UrbanGrowth NSW Development Corporation

Acid Sulfate Soil Management Plan

The new Sydney Fish Market
1A to 1C Bridge Rd, Glebe NSW

4 April 2019

54162/113896 (Rev 2)

JBS&G Australia Pty Ltd

www.jbsg.com.au

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1. Introduction

1.1 Introduction and Development Details

JBS&G Australia Pty Ltd (JBS&G) was engaged by UrbanGrowth NSW Development Corporation (UrbanGrowth NSW, the client) to prepare an Acid Sulfate Soil Management Plan (ASSMP) for the proposed new Sydney Fish Market site located at the head of Blackwattle Bay between the Pyrmont Peninsula and the foreshore of Glebe (the site). The site is legally identified as Lots 3-5 in DP 1064339, part Lot 107 in DP 1076596 and part Lot 1 in DP835794 as shown on **Figures 1** and **2**. The individual lots fall within City of Sydney (CoS) local government area. The site area is approximately 3.7 Ha, of which 0.7 Ha consists of soil based materials present behind an existing sea wall above the high water mark.

The proposed new Sydney Fish Market site is situated at the southern portion of Blackwattle Bay, which is one portion of the Bays Precinct Urban Transformation Area (BPUT) that comprises approximately 80 Ha of land, in addition to 94 Ha of water that is the subject of a NSW Government urban transformation project that will have the potential to deliver additional residential, commercial, recreational and community developments over a 20-30 year timeframe.

Review of the *Acid Sulfate Soil Risk Map for Prospect/Parramatta*[1] indicates that the site is located within an area of '*high probability of occurrence of Acid Sulfate Soils*'. In such areas there is a severe environmental risk if bottom sediments are disturbed by activities such as dredging. Previous investigations have identified potential indicators of ASS comprising odorous marine sediments with sea shells observed in boreholes located in the southern portion of the site (overlying the land portion of the site) and within marine sediments in Blackwattle Bay.

With due consideration to the geological and soil characteristics of the site (i.e. fine-grained sediments), in addition to historical information, management of development activities is required to consider the potential for disturbance of acid sulfate soil (ASS) including Potential ASS (PASS) if development activities involve excavation or otherwise oxidation of soils beneath the water table.

Site development activities within the land portion of the site are largely at grade, however, it is anticipated that works associated with construction of the new development will require disturbance of sediments within the bay as a result of piling installation activities and adjustment of sediment bed levels for stormwater culvert maintenance. Given the preliminary nature of the design, there is currently limited information as to potential amendments to existing underground services infrastructure arrangements and the proposed water level interaction area both behind and in front of the sea wall.

As such an ASSMP is required to document procedures to be implemented to manage the potential environmental risk associated with disturbance of these materials. This ASSMP has been prepared in accordance with the general requirements of the Acid Sulfate Soil Manual (ASSMAC 1998[2]) and with consideration to the National Acid Sulfate Soils Guidance (DAWR 2018[3]).

1.2 Aims and Objectives

The aim of this ASSMP is to outline management techniques that may be employed to mitigate the potential environmental impacts associated with the risk of disturbance of ASS/PASS during the proposed site construction works. Specifically, the objectives of this ASSMP are to document:

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1 *Acid Sulfate Soil Risk Map – Prospect/Parramatta,* Edition 2, 1997 1:25 000 Ref: 91 30N2. NSW DLWC (1997)

2 *Acid Sulfate Soil Manual*, NSW Acid Sulfate Soil Management Advisory Committee, August 1998 (ASSMAC 1998)

3 *National Acid Sulfate Soil Guidance*. Australian Government Department of Agriculture and Water Resources (DAWR), June 2018 (AGDAW, 2018)

- The known and anticipated site sub-surface characteristics expected to be encountered during future excavation works for consideration in development of future investigative and management activities;
- A monitoring and sampling strategy to be implemented prior to and during the proposed ground disturbance activities such that ASS/PASS may be appropriately identified and managed during the excavation works;
- Evaluation of potential ASS/PASS management opportunities and constraints resulting in the identification of a preferred management strategy(ies); and
- Procedures for the management and validation of ASS during the future site excavation works so as to minimise the potential for adverse environmental impacts as a result of the ASS/PASS disturbance activities.

1.3 Proposed Development

It is understood that statutory approval for the proposed development scheme will be sought in two stages, comprising the initial concept development application, being for the demolition of existing structures and approval for the proposed development envelope for use of the site as a fish market. The second development application (Main Works) will seek approval for the construction of the new fish market and associated works.

Specifically, the Concept development application seeks approval for:

- the use of the site for the fish market including waterfront commercial and tourist facilities and ancillary uses and the distribution of uses;
- a gross floor area of up to 30,000m^2 contained within a defined building envelope;
- waterfront structures such as wharves;
- concepts for improvements to the public domain including promenades, access to Blackwattle Bay and landscaping;
- pedestrian cycle and road access and circulation principles; and
- principles for infrastructure provision and waste management.

The development application will also set out details of the first stage of the development being the demolition of land and water-based structures on the site including removal of marine piles and any resulting repairs to the existing sea wall, and related services relocations.

The Main Works development application seeks approval for:

- the construction of a new fish market including land and water-based structures.
- the use of the site for the fish market including waterfront commercial and tourist facilities and ancillary uses and the distribution of uses;
- a gross floor area of approximately 26,000m^2 as calculated according to the definition of GFA under SREP 26 (approximately 25,600m^2 as calculated according to the definition of GFA under the Standard Instrument).
- public domain works including promenades access to Blackwattle Bay and landscaping;
- pedestrian, cycle and road access and circulation;
- infrastructure provision and waste management; and
- associated works as required.

The proposed uses comprise:

Below Ground Level

- Parking for service and delivery, and private vehicles up to approximately 417 vehicles;
- Plant and storage;
- Waste Management facilities; and
- End of journey facilities.

Ground Level - Outside of Building Envelope

- Up to three operational wharves for fishing fleet servicing and product unloading/loading, multi-purpose wharf space, private-operated ferry stop, recreational vehicles and the like;
- Vehicular access driveways; and
- Publicly accessible promenade.

Ground Level - Within Building Envelope

- Wholesale services space including product storage and processing;
- Auction floor and associated refrigeration and handling space.
- Loading dock including time-limited delivery and service vehicle parking area;
- Waste management facilities;
- Office space including buyers room; and
- Staff amenities, plant and storage.

Upper Ground Level (L1)

- Retail premises including fresh food retail, food and drink premises including harbourside dining;
- External/shared dining space;
- Ancillary back of house space and staff amenities; and
- Circulation areas.

Upper Level 2 (Mezzanine)

- Catering space;
- The Sydney Seafood School;
- Tenant and subtenant office space; and
- Plant and storage space.

Specifically, the proposed development works to occur within the works area as shown in **Figure 4** will include:

- Retention, rehabilitation/repair of the existing sea wall structures;
- Removal/decommissioning of all existing industrial and wharf infrastructure;
- Construction of a new basement level carpark in front of the existing sea wall with appropriate measures to allow the continued discharge of stormwater through existing culverts.

- Foundations for the new structures will be completed as driven steel piles with the basement constructed as a precast stainless steel structure within which a membrane will be fitted and in-situ basement pavements poured resulting in a water tight structure.
- The proposed basement finished floor level (FFL) has been designed at -0.3 m AHD. Allowing for a hydrostatic slab and steel structure, JBS&G has conservatively assumed a base of structure of approximately -1.3 m AHD.
- A coffer dam will be installed around the construction footprint to enclose the site and enable temporary partial dewatering to facilitate construction requirements whilst ensuring that sediments remain saturated.
- To facilitate continued use of the existing stormwater culverts, etc the proposed works will include some dredging of sediment in the vicinity of an existing culvert within the new building footprint. These works will be completed to provide a gap of at least 1 m between the culvert mouth and the new basement structure. It is anticipated that approximately 55 m^3 of sediment/silt will require movement to an elevation of -3.01 m RL. The sediment/silt movement will relocate excess material within the basement footprint so as to minimise the level of disturbance of both the material and ecological receptors. In addition, it is anticipated that approximately 470 m^3 of existing rock revetment will also require removal within the zone along the base of the sea wall. Given the inherent uncertainties associated with the survey methodology and the potential for movement of sediment/silt within the building footprint between the survey period and commencement of works, the reported volumes requiring removal should be preliminary estimates and contingency allowed should additional material required removal to achieve the drainage/construction objectives.

