the PASS material to below the permanent water table.

6.12 Water Quality Management

The quality of water within The Block 5 Remediation Area will be maintained according to the procedures outlined in the CEMP to be prepared for the Declaration Area. Management procedures to be utilised for treatment of acid leachate generated from exposure of PASS material and stormwater runoff will include:

- Direct drainage within The Block 5 Remediation Area Area to a collection sump for treatment or pumping to a treatment point;
- All external drainage will be directed away from the excavated site to minimise the volume of water within the site that may require treatment;
- Any water collecting within the excavation will be treated with hydrated lime or equivalent prior to discharge. Water accumulating within the construction site will not be discharged until it meets acceptable water quality standards outlined in the CEMP to be prepared for the Declaration Area to be prepared separately to this report; and
- Discharge from the water treatment point will be undertaken once the pH of the water has reached 6.5-9.0, has low suspended solids <50 mg/l and is in compliance with water quality limits detailed in the CEMP to be prepared for the Declaration Area to be prepared separately to this report.

6.13 Procedures

The following tables provide a detailed checklist of procedures for management of PASS and mitigation of their potential impacts.

Table 4 Procedure 1: Acid Sulfate Soil Assessment and Treatment During Excavation Works

Issue	Procedure
Operational Policy	To prevent, mitigate or manage potential impacts from acid sulfate forming material. To minimise impacts of acid sulfate soils on the surrounding watercourses and ecology.
Performance Criteria	Final placement of soils will not be carried out until validation sampling ensures compliance with governing Guidelines for action levels for oxidisable sulfur.
Implementation Strategy/Mitigation Measures	Assessment and management of acid sulfate material will be conducted in accordance with Industry best practice and will incorporate the following procedures: An appropriately qualified contractor/consultant will be engaged to identify the PASS during excavation works. Soils within a site designated for acid sulfate soils will be tested for acid sulfate potential and classified; suitable methods of treatment based on the testing classification will be designed, including calculation of liming rates using a safety factor of 1.5 and bulk densities (where applicable) of the material to be treated. Exposure of PASS material within an excavated trench site will be minimised to reduce the potential for oxidation and acid leachate generation. Excavation for construction will be done under dry conditions, where possible using a truck and shovel (tracked excavator) operation. Watertable will be lowered within excavation areas, as part of excavation dewatering. Non-PASS material will be used as fill wherever possible. Excavated fill will be monitored for colour and leachate quality. No PASS material will be placed and left at surface untreated. Place material will be stabilised to reduce dust emissions. Height of stockpiles must be <2m. Stockpiled material will be monitored for colour and leachate quality; stockpiling of PASS material will be minimised where possible.
Monitoring/Validation Sampling of Liming Rates	Treated material will be monitored regularly for success using field-based tests and lab. TPA or S_{CR} and TAA on representative samples of material being treated at a rate of one sample per 500 m^3 (if field sampling indicates the presence of PASS soils). It is anticipated that no sample will have a pH <6.5 after peroxide oxidation. Monitoring of surface water around the treatment site will be undertaken to detect temporary failures. Any leachate generated within the treatment site will be collected and treated within a bunded area if high acidities persist; the collected leachate will be treated using alkaline additives to an approximate pH of 6.5; and Records will be kept of lime dosing rates and monitoring results.
Identification of Incident or Failure to Comply	Acid sulfate field test and lab TPA results indicate PASS materials found in the treated excavated material.
Corrective Action	Further testing of materials in vicinity of the excavation using Chromium Suite method (S_{CR} and TAA) or equivalent. Reprocessing of materials and treatment with lime.