1.4 Previous Assessments

Review of the following site investigation (environmental and geotechnical) reports has been undertaken in forming the basis for the requirements of the ASSMP. The available reports included:

- *Environmental Site Investigation Blackwattle Bay Maritime Precinct Blackwattle Bay Maritime Precinct, NSW*, March 2009, Parsons Brinkerhoff (PB 2009)
- *Sydney Bays Precinct Urban Growth NSW Geotechnical Desktop Review*, 6 August 2014, Jacobs Group (Australia) Pty Limited (Jacobs 2014);
- *UrbanGrowth NSW Environmental Site Assessment The Bays Precinct Urban Transformation Area.* Rev 1, 18 November 2015, JBS&G Australia Pty Ltd (JBS&G 2015a);
- *Contamination Investigation The Bays Precinct – Separable Portion 1 Blackwattle Bay, Pyrmont, NSW*, 12 July 2017, Environmental Investigation Services (EIS 2017);
- *Revised Geotechnical Report to Urbangrowth NSW on Geotechnical Investigation for Proposed Bays Market District at Blackwattle Bay & Wentworth Park, Pyrmont, NSW rev 2*, 14 September 2017, JK Geotechnics (JK 2017);
- *Environmental Site Assessment, the new Sydney Fish Market, 1A to 1C Bridge Road, Glebe, NSW*. 4 April 2019, Rev 3, JBS&G Australia Pty Ltd (JBS&G 2019a); and
- *Remedial Action Plan, the new Sydney Fish Market, 1A to 1C Bridge Road, Glebe, NSW*. 4 April 2019, Rev 3, JBS&G Australia Pty Ltd (JBS&G 2019b);

2. Acid Sulfate Soil General Information

2.1 Acid Sulfate Soils Background

ASS is a common name given to naturally occurring sediments and soils containing iron sulfides (generally as iron sulfide or iron disulfide). These soil profiles are typically located in coastal, low-lying alluvial or estuarine areas such as mangroves, salt marshes, coastal rivers and creeks, estuaries, tidal lakes and coastal floodplains where historical iron rich sediment deposition in the presence of a sulfate source (commonly salt water), organic matter and microbial action over time has resulted in the formation of particular environmental conditions. ASSs are predominantly encountered in areas where the soil profile has an elevation of less than 5 m Australian Height Datum (AHD), and may be found close to the ground level or at depth in the soil profile where continued deposition actions have resulted in raising of the ground levels.

Changes in environmental conditions which result in the exposure of these materials to air, via excavation or drainage of subsurface soils, can lead to the reaction of the iron sulfides with oxygen, causing the generation of sulfuric acid. This may result in significant environmental and infrastructure damage if the produced acid is spread by groundwater or surface water.

ASS consist of two major categories:

- Acid Sulfate Soils (ASS) are soils that have been exposed to air which has caused the oxidation of iron sulfides to form sulfuric acid. Some of this acid is commonly neutralised by other soil particles in a process known as buffering, however the excess acid is spread by water movement through the soil; and
- Potential Acid Sulfate Soils (PASS) are soils which contain iron sulfides, but which have not been exposed to air and oxidised. These soils are generally kept from contact with air by permanent waterlogging or the density of the soil profile and so are relatively stable, or in equilibrium. In this state the soils are generally non-acidic and are considered harmless to the environment. However, oxidation of such soils through disturbance has the potential to generate acidic conditions.

Commonly, an ASS profile will consist of a combination of both ASS and PASS material as a result of ongoing chemical reactions in response to environmental changes including groundwater fluctuations and seasonal soil moisture changes.

The following types of site activities are likely to result in disturbance of ASS (both ASS and PASS) during urban development activities:

- Bulk excavation works which encounter subsurface soil which may be completed to achieve basement levels, installation of drainage infrastructure, alteration of existing site levels to achieve modified ground levels, dredging or otherwise mobilisation such that the sediment may become oxidised, etc.;
- Dewatering activities associated with construction works proposed at elevations below the standing water table, for example installation of drainage infrastructure, etc. which may result in ASS beyond the excavation extent becoming exposed to oxygen due to a lowering of groundwater levels, thereby generating acidic conditions; and
- Generation of spoil which may return ASS to the ground surface associated with foundation construction works, including piling spoil during CFA or bored pile installation activities, directional drilling works for infrastructure services installation, etc.

2.2 Laboratory Assessment Criteria

The assessment of site soil conditions with respect to ASS occurrence is completed in accordance with the guidance provided in ASSMAC (1998). The requirement to manage soils for ASS is evaluated by comparison of laboratory analysis results with Site Action Criteria (SAC) developed based on three broad soil texture categories. The SAC are based on the percentage of oxidisable sulfur or equivalent acid trail (i.e. titratable actual acidity-TAA or titratable potential acidity-TPA) results. There are two categories based on the scale of the proposed disturbance, with the SAC for small scale (i.e. less than 1000 tonnes) works based upon the texture of the soil material and the SAC for large scale works adopting the most sensitive SAC being the SAC for coarse textured soils in small scale works.

Table 2.1: ASSMAC Site Action Criteria based on General Soil Texture Categories

Type of material		Action Criteria 1-1000 tonnes disturbed		Action Criteria if more than 1000 tonnes disturbed	
Texture Range. McDonald at al. (1990)	Approx. clay content (%<0.002 mm)	Sulfur trail % S oxidisable (oven-dry basis) e.g. S_{Cr} or S_{pos}	Acid trail Mol H^+ /tonne (oven-dry basis) e.g., TPA or TSA	Sulfur Trail % S oxidisable (oven-dry basis) e.g. S_{Cr} or S_{pos}	Acid trail Mol H^+ /tonne (oven-dry basis) e.g., TPA or TSA
Coarse Texture Sands to loamy sands	≤5	0.03	18	0.03	18
Medium texture Sandy loams to light clay	5-40	0.06	36	0.03	18
Fine texture Medium to Heavy clays and silty clays	≥40	0.1	62	0.03	18

Exceedance of the SAC attributable to ASS material generally triggers the need to prepare a management plan and is based on the percentage of oxidisable sulfur (or equivalent TPA, TAA) for broad categories of soil. However, it is noted that other soil properties and constituents may cause acidic conditions in soils that are not related to acid sulfate soil conditions. This may include sources of organic acidity where the soils have a pH of less than 5 and positive titratable actual acidity (TAA) or titratable potential acidity (TPA) but have no detectable sulfur source (i.e. no S%). In this case, exceedance of the Acid Trail SAC does not trigger treatment of these soils (DWAR 2018e[4]).

Given the nature of the works to be undertaken at the site (expected to result in >1000 tonnes of materials disturbed) and with consideration to the variability of the soils types noted in previous investigations, the SAC adopted for assessment and management of ASS at this site are:

- Sulfur Trail Criteria (S_{pos} or S_{Cr} %) > 0.03 %;
- Acid Trail Criteria (TSA, TPA) > 18 mol H^+ / tonne soil.

2.3 Other Regulatory Guidance

Section 105 of the *Contaminated Land Management Act 1997* (CLM Act) allows the Environment Protection Authority (EPA) to "make or approve" guidelines for any purpose related to the objects of the Act. In addition to ASSMAC (1998), this management plan has been prepared with reference to the following:

- *Waste Classification Guidelines Part 1: Classifying Waste* (EPA 2014a);
- *Waste Classification Guidelines Part 4: Acid Sulfate Soils* (EPA 2014b);
- *Contaminated Sites: Guidelines for NSW Site Auditor Scheme*, 3rd Edition, EPA (2017); and
- *Protection of the Environment Operations Act* 1997 (POEO Act) and associated regulations.

Note is also made of the National Acid Sulfate Soil Guidance issued in June 2018 by the Australian Government Department of Agriculture and Water Resources (DAWR), including:

[4] *Guideline for the Dredging of Acid Sulfate Soil Sediments and Associated Dredge Spoil Management, Australian Government Department of Agriculture and Water Resources, June 2018 (DAWR 2018e)*

- *National Acid Sulfate Soil Guidance: A Synthesis* (DAWR 2018a);
- *National Strategy for the Management of Coastal Acid Sulfate Soils* (DAWR 2018b);
- *National Acid Sulfate Soils Sampling and Identification Methods Manual (DAWR 2018c);*
- *National Acid Sulfate Soils Sampling and Laboratory Methods Manual (DAWR 2018c);*
- *Guidance for the Dewatering of Acid Sulfate Soils in Shallow Groundwater Environments* (DAWR 2018d); and
- *Guideline for the Dredging of Acid Sulfate Soil Sediments and Associated Dredge Spoil Management (DAWR 2018e).*

3. Site Condition

3.1 Site Identification

The site location is shown in **Figure 1**, and current site layout is shown in **Figure 2**. The site details are summarised in **Table 3.1** and described in the following sections.

Table 3.1 Summary Site Details

Lot / DP	Lots 3-5 in DP 1064339 Part Lot 107 in DP1076596 Part Lot 1 in DP835794
Address	1A to 1C Bridge Road, Glebe NSW and part 56-60 Pyrmont Bridge Road, Pyrmont NSW
Local Government Authority	City of Sydney Council
Approximate MGA Coordinates (MGA 56)	Easting: 332669.678 Northing: 6250259.919
Site Zoning	Ports and Employment under State Environmental Planning Policy (SEPP) No. 26 – City West and Maritime Waters under Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005
Current Use	Various industrial and commercial uses (concrete batching plant and commercial boat hire operations).
Proposed Use	Commercial use (fish market)
Site Area	Approximately 3.7 Ha

3.2 Site Condition

A detailed site description and environmental setting is provided in JBS&G (2019a). At the time of preparing this ASSMP, the site was still operational as a concrete batching plant and commercial boat hire business as described previously. It has been assumed that all site structures will be demolished in accordance with provisions detailed in a Hazardous Building Material Survey (HMBS) understood to have been completed on site structures prior to any remediation/development works.

3.3 Geology and Soils

Jacobs (2014) reported that review of existing geotechnical maps indicate that the area of the site is underlain by a significant depth (>3 m) of fill material, as consistent with historical reclamation of the area from Blackwattle Bay. This is consistent with Wentworth Park as located further south of the site. Hawkesbury Sandstone was anticipated under site filling.

JK (2017a) reported that the 1:100,000 Geological Map of Sydney indicated the site to be underlain by man-made fill and estuarine soils overlying Hawkesbury Sandstone of the Wianamatta Group. The Hawkesbury Sandstone comprises medium to coarse grained quartz sandstone with very minor shale and laminite lenses. It was further noted that at least two dykes were believed to extend through the site in a rough north-west to south-east alignment.

Boreholes in Blackwattle Bay undertaken for JK (2017a) disclosed a subsurface profile generally comprising natural clay and sandy clay sediment/soils of medium to high plasticity and clayey sand sediment/soil overlying sandstone bedrock. In the bay, the boreholes typically encountered no fill from the seabed level, except the boreholes close to the existing shoreline where fill extending up to 4.7m depth was encountered. There generally appeared to be a fill layer close to the southern shoreline. The fill sediments were reported to comprise a clayey sand and silty clay with trace amounts of fine to medium grained sand and coal and plastic fragments. Boreholes in the adjoining Wentworth Park identified fill comprising silty sand or sandy clay containing varying amounts of inclusions such as sandstone and igneous gravel, also timber, tile, ceramic, glass, shell, concrete and brick fragments, slag and ash.

Natural soils/sediments were encountered either from seabed level or about 0.5m depth in the Bay comprised interbedded layers of silty clay, sandy clay and clayey sand soils. The predominantly clay samples were assessed as having moisture content greater than their plastic limits and based upon hand penetrometer tests completed on the samples, ranged in strength from very soft to very stiff. The clays were assessed as generally being of medium to high plasticity, although more sandy clays were generally of low to medium plasticity. The predominantly sandy samples were assessed as wet and ranged from very loose to dense relative density. The natural soils contained varying amounts of fine to coarse grained gravel, shell fragments and other organic materials.

Sandstone bedrock was encountered underlying natural soils at depths ranging from approximately 5.5 - 13.4 m below ground surface (bgs) being -9.1 to -18.5 m AHD.

3.4 Acid Sulfate Soils

Review of the Acid Sulfate Soil (ASS) Risk Map for Prospect/Parramatta (DLWC 1997) indicates that the subject site is located within an area of 'high probability' of acid sulfate soils within bottom sediments. In such areas, there is the potential for severe environmental risk if bottom sediments are disturbed by activities such as dredging. The high probability classification covers the whole site footprint as shown in **Figure 3**.

PB (2009) noted potential indicators of ASS comprising odorous marine sediments with sea shells in boreholes located in the southern portion of the site (overlying the land portion of the site) and within marine sediments in Blackwattle Bay. Similar observations were reported in JBS&G (2015) and EIS (2017), however no samples were analysed at a laboratory to confirm the nature of acid generation potential. As documented in JBS&G (2015), marine sediments underlying the bay and underlying fill material behind sea walls bordering Blackwattle Bay have previously been identified via laboratory characterisation as PASS.

3.5 Topography and Hydrology

The site is situated on predominantly flat terrain associated with reclamation of the former extent of Blackwattle Bay underlying Bridge Road and Wentworth Park further to the south-east of the site. These areas were reclaimed during the period between 1836 and 1891. Review of topographic information obtained from regional topographic maps available on NearMap spatial information database indicated that southern portion of the site that has been subject to land reclamation and has an elevation of approximately 2 m Australian Height Datum (AHD), retained by a sandstone block and in parts concrete block retaining wall. The northern portion of the current site improvements comprise a concrete deck wharf structure overlying hardwood girders, or alternatively, a concrete pavement supported on timber beams and turpentine piles.

Site surface water is anticipated to drain directly into Blackwattle Bay.

3.6 Hydrogeology

A review of the registered bore information (NSW DPI 2017[5]) indicated that there are 14 registered bores within a 500 m radius of the site. The closest wells (approximately 250 m south-west of site) were constructed for monitoring purposes and were reported to contain a standing water level of approximately 0.6 m within shallow fill materials.

Groundwater monitoring as undertaken within the extent of the site as part of previous investigation and has identified:

- Site groundwater to have reported total dissolved solids (TDS) concentrations consistent with saline waters; and
- Standing water levels correspond with tidal surface water levels of Blackwattle Bay in which site groundwater is anticipated to discharge.

[5] NSW Department of Primary Industries, 2015. Groundwater Monitoring Overview Map. Http://allwaterdata.water.nsw.gov.au/water.stm. Accessed 13 February 2018

4. Extent of Acid Sulfate Soils

Previous investigations noted potential indicators of ASS comprising odorous marine sediments with sea shells in boreholes located in the southern portion of the site (overlying the land portion of the site) and within marine sediments in Blackwattle Bay. Based on the physical observations of sediment character and previous broader information on PASS conditions around the Bay, for the purposes of this ASSMP, all marine sediments have been characterised as PASS material. Such conditions extend beyond the site boundaries in all directions.

Within the land portion of the site, the potential ASS materials were encountered within saturated marine sediments underlying the placed fill material at depths ranging from approximately 3.5-5.5 m below ground surface (bgs).

During previous site investigation activities, no obvious visual/olfactory potential indicators of ASS were noted on the borehole logs within the overlying fill material. However, it is noted that to date there has only been a limited number of boreholes completed within this portion of the site. It is further noted that the fill used for land reclamation in this portion of the site may have been sourced from alluvial/marine sediments in Blackwattle Bay or adjoining areas and therefore this material has the potential to also comprise potential ASS.

As such, for the purposes of this ASSMP, it is considered that all ground disturbance activities will require consideration of ASS management requirements. Further site assessment (field and/or laboratory based testing) is required to be undertaken prior to, and also potentially during development activities, as outlined in this ASSMP to confirm specific requirements for management of material types during the works such that the risk of acid generation is appropriately managed. As discussed within the RAP (JBS&G 2018b), it is anticipated that additional characterisation of soil and sediment will be undertaken prior to commencement of works at the site for both contamination and acid sulfate soil management objectives.

In addition, given that the marine sediments within the bay portion of the site are expected to also be representative of ASS, any works that result in their significant disturbance, including excavation, dewatering and/or mobilisation (sediment resuspension) into the overlying water column, will require specific consideration of ASS management requirements.