Table 5 Procedure 2: Surface Water Quality Management

<table>
<tr><th>Issue</th><th colspan="3">Procedure</th></tr>
<tr><td>Operational policy</td><td colspan="3">Treatment and management of surface water flows from areas containing acid sulfate soils to prevent leaching of acidic waters and metal contaminants into the environment, maintaining present surface water quality wherever practicably possible.</td></tr>
<tr><td rowspan="8">Performance Criteria</td><td colspan="3">All leachate water collected from PASS soils and discharged from Block 5 must be treated within the Site WWTP. Prior to discharge from the WWTP, consideration should be given to the following criteria:</td></tr>
<tr><td>Indicator</td><td>Fresh Water</td><td>Marine Water</td></tr>
<tr><td>pH</td><td>6.5-8.0</td><td>8.0-8.4 and <0.2 unit change</td></tr>
<tr><td>Suspended Solids</td><td colspan="2">Not defined</td></tr>
<tr><td>Turbidity (NTU)</td><td>1-20</td><td>0.5-10</td></tr>
<tr><td>Dissolved Oxygen (field measured, %)</td><td colspan="2">110</td></tr>
<tr><td>Oil and Grease</td><td colspan="2">None visible or detected</td></tr>
<tr><td>Iron Floc and Scum</td><td colspan="2">None visible or detected in discharge water</td></tr>
<tr><td colspan="3">Testing parameters will include Aluminium and Iron should the pH fall below 6.0</td></tr>
<tr><td>Implementation Strategy/Mitigation Measures</td><td colspan="3">Surface water monitoring locations will be detailed and provided to regulatory authority (e.g. local Council) for approval (where required) prior to commencement of construction.
Leachate collection ponds will be constructed to accommodate the leachate and runoff water that would be generated in a 1 year ARI, 72-hour duration storm event.
All leachate from acid sulfate soil treatment areas and areas of disturbed acid sulfate soils including areas where groundwater levels are lowered due to dewatering will be collected and directed to a centralised polishing pond for treatment of acidity.
Ponded water within the Block 5 Remediation Area will be minimised wherever possible, unless part of the treatment process.
Stormwater control will rely on the maintenance of directed drains to the excavations or a centralised settlement pond.
All stormwater runoff from undisturbed areas and areas not affected by the development will be directed away from development disturbed areas; and existing surface water conditions shall be maintained wherever possible.
Where sediment problems are identified settling in the excavations shall be aided by dosing with suitable flocculation agents.
If increasing acidity is encountered, the collected waters from the excavations will be treated until a minimum pH of 6.5 has been achieved prior to discharge.
Acidity will be treated with a suitable neutralising agent such as hydrated lime to the prescribed pH in the Performance Criteria of this Procedure prior to discharge.
Suitable OHS standards for storage and handling alkaline substances such as hydrated lime must be strictly maintained during operation, in accordance with the registered MSDS.
Sufficient quantities of hydrated lime must be maintained within the Block 5 Remediation Area to treat any acidic runoff water or leachate.</td></tr>
</table>

<table>
<tr><th>Issue</th><th>Procedure</th></tr>
<tr><td>Monitoring</td><td>Weekly monitoring in water bodies with hand held pH and EC meter during construction.
Daily monitoring of water within the settlement/polishing pond/tank with hand held pH meter and Secchi disk during period of treatment.
Monthly laboratory analyses at a NATA registered laboratory for: Sulfate, Chloride, Alkalinity and Acidity for the polishing pond and adjoining the point of discharge. Determination of Chloride: Sulfate ratios (it should be ~7 for marine waters).
Analysis of settlement pond water for Chloride and Sulfate (if EC < 10µS/cm), Alkalinity and Acidity, NFR (true colour) and DO prior to discharge.
During flood events, samples of stormwater runoff will be collected and analysed for Colour, NFR (true colour) where access permits.
Visual inspection will be undertaken following each rainfall event and on a regular basis during dry periods to determine the presence or absence of oil, grease and iron floc/precipitate.</td></tr>
<tr><td></td><td>The frequency of Surface Water Monitoring related to PASS soils is anticipated to be as follows:
<table>
<tr><th>Indicator</th><th>Monitoring Sites</th><th>Frequency</th></tr>
<tr><td>pH, EC, Secchi disc (or equivalent)</td><td>Settlement / Polishing pond
All Sites</td><td>Daily during period of water treatment
Weekly in non-treatment period</td></tr>
<tr><td>Suspended Solids</td><td>All Sites</td><td>Weekly</td></tr>
<tr><td>Dissolved Oxygen Field Measured</td><td>All Sites</td><td>Prior to discharge</td></tr>
<tr><td>Oil and Grease</td><td>All Sites</td><td>Weekly</td></tr>
<tr><td>Iron Floc and Scum</td><td>All Sites</td><td>Weekly</td></tr>
<tr><td>Sulfate, Chloride, Alkalinity, Acidity</td><td>All Sites</td><td>Weekly prior to discharge during water treatment periods
Monthly in non-treatment periods</td></tr>
</table></td></tr>
<tr><td>Auditing</td><td>Auditing to ensure assessment and treatment procedures according to the performance criteria prior to discharge of surface water from The Block 5 Remediation Area.</td></tr>
<tr><td>Reporting</td><td>Weekly result sheets will be compiled for monitoring results relating to water quality of water bodies. Results will be available at all times.</td></tr>
<tr><td>Identification of Incident or Failure to Comply</td><td>Fall in surface water quality as per water quality criteria, at the environmental monitoring points to below background level.</td></tr>
<tr><td>Corrective Action</td><td>Identify reason for deterioration in surface water quality and determine if it is linked to the construction operations.
Review of construction operation.
View and upgrade neutralisation treatment procedure.</td></tr>
</table>