5. Management Procedures

The aim of the following management procedures is to identify ASS/PASS material and implement appropriate mitigation measures such that the potential environmental impacts associated with disturbance of ASS/PASS during the proposed site remediation and construction works may be appropriately managed. Specifically, the objectives are to provide:

- A methodology for the identification of materials requiring management;
- Protocols for the on-site treatment and management of ASS/PASS materials and associated leachate water (as required) during the proposed works;
- Excavation inspection and validation assessment protocols to be implemented during the proposed works such that the extent of ASS/PASS material may be delineated from non-ASS material (overlying non-ASS material, residual soils, etc) to provide for off-site disposal of the balance of excavated material without the need for lime stabilisation);
- Water and soil quality targets for the excavation, treatment and removal of material encountered during the proposed works; and
- A contingency framework in the event that additional ASS conditions are encountered during the site works; monitoring indicates disturbance of off-site ASS materials; or the proposed treatment strategy fails.

5.1 Scope of Soil /Sediment Disturbance Activities

The proposed development works will include removal of the existing site infrastructure, installation of a coffer dam at the southern end of Blackwattle Bay and then installation of new piled footings for the above water site portion, excavation/installation of footings, fixtures, foundations and retaining walls on the land portion, all of which may require the excavation of fill material, natural soils and sediments from below the water table. In a small area of the site, sediment relocation activities will be required to ensure maintenance of a stormwater culvert operation, in addition to removal of a portion of the existing rock revetment along the sea wall for construction of the new basement. In addition, the installation of underground services will require trenching within fill materials and potentially natural soils/sediments within the land portion of the site. On this basis, there is the potential for the disturbance of ASS material during development works.

It is anticipated that once development consent has been obtained for the proposed new Sydney Fish Market, the detailed design phase will commence. These processes will consider the nature and extent of ASS/PASS material in development of the proposed construction methodology and so the minimisation of activities with the potential to result in disturbance of ASS/PASS will form part of the evaluation strategy.

The final scope of ASS/PASS disturbance activities will be evaluated following detailed further characterisation of site conditions and also issue of the final for construction design and engineering drawings.

5.2 Investigation of Occurrence of ASS and/or PASS Material

Historically, only limited field and laboratory assessment of PASS conditions has been completed within soils/sediment at or in the vicinity of the site. Further investigation of the location and extent of ASS/PASS material within the site should therefore be undertaken either prior to the commencement of ground disturbance activities and/or sequentially as areas of disturbance extend across the site such that material requiring management may be identified and treatment requirements established as separate to non-ASS material.

To evaluate the potential presence and extent of ASS/PASS material, the following assessment activities should be undertaken by an appropriately qualified environmental consultant in accordance with the general philosophies outlined in ASSMP (1998)/ DAWR (2018) with regard to the identification of ASS/PASS material:

- Sampling locations should be completed at an even grid spacing of no greater than 20 m in areas of anticipated ground disturbance to provide for assessment of the variability of ASS/PASS conditions. In transitional zones between areas of likely disturbance and those of no disturbance, sufficient sampling should be completed to ensure management requirements may be suitably understood prior to commencement of works. Each sampling location should be extended to confirm the presence of bedrock, or to a maximum of 1 m below the proposed level of disturbance (whichever is less);
- Visual inspection and sampling of representative soil profiles of damp to saturated soil/sediment at a frequency of no less than one sample per 1 m per metre depth interval, or discrete strata, at each sampling location. Each sample should be the subject of field pH_f and pH_{fox} tests;
- Based on the inspection and field testing results, no less than one sample per 1 metre per material type per area/material type should subsequently be selected for sPOCAS or chromium reducible sulfur (S_{Cr}) laboratory analysis to confirm the presence/absence of ASS/PASS material requiring management;
- Based upon the results of the field and laboratory analysis program, an updated inferred plan of the lateral and vertical extent of ASS/PASS requiring management will be provided to the Principal Contractor. In addition, the laboratory data will be used to identify anticipated liming requirements for ASS/PASS material types at the site (where appropriate); and
- The results of the assessment will provide a line of evidence for the validation of material beyond the ASS/PASS zone (if identified) for characterisation of the balance of surrounding/overlying soils as non-ASS material.

5.3 Evaluation of Potential Management Strategies

Where the presence of ASS/PASS has been identified, evaluation of options to minimise the level of disturbance and to mitigate the potential impact of disturbance (if necessary) of the materials is required. As per ASSMP (1998)/DAWR (2018), potential mitigation approaches have been identified:

- Avoid ASS materials being encountered during works by not undertaking the proposed development works or by altering the proposed development plans, i.e. removing excavation and/or dewatering requirements, use of non-intrusive/less intrusive trenching, pile installation, etc methods;
- Where encountering ASS/PASS during works cannot be avoided, manage the potential for acid generation by neutralising disturbed materials, preventing movement of acid impacted water, and the use of suitable construction materials;
- If ASS/PASS materials have previously been disturbed, undertake works to mitigate the existing conditions, minimise the production of further acid during the proposed works and rehabilitate impacted areas;
- Treat soil by allowing full oxidation of the sulfide component under controlled conditions followed by flushing the acid from the soil with water and neutralisation of the subsequent leachate;
- Avoid using untreated ASS/PASS materials as fill material in non-ASS areas by either leaving material on-site, or managing the potential for acid generation prior to material being transported from the site of origin; and/or

- Reburial of ASS/PASS materials beneath the permanent water table or beneath a dense soil profile which excludes oxygen exposure such as an engineered clay cap. This may be undertaken on-site if there are low lying areas where reburial and consequential flooding of the soil profile or construction of a suitable capping layer can be undertaken as part of development works, or at an alternative off-site location provided that sufficient stabilisation of material is undertaken to minimise acid generation during transportation and handling.

The potential suitability of the various options is further discussed in the following sections.

5.3.1 Avoidance Strategies

Avoidance of ASS/PASS disturbance is generally considered to be the preferred means of ASS/PASS risk management where such actions can be achieved. However, given the extent of the development footprint associated with foundations, fixtures, footings and requirements to maintain operation of the existing culvert infrastructure, the use of avoidance as a large scale risk management strategy is not a suitable option.

However, with regard to disturbance of sediment within the water portion of the site, wherever possible measures will be undertaken to minimise the risk of oxidation of the sediments underlying the water column. Where construction works are required that may result in disturbance of bay sediment surface or near-surface sediments, management procedures will be implemented to minimise the lateral scale and depth of sediment mobilisation/disturbance.

5.3.2 Management by Neutralisation

Neutralisation techniques can be used to treat ASS by the addition of chemicals that react with the produced acid to ensure that acid is not released from the treated material. The neutralisation activities should result in the pH of the disturbed materials (water, sediment and/or soil) being between 5.5 to 7.5 and requires that ASS material disturbed during site activities be treated with the preferred neutralising agent.

Laboratory analysis is used to assess the levels of existing and/or actual acidity and indicates the level of neutralising capacity required to react with all potential acidity that may be generated during/following disturbance of the ASS material.

The potential uncertainty associated with the quantity of neutralising capacity to be added is commonly managed by the use of a factor of safety of 1.2 or 2 depending upon the level of uncertainty.

Sufficient capacity in terms of a suitable treatment area, machinery, budget to purchase the neutralising agent and time is necessary to successfully implement ASS neutralisation. Implementation of environmental controls is also necessary to ensure that all potentially acidic leachate produced during the treatment process is captured and adequately treated and that heavy metals which may be released during oxidation of ASS material are also appropriately managed.

An evaluation of potential neutralisation chemicals should be undertaken during the planning process and appropriate quantities of the preferred chemicals sourced for the duration of the site activities.

For the purposes of this plan, the neutralising chemical is assumed to be high quality agricultural lime (aglime). The aglime should be fine ground (<1mm) calcium carbonate ($CaCO_3$) or calcite (limestone or marble powder). In the event that neutralising products other than high quality aglime are selected for use in this project, there are several issues that should be considered:

- Is there any potential environmental risk associated with use of the compounds (i.e. other components that may contaminate water, result in a much higher pH value (i.e. hydrated lime), stain treatment areas, etc.);

- Will the neutralising agent be of comparable effectiveness or will properties including: neutralising value, effective neutralising capacity, solubility, pH, chemical components, moisture content, impurities and particle size; require the quantity of agent addition to be varied by a consistent factor.

It is recommended that small scale treatment trials be implemented prior to broad scale implementation of alternative neutralising compounds. The small scale trials should document the effectiveness of the revised approach in terms of the time, cost, availability, suitability, etc. Consideration will also be required as to the feasibility of dewatering material and associated management of separated water and solids. Alternatively, consideration may be given to disposal of all material as liquid waste (as per EPA 2014 requirements).

During works, a sufficient supply of agricultural lime (aglime) will be required to be kept on site at all times. The quantity is based on requirements for the treatment of ASS to be neutralised within the treatment area; for application on exposed excavation faces where ASS is expected or suspected; and for wet weather events where existing applications will require replacement and/or treatment of acidic water is necessary. Receipts, dockets and other field records showing the storage locations of all chemicals and location of all applications of neutralising agents must be kept.

ASS management by neutralisation is considered to be a suitable option for the proposed works associated with the land based portion of the site and where sediments are generated at the ground/water surface (rather than at the bay sediment bed level) as:

- Material disturbed to achieve installation of services trenches, foundations or similar within the land based portion of the site will subsequently be surplus to development requirements, and as such neutralisation of the material following excavation will not affect the installation program (material may be set aside for treatment by others, whilst installation works continue, following which the material will be disposed of off-site);
- The majority of the piling works (and therefore the majority of spoil requiring treatment) is to be undertaken within the waterborne portion of the site and so this will provide an opportunity to treat the materials on the land portion of the site;
- Via staging of the excavation works, a contractor will be able to ensure sufficient space can be made available within the site to set aside a treatment area(s) close to the identified ASS disturbance which can be hydraulically isolated from the remainder of the site;
- The proposed works are able to be staged in a manner which will allow treatment of ASS material in a timely manner;
- Appropriate machinery to mix the soil and neutralisation chemicals can be supplied by the civil works/earthworks contractors completing works on site; and
- Following successful completion of the neutralisation process, the treated soils/sediments are no longer considered to be ASS materials and so may be removed off-site as waste.

5.3.3 Full Oxidation and Leachate Collection

In the event that the acid production potential is relatively low, or there is a relatively low quantity of material to be treated, consideration may be given to the excavation and exposure of the soils to promote full oxidation. This option requires the implementation of environmental controls to ensure that all acid produced is flushed from the soil as leachate. Similar to management by neutralisation, a suitable treatment area is necessary where material can be spread and reworked to allow oxygen to react with the sulfides in the soil and where all leachate produced can be captured and treated by neutralisation.

This method is considered not to be a viable option for the proposed works as the process of soil oxidation may take extended periods (weeks to months) to reach completion. There is also a significant level of uncertainty in the volumes of leachate that would require neutralisation and disposal due to climatic variation, including rainfall events. Given the currently unknown anticipated volume of material requiring treatment, the requirement to maintain environmental controls for this period and the potential for such works to extent the civil works program, this option is considered undesirable when compared to the relatively low cost of neutralisation chemicals as discussed in **Section 5.3.2** above.

5.3.4 Reburial of ASS Material

Strategic reburial or interment techniques can be used to manage PASS material by prevention of oxidation through permanent storage in an anoxic environment. These techniques are often adopted where areas are available for reburial and cost savings can be achieved by avoiding soil handling labour and neutralisation chemical costs. An alternative method of achieving reburial is over excavation of non-acid sulfate soil materials followed by reinstatement of the excavation with potential ASS material. Potential reburial sites must have a permanent groundwater table level above the proposed top of the reburial cell or alternatively measures to minimise oxygen exposure to ensure that the material is returned to an anoxic environment.

Reburial may occur within the site or alternatively, where appropriate licences are obtained, at a site lawfully able to accept this material in accordance with the requirements of EPA (2014).

Excavation of ASS and creation of re-interment voids must be staged to ensure that adequate space is available for all ASS materials to be adequately reburied below a permanent water table and that the ASS will not be buried in conditions that may cause the formation of acidic conditions. A maximum period of time between the commencement of disturbance and completion of interment works of approximately 48 hours should be adopted in all instances. If the material is to remain exposed for longer the 24 hours the pH levels should be monitored every 12 hours to ensure acid conditions are not developing.

On this site, given the number of excavations to accommodate foundations, footings and fixtures including significant piling works, strategic reburial of PASS material sourced from within the land portion of the site, or alternatively from piling spoil, without neutralisation is not considered a viable/recommended option.

However, adoption of these techniques is considered to potentially be appropriate in addressing the requirement to adjust sediment levels to achieve required construction levels for the basement structure. Following construction of the coffer dam, management of works to adjust the sediment levels will be required to facilitate the continued operation of an existing stormwater culvert to the rear of the basement as shown in **Figure 4**. The works will be conducted within controlled areas of identified need using methods that will minimise the mobilisation of sediment into the water column. It is anticipated that this will comprise use of a long arm excavator, clam shell apparatus or similar, to carefully excavate and then place saturated material within a silt curtain rimmed zone so as to minimise oxygen exposure to the sediments and avoid the generation of acidic soil/water conditions. Subsequent to further characterisation of sediment conditions in this area of the site and detailed design of the development, consideration will be given as to whether the placed sediments should also be capped in-situ as part of the relocation works following placement beneath the proposed basement footprint beyond the culvert zone.

5.3.5 Separation Techniques

Separation techniques are increasingly being implemented to reduce the quantity of PASS material requiring treatment in areas where works include the disturbance of large quantities of PASS. These activities include the removal of fine ASS particles including pyrite and monosulfides from coarser grained soil particles. This results in two material streams, concentrated 'ASS fines' and non-ASS material which can be removed from the management process. Management of ASS fines would then involve implementation of other ASS management techniques such as reburial, neutralisation, etc.

Separation is typically implemented by creating a soil slurry where fine particles can be suspended in solution away from heavier soil particles using methods such as sluicing or cycloning. Typically, such methods require suitably grained soils such as sand or non-consolidated sediments and a significant water source to implement the separation.

Environmental controls are required during the separation processes to ensure that the PASS fines do not undergo oxidation prior to the implementation of other management measures and validation of the non-ASS stream would then be necessary to confirm that the ASS fines have been adequately removed.

On this site, separation techniques are considered not to be a viable management option as it is anticipated that the majority of the material requiring management will result from piling spoil which would be significantly homogenised.

5.3.6 Selection of Preferred Management Strategies

Evaluation of potential management strategies has identified the use of neutralisation techniques, where disturbance cannot be avoided (as discussed in **Section 5.4** following) as the most appropriate technique for management of disturbed soil and sediment across the majority of this site. Where adjustment of the sediment bed level will be required (primarily expected in the south section of the proposed basement footprint as shown in **Figure 4**), management will be via implementation of measures as discussed in **Section 5.5** that avoid the oxidation of the saturated sediment in addition to the potential for re-burial of disturbed material such that there is no risk of occurrence of acid generation.

Management measures for excavated ASS/PASS material will include the application of neutralisation chemicals, neutralisation of exposed excavation faces during staged treatment works and neutralisation of groundwater seepage and drainage leachate produced during the excavation and treatment works. Following validation to confirm the acid generation potential of the material has been appropriately neutralised, the material will either be set aside for use as engineered fill material within the site, or alternatively, will require off-site disposal in accordance with the requirements of EPA (2014).

5.4 General Site Management Strategy

The site management strategy to be implemented during works which may disturb ASS/PASS materials as identified via works described in **Section 5.2** (other than the sediment bed disturbance/adjustment activities) will ensure the following:

- Adequate treatment of ASS/PASS material such that there is sufficient acid neutralizing capacity and no net acidity following stabilization (as measured through appropriate field testing and laboratory validation);
- Water discharged from the excavation and treatment areas (including run-off, water from dewatering and leachate) is neutral and discharged to stormwater once it has been shown to meet with the criteria specified in this plan, shall be reused on site, or alternatively reused on site for dust suppression;
- Surface/groundwater quality indicators and levels are not significantly changed beyond the construction footprint from the existing levels/quality during excavation activities and are re-established after the completion of construction works; and

- Implementation of additional assessment procedures during earthworks operations for the effective treatment and management of any drained, disturbed or excavated acid sulfate soils.