7.0 References

AECOM Australia Pty Ltd, 2010a. Sampling Analysis and Quality Plan, Declaration Area – Issue 2 VMP and PDA Works, NSW EPA Declaration Area 21122, former Millers Point Gasworks. 4 March.

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Appendix A

Figures

PROJECT ID: 60153531 MP10_0026
CREATED BY: TO
LAST MODIFIED: TO 23 11 2010

AECOM
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0 600m

Site Location

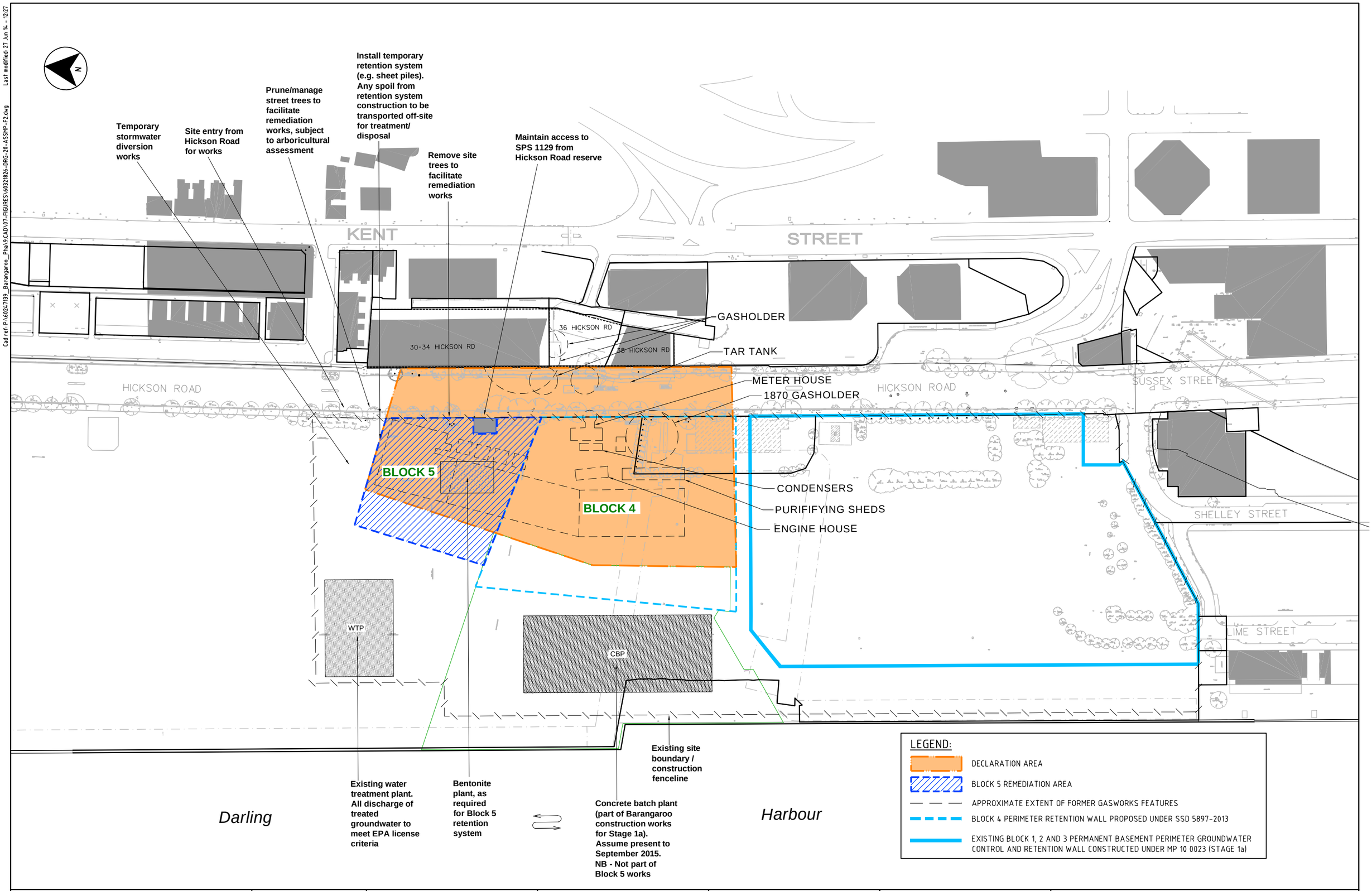
Lend Lease (Millers Point) Pty Ltd
Acid Sulfate Soils Management Plan
Barangaroo Declaration Area No. 21122,
Hickson Road, Millers Point NSW