5.4.1 Pre-disturbance Works

Subsequent to the additional investigation activities as identified in **Section 5.2**, and prior to the commencement of any ground disturbance works which may disturb ASS/PASS materials at the site, including demolition and piling activities with the potential to disturb sediments and/or generate spoil, the following preparations should be implemented:

- The sequencing of proposed demolition, sediment bed disturbance activities, piling, excavation, services installation and other activities should be planned in detail taking into account the time and space necessary to complete the ASS/PASS management activities outlined in this document. The planning should provide a contingency for treatment of additional quantities of materials in the event that requirements for the disturbance of additional ASS/PASS material is identified following the commencement of site works, or heavy rainfall/storm/tide events result in significant additional quantities of collected impacted water; and
- The actual areas of ASS/PASS occurrence where disturbance/excavation will occur during each stage of works (piling, excavation, services installation, etc.) as part of the site activities should be identified and suitable location(s) for treatment areas close to the areas of disturbance identified. Based on the proposed works, the available space for treatment and the approximate volume anticipated to be disturbed, staging of the disturbance activities should then be planned such that sufficient drying and mixing time can be achieved for all materials needing treatment. The staging should also allow for adequate time to obtain the results of verification testing before the material is placed at the final location or removed from the site.

5.4.2 Neutralisation Chemicals

An evaluation of potential neutralisation chemicals should be undertaken during the planning process and appropriate quantities of the preferred chemicals sourced for the duration of the site activities. For the purposes of this plan, the neutralising chemical is assumed to be high quality agricultural lime (aglime). The aglime should be fine ground (<1 mm) calcium carbonate ($CaCO_3$) or calcite (limestone or marble powder). In the event that neutralising products other than high quality aglime are selected for use in this project, there are several issues that should be considered:

- Is there any potential environmental risk associated with use of the compounds (i.e. other components that may contaminate water, result in a much higher pH value (i.e. hydrated lime), stain treatment areas, etc); and
- Will the neutralising agent be of comparable effectiveness or will properties including: neutralising value, effective neutralising capacity, solubility, pH, chemical components, moisture content, impurities and particle size; require the quantity of agent addition to be varied by a consistent factor.

It is recommended that a small scale treatment trial be implemented at the commencement of site works prior to broad scale implementation of alternative neutralising compounds. The small scale trials should document the effectiveness of the revised approach in terms of the time, cost, availability, suitability, etc.

5.4.3 Treatment Area Design

As noted above, the treatment area should be situated in an appropriate location(s) with respect to site disturbance activities. In addition, consideration should also be given to the ease with which environmental controls can be implemented and potential requirement for off-site disposal of the material once stabilised and validated.

Small Quantities

For small scale disturbance activities, it is anticipated that a large lined skip bin or suitable structure could be used as a 'treatment cell' to minimise the potential for release of acidic leachate or partially treated soil.

Significant Excavation Quantities

Should quantities of material disturbed in a staged manner exceed that able to be managed in a large skip bin, a treatment area should be established with consideration of the following:

- The treatment area should be established separate to the area of disturbance but able to be accessed from the area of disturbance by plant/vehicles transporting the material to be treated and material to be removed from the treatment area at the completion of stabilisation activities;
- The treatment areas should be sufficiently large to facilitate a pre-treatment stockpile area, a treatment pad, water/sediment collection and treatment measures, post treatment stockpile storage area and lime storage area.
- The treatment area should be isolated from major external surface water catchments, including overland surface water flow and potential flood water, excavation flooding by rainfall events, by ground surface contouring, installation of perimeter drains or bunds covered with an impervious layer (concrete, geomembrane, compacted non-ASS clay, etc.).
- Infiltration of surface water (rain or drainage) through the ASS to groundwater or Blackwattle Bay surface waters within the treatment area should also be prevented to the extent possible. A layer of lime stabilised soil should be prepared on the ground surface within the treatment area that will act to neutralise any acidic water that my infiltrate the ground surface during treatment activities. The minimum application should be no less than 5 kg lime/m^2 of treatment area. This application should not be taken into account when material to be treated is placed within the treatment area as the neutralisation capacity of these added chemicals will decrease with time as a result of insoluble iron coating generation and it is difficult to ensure that there has been adequate mixing of the neutralising agent within the soil added to the site.
- Pre-treatment and post-treatment stockpile areas should be separately bunded or drained to minimise the potential for re-acidification of treated material.
- The treatment pad should be of a size that would allow treatment of material by a single machine over a reasonable timeframe to minimise the oxidation of material during spreading and treatment. Assuming the material the subject of treatment is spread to a depth of approximately 0.3 m, a single treatment area 10 m by 20 m could treat 60 m^3 of material per treatment cycle. Should capacity to treat more material be required, two or three treatment pads could be established, separated by a suitable width to allow for excavator movement between the bunds of each pad.
- The bund surrounding each treatment pad may be constructed of concrete, compacted non-ASS clay, sand and lime filled sandbags or other suitable materials that are relatively impervious and can be coated with a guard layer of lime to neutralise acidic leachate that may contact the bund.
- The base of the treatment pad should be surfaced with concrete, asphaltic concrete, or soil mixed with lime as discussed above. This base should be graded where possible at a

minimum fall of 1° to facilitate drainage of leachate such that it can be collected and/or pumped to a treatment/holding tank.

- Once well mixed with a suitable quantity of neutralisation agent, the material should be transferred to the post treatment stockpile area. Here the validation testing will be completed and the material will remain until receipt of the validation results. The material will then be cleared for beneficial reuse within the site, or alternatively for off-site disposal to landfill.
- Surface water flows will be diverted around the treatment area where possible. Water falling within the various portions of the treatment area will be collected at appropriate locations and transferred either to a holding tank or artificial detention basin. The water quality will be monitored to ensure only water of suitable quality is discharged from the treatment area of the site. Dilution of water collected within the treatment area is not an acceptable method of treatment at this site. Contaminants resulting from oxidation of ASS should be collected, treated and/or managed on-site. Water discharges from the site must not have a significant impact on pH, buffering capacity, turbidity, colour or ionic composition of the receiving water body (stormwater, groundwater, sewer, etc) as per the requirements of the POEO Act (1997).
- A sufficient supply of aglime should be kept on site at all times for the treatment of ASS to be neutralised within the treatment area, for application on exposed excavation faces where ASS is expected or suspected; and for wet weather events where existing applications will require replacement and/or treatment of acidic water is necessary. Receipts, dockets and other field records showing the storage locations of all chemicals and location of all applications of neutralising agents must be kept.
- The supply shall be stored in a covered and bunded area to prevent accidental exposure to water and deterioration of the inherent neutralizing capacity. ASS treatment materials should be stored in a manner that minimise the exposure of the materials to wet or humid conditions. Such conditions may result in the clumping or surface crusting of particulate lime which can reduce the level of effectiveness in neutralising water or soil.

5.4.4 General Site Management

All natural soils/sediments within areas of ASS must be treated as ASS material until such a time as the material is demonstrated to be non-ASS material or treatment effectively reduces the risk associated with the material and validation results meet the relevant specifications.

ASS/PASS materials that have been excavated (or otherwise brought to the ground/water surface) should be immediately transferred to the treatment area or treated in-situ as soon as practicable to minimise the quantity of soil, sediment and/or water requiring treatment and the risk of environmental harm to the site and/or down-gradient receptors.

Bunding, diversion drains, contaminated water treatment/containment etc. may be used to contain surface water run-off from ASS storage and treatment areas. However, ASS materials must not be used in the construction of bunds and other diversion devices.

Equipment used in the treatment of ASS shall be washed with an alkaline solution at the completion of each work period to minimize corrosion of equipment.

5.4.5 Excavation Works

Excavation works should be undertaken in the following manner:

- Any material identified as non-ASS (as determined through additional investigations as detailed in **Section 5.2**) is to be removed from within the ASS zone footprint and treatment area as per the requirements of the site RAP;

- Natural sediments or materials identified as ASS, or suspected to comprise physical properties indicative of ASS should be assumed to be ASS unless demonstrated otherwise. All excavated natural sediment material brought to the ground/water surface should be transferred immediately to the treatment area;
- Works including disturbance of natural soils/sediments will be subject to field testing upon initial exposure of each natural soil horizon. Field testing will include pH_f and post peroxide pH_{fox}, with both required to meet the validation criteria of pH 6 to be considered non-ASS soil. Alternatively, dependent upon the scheduling of the excavation works, laboratory pre-testing of soils from this zone may be undertaken using sPOCAS or S_{Cr} methods. If either the field criteria or laboratory analysis results indicate the material is considered to be ASS, then the material will require treatment as discussed in the following section;
- At the completion of the day's activities, where excavation works result in the exposure of known or suspected ASS, a guard layer of fine aglime will be applied to the base of the excavation at a rate of 5 kg lime/m^2 of exposed soil. If the base of the excavation is to remain exposed for an extended period (i.e. more than three days) the lime coating should be checked and re-limed as necessary. Alternatively, the lime may be covered with a layer of compacted non-ASS material at least 0.3 m in thickness. It is noted that this will not be required during piling works in the waterborne area of the site;
- All cut batters/exposed faces potentially including ASS, (i.e. faces at the edge of excavation faces, etc), shall be coated with fine aglime at a rate of 5 kg/m^2 and the lime coating should be checked and re-limed as necessary on a daily basis during periods of dewatering, whilst the faces are temporarily exposed and/or following wet weather events.

5.4.6 Treatment of Excavated PASS Material

Treatment of ASS soils will comprise the addition of sufficient quantities of finely ground neutralising agent to treat all oxidisable S% and actual acidity and provide a factor of safety to compensate for potential impurities in the neutralising agent, non-homogenous mixing and limitations to the solubility of the neutralising agent. This will need to be determined on the basis of analysis data collected as per **Section 5.2**.

The excavated ASS material will be immediately transferred to the treatment area and placed either in a stockpile within the pre-treatment stockpile area or immediately on the treatment pad. Treatment of excavated material should occur within one day of excavation of the material.

If stockpiled, the material should be formed into a conical stockpile to minimise the exposure of the material to air. In the event of significant wet weather periods, the stockpiles should be covered with builder's plastic or similar to limit the infiltration of rainfall into the stockpiles.

If site conditions require the stockpiling of material for longer than 24 hours, the stockpiles should be treated with a guard layer of aglime of 5 kg lime/ m^2 per vertical metre of soil in the stockpile. This would result in a two metre high stockpile requiring an application of 10 kg lime/m^2 surface area. The stockpile should then be covered with an impervious surface (i.e. builder's plastic) that covers the top and sides of the stockpile to minimise drying by wind and sun and to prevent rainfall entering the stockpile.

Following placement within the treatment pad the material should be spread to a depth that will allow the material to be properly treated by thoroughly mixing neutralising agent through the soil. The actual depth of spreading will be somewhat dependent upon the soil type, the machinery used to mix the material and the form of the neutralising agent. However, the nominal spread depth should initially be no more than 0.3 m. Mixing of the lime and soil mixture may be undertaken by harrowing, rotary hoeing, using an excavator shaker bucket to blend the material, the use of a pug mill or similar equipment.

Care shall be taken to ensure that mixing occurs throughout the depth of the layer. The soil must be managed to achieve a consistency that will allow for thorough mixing of the soil and neutralising agent to ensure that the effective neutralisation occurs. This may require drying of the disturbed material (with associated management of any acidic leachate and other resulting contaminants), mechanical turning and breaking up of soil. Drying should not be undertaken during foreseeable wet weather events due to the increased risk of runoff flushing acid from the material and into uncontrolled areas.

Following mixing, aglime shall be spread at a rate of approximately 5 kg lime/m^2 around the toe of the treated soil, around a 1 m perimeter between the toe of the material and across the exposed face of the bund to neutralise any leachate released from the soil. Once the soil has sufficiently dried that no more leachate is being released, the material should be turned to ensure that all leachate is released from the treatment area.

If there is a likelihood that neutralisation treatment of particular soils encountered during works (i.e. heavy clays) will not be effective for the soil type/s, a small scale trial to demonstrate that the proposal is practical should be performed before larger scale disturbance of this soil type.

5.4.7 Water Management During Treatment

Surface drainage, marine water within the coffer dam and groundwater that comes into contact with ASS materials has the potential to become acidic and contaminated with heavy metals leached from the acidified soil. Sources of water may include ground surface drainage associated with rainfall, dewatering product produced during the excavation works, leachate produced during treatment of excavated soils, and groundwater inflow into open excavations.

In general, soil and water at the site is required to be managed under an earthworks Soil and Water Management Plan to be for the site prior to the commencement of site works. However, in addition to these requirements, water from within the treatment area will be required to be collected, assessed and if necessary treated prior to discharge from the site. Once pH, suspended sediment and contaminant concentrations are considered suitable for discharge from the site, the water may be used for dust suppression at the site and/or released to the site stormwater system.

Additional water holding tanks may be necessary in the vicinity of the treatment works zones to store collected water prior to treatment. The water holding capacity directly related to the acid sulfate soil excavation and treatment areas should be maintained at a minimum quantity associated with a 1 in 10 year rainfall event to ensure that sufficient capacity is available to store all potentially acidic water that may be generated during site works.

Water will be neutralised, where required by the addition of lime (or equivalent alkaline product) within a dedicated treatment tank or lined detention basin. Lime shall be added incrementally and thoroughly mixed within the treatment vessel. Approximate lime application rates based on initial pH are provided in **Table 5.1** below.

Table 5.1: Treatment of Acidic Dewater

Water pH	Agricultural Lime / 1000L Water
0.5	11.7kg
1.0	3.7kg
1.5	1.2kg
2.0	0.37kg
2.5	0.12kg
3.0	37g
3.5	12g
4.0	4g
4.5	1.2g

Water pH	Agricultural Lime / 1000L Water
5.0	0.37g
5.5	0.12g

Lime addition and mixing shall continue until the pH of the water is within the range of 6.5 – 8.5.

In the event water volumes greater than the capacity of the water treatment holding capacity are produced during the acid sulfate soil management activities, consideration should be given to off-site disposal of water via a licensed contractor or treatment of water using neutralisation chemical dosing within holding tanks prior to re-irrigation of open excavations once the pH of the water has been demonstrated to be suitable.

5.4.8 Validation of Treated PASS Material

Following the application and mixing of lime to the ASS at the treatment pad the material should be allowed to stand for a minimum of 48 hours prior to validation assessment. The spread soil should then be assessed to establish whether the following performance criteria have been achieved:

- The neutralising capacity of the treated soil must exceed the sum of the TAA and TPA of the soil, i.e. there is no net acidity in the soil as measured by sPOCAS / SCr < 0.03%S;
- Post neutralisation, the soil pH is greater than pH 5.5 (and preferably less than 9); and
- Excess neutralising potential should remain in the soil as all acid generation reactions may not be complete and so the soil may still have further capacity to generate acidity.

Validation testing using field tests to measure the soil/water pH shall be undertaken at a rate of ten samples per treatment batch (to a maximum quantity of 100 m^3, or a rate of 1 sample per 20 m^3). Field testing will include pH_f and post treatment peroxide pH_{fox}, with both required to meet the post neutralisation criteria noted above for all samples per treatment batch.

Confirmatory laboratory analysis (pH and sPOCAS / SCr) will be undertaken at a rate of one sample per treatment batch (to a maximum quantity of 100 m^3, or a rate of 1 sample per 100 m^3 for larger quantities). The samples obtained for laboratory analysis may be obtained by compositing three subsamples obtained from the treatment material to provide a broader indication of net acidity levels. All samples will be obtained from no less than 0.1 m below the stockpile surface at the time of sampling to ensure representative samples are obtained for field testing/laboratory analysis.

Samples should be obtained immediately following movement of the material from the treatment pad area to the post-treatment stockpile area of the treatment zone. Each stockpile should be identified with a unique identifier and its location logged with the laboratory validation sample identification so that laboratory results can then be matched to each stockpile within the post-treatment area. Following additional applications of neutralisation chemicals, a greater density of validation sampling is necessary to confirm the successful neutralisation.

In the presence of positive field validation tests, laboratory analysis of validation samples may be employed to determine the level of net acidity and confirm that the treatment has been successful, or provide an indication of the quantity of further aglime application necessary to neutralise the soil.

If negative field tests occur but the confirmatory laboratory analysis results indicate that there is still net acidity, a further application of aglime will be mixed with material to ensure additional neutralisation capacity, prior to further confirmatory analysis.