Figure
F1

Map Document: G:\Projects\601\60153531 Barangaroo\FIGURES\Acid Sulfate Soils Management Plan\60153531 F1

A4 Size

Cad ref: P:\60241739_Barangaroo_Pha\9.CAD\07-FIGURES\60321826-DRG-20-ASSMP-F2.dwg Last modified: 27 Jun 14 - 12:27



REVISIONS

No.	BY	DATE	DESCRIPTION	APPD
02	PAS	27.06.14	FINAL ISSUE	AKL
01	PAS	16.05.14	DRAFT ISSUE	AR

SCALES:

10 0 10 20 30 40m

1 : 2000 FULL SIZE A3

THE SIGNING OF THIS TITLE BLOCK CONFIRMS THE DESIGN AND DRAFTING OF THIS PROJECT HAVE BEEN PREPARED AND CHECKED IN ACCORDANCE WITH THE AECOM QUALITY ASSURANCE SYSTEM TO ISO 9001-2000

DESIGNED	AD	CHECKED	AR
DRAWN	PAS	CHECKED	
APPROVED	AKL	DATE	27.06.14

DESIGNER:

AECOM

AECOM Australia Pty Ltd A.B.N. 20 093 846 925

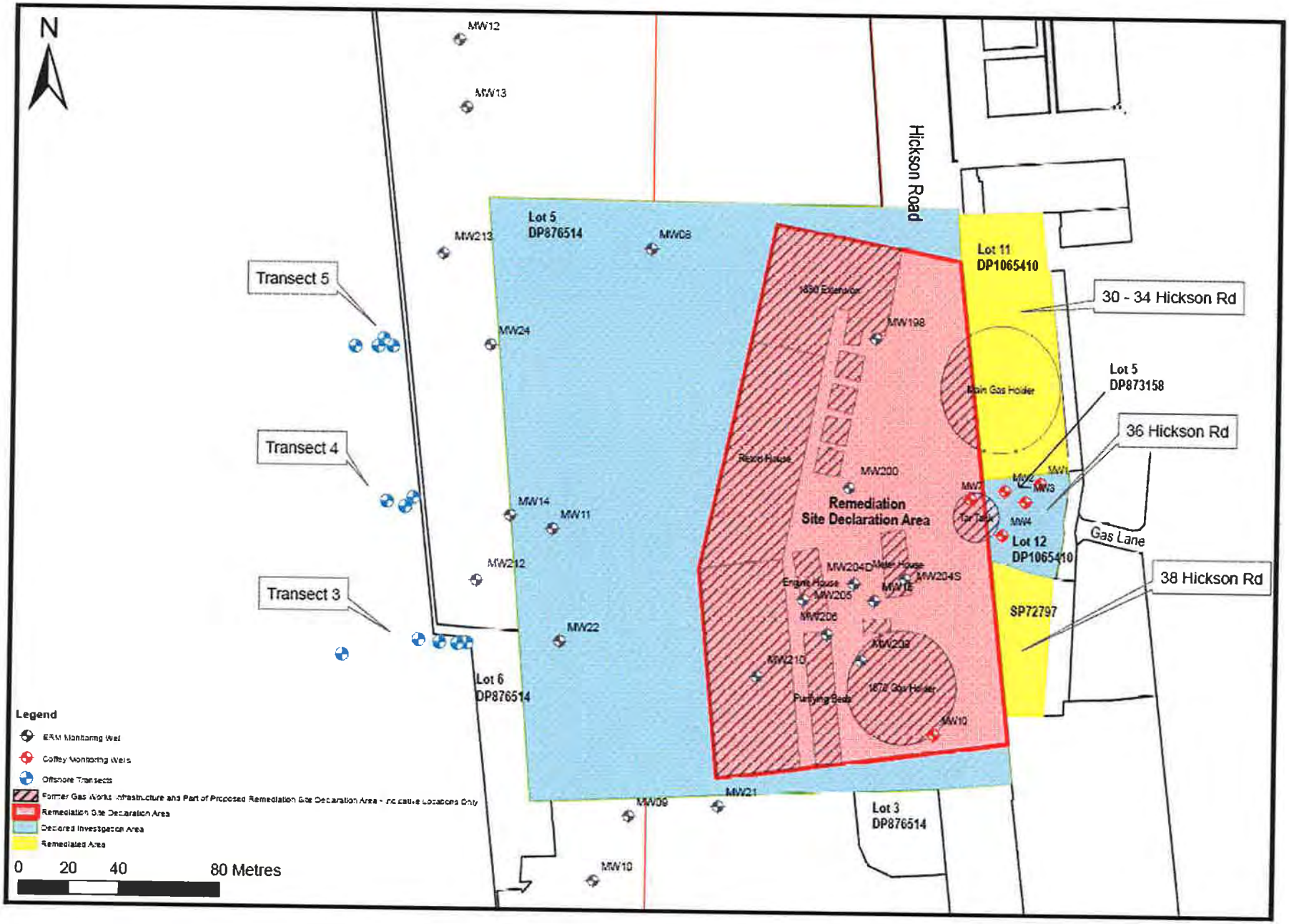
ACID SULFATE SOILS MANAGEMENT PLAN, BLOCK 5, BARANGAROO

FIGURE 2:
SITE LAYOUT AND SURROUNDING AREA
REMEDIATION DEVELOPMENT APPLICATION, BARANGAROO BLOCK 5

STATUS:	DRAWING NO:	REV:
FINAL	60321826-DRG-20-ASSMP-F2	02

Appendix B

Declaration Area as gazetted by EPA


N
MW12
MW13
MW213
MW08
Hickson Road
Lot 5
DP876514
Lot 11
DP1065410
30 - 34 Hickson Rd
Transect 5
MW24
MW198
1830 Extension
Main Gas Holder
Lot 5
DP873158
36 Hickson Rd
Transect 4
Retort House
MW200
MW14
MW11
Remediation
Site Declaration Area
MW2
MW3
MW1
MW4
Tar Tank
Lot 12
DP1065410
Gas Lane
MW212
MW204D
Meter House
MW204S
Engine House
MW205
MW1E
38 Hickson Rd
Transect 3
MW206
SP72797
MW22
MW209
MW210
1878 Gas Holder
Purifying Beds
Lot 6
DP876514
MW10
MW09
MW21
Lot 3
DP876514
MW10
Legend
ERM Monitoring Well
Coffey Monitoring Wells
Offshore Transects
Former Gas Works Infrastructure and Part of Proposed Remediation Site Declaration Area - Indicative Locations Only
Remediation Site Declaration Area
Declared Investigation Area
Remediated Area
0
20
40
80 Metres