Following receipt and logging of the successful laboratory validation results, the stockpile may then be released for beneficial reuse of material at the site, or alternatively, for off-site disposal. In the event that the laboratory results indicate that the stockpile requires further treatment, the material should be returned to the treatment pad as a unique treatment batch and treated as required prior to re-sampling.

5.4.9 Site Condition Monitoring

It is anticipated that monitoring of conditions will be undertaken by both the site contractors and an independent appropriately qualified consultant to ensure that the appropriate environmental controls are in place and the treatment strategy is minimising the environmental risk associated with the ASS materials.

The following inspection/monitoring regime will be implemented during the site works period and documented as appropriate to demonstrate compliance with this ASSMP:

- Stockpiles of material within the treatment area and of treated material will be inspected daily by the site contractors with pH measurements of any retained leachate taken and recorded. In the event that leachate is significantly acidic (pH < 5.0), the stockpiled material will be returned to the pre-treatment area until the laboratory results are available and the quantity of required additional lime application is known;
- In the event that an on-site sump/detention basin is used to manage water ingress, surface water monitoring points will be sampled and field tested and the pH recorded every day by site contractors during active site activities and weekly during periods where no active ground works are being undertaken within the ASS area;
- All treated excavation faces to be retained for more than three days will be inspected on the third morning and lime reapplied as necessary each following morning;
- As part of broader environmental monitoring during construction works, surface waters within the construction works zone and within Blackwattle Bay beyond the works zone will be monitored on a daily basis for pH and turbidity with results compared to established site baseline conditions. These requirements will be defined within the contractor level CEMP prior to the commencement of works.

Regular inspection of all excavation and treatment areas will be undertaken to identify potential indications of PASS oxidation. These inspections should note:

- Unexplained scalding, corrosion or degradation of onsite steel equipment and concrete paved surfaces;
- Formation of the mineral jarosite or other acidic salts in exposed or excavated soils;
- Areas of surface water blue-green, blue-white in colour or extremely clarified indicating high concentrations of aluminium; and
- Rust coloured deposits on excavation faces, in drainage paths, on bunds, channels, etc indicating iron precipitates.
- Such inspections should also identify the presence of unusual odours, including strong organic or sulfurous smells (i.e. rotten egg gas).

5.4.10 Removal of Neutralised ASS Material from the Site

Only material confirmed to be below the criteria listed in **Section 5.4.8** will be considered as stabilised ASS material for potential reuse within or removal from the site. Once stabilised, the material will be provided a final waste classification as per the requirements of EPA (2014) for off-site disposal to a lawful facility. A final round of field pH testing should be undertaken prior to loading of the trucks to ensure that pH levels remain above 6. Should material continue to have a high moisture content, consideration may be given to off-site removal as liquid waste as per EPA (2014).

5.5 Sediment Adjustment Management Strategy

As noted above, disturbance of sediment within the water portion of the site will, where possible be minimised via implementation of design solutions prior to commencement of works on site. However, based on current sediment bed survey information, it is anticipated that some sediments in the southern portion of the building basement footprint may require adjustment to ensure maintenance of culvert infrastructure performance and removal of rock revetment to provide for the basement structure construction.

In this instance, disturbance of the ASS material is unlikely to be avoidable. As such, implementation of management measures are therefore required to address the acid generation potential of the material during the movement and placement. Given the sediments are currently permanently water logged as a result of their location, exposure of underlying sediments at depth during these works is not expected to result in significant oxidation of the underlying material that becomes the exposed face. As such, beyond minimising any mobilisation of newly exposed sediment into the water column, no specific actions are required in relation to this material. However, should further assessment of site conditions prior to, or during disturbance identify geochemical changes in the sediments upon this limited disturbance, consideration will be given to capping the newly disturbed material so as to preserve the anoxic environment.

For the material subject to movement to achieve construction objectives, the primary management techniques proposed will comprise the minimisation of disturbance to the extent practicable. Implementation of the coffer dam structure will eliminate the potential for ASS impacts beyond the site works extent as there will be no opportunity for mixing of on-site and off-site soil/sediment/water. Within the coffer dam, application of industry best practice measures including adoption of measured excavation procedures, management of overlying water level depths and use of dedicated double silt curtains, etc will be required to contain any disturbance activities that may cause acid generation. For areas where piling activities may result in localised re-suspension of sediments, dedicated silt curtains surrounding individual works areas will be adopted to minimise the spread of any suspended sediment and ensure its minimisation.

The methodology and associated management techniques will be refined with the appointed Principal Contractor (and where appropriate a specialist sub-contractor), however the following points will generally be employed:

- The sediments will require at all times to remain below the water's surface such that they are not the drained and/or exposed to the air;
- Sediments will be gently excavated using a long armed excavator or similar and gently placed at the adjusted location to minimise mobilisation of the sediment into the water column;
- Sediments will be moved discretely from the required location to the proposed placement location, rather than using progressive shovelling and spreading techniques across the sediment bed which will break down the existing sediment structure and introduce oxygenated water to previously buried sediments;
- Closely held sediment curtains will be employed to minimise the potential mobilisation of sediment into the water column;

Given the high buffering capacity of salt water within the Bay, such measures are considered sufficient to minimise the risk of acid generation during the adjustment works.

Continuous monitoring of water column turbidity and water pH will be undertaken during all adjustment activities to ensure measures are appropriate to achieve the required minimal generation of acidity.

6. Responsibilities

The selection of samples for environmental analysis as per **Section 5.2** shall be undertaken by a suitably qualified and experienced environmental consultant. Results of analysis shall be assessed and evaluated by a suitably qualified and experienced consultant.

Implementation of the physical treatment, material management and environmental controls portions of this ASSMP will be the responsibility of the site contractor engaged to complete remediation and/or construction earthworks within the site. The monitoring of conditions, unless otherwise specified in the monitoring sections will be the responsibility of a suitable qualified environmental consultant who will regularly inspect the site, the treatment area and treatment activities and implement the validation assessments to document compliance with this ASSMP.

The contractor should appoint a foreman or other responsible employee to undertake the appropriate monitoring activities as designated in this ASSMP. This person should be appropriately trained by the environmental consultant in all actions to be completed by the contractor. Where doubt arises concerning the results of the inspections or of field test validity, the environmental consultant should be contacted for verification of appropriate actions.

The contractor is not authorised to make any changes to this ASSMP or implement unapproved variations to the treatment and/or monitoring protocols outlined in this document unless explicit written approval is obtained from the environmental consultant prior to implementation of the changes.

Where ambiguity or conflicts in procedures arise, it is the contractor's responsibility to seek clarification on appropriate actions from the environmental consultant.

ASS mitigation measures should be documented as they apply to all individual works activities to be undertaken at the site. All persons responsible for the works activities should be made aware of their responsibilities in writing and suitable ASS management training should be provided to those persons to ensure that the responsibilities can be achieved.

Where contingency actions are necessary, or in the event that non-compliance with the ASSMP is identified by the contractor, the environmental consultant should be immediately informed in writing. The environmental consultant will then be obliged to provide a timely response documenting the necessary corrective actions.

7. Contingencies

In the event of unexpected events, including the failure of management measures as described in this ASSMP, the associated environmental risk will be managed by the evaluation and implementation of the contingency procedures and mitigation strategies.

7.1.1 Failure of Initial Acid Neutralisation Treatment

As described in **Section 5.4.8** following the treatment of materials within the treatment pad area, validation sampling will be completed to assess the success of the neutralisation process prior to removal of the material from the holding area. In the event that the validation testing indicates that neutralisation of the material is incomplete (i.e. pH<6 or S>0.03 %), a further application of lime and repeat of the treatment procedure will be undertaken prior to further validation assessment. If the proposed techniques fail, further consideration may be given to alternative management strategies as outlined in **Section 5.3**.

7.1.2 Significant Acidification of Surface Water

Monitoring of contained water conditions within the site will be undertaken prior to the commencement of site disturbance activities and during the period of disturbance as ASS conditions are identified as outlined in **Section 5.4.9**. Should the works identify the acidification of contained water not directly related to the treatment area, all works associated with the potential disturbance of ASS at the site shall cease.

Active exposure areas will require to be limed with a guard layer of at least 5 kg lime/m^2 exposed soil and all treatment areas will be checked to ensure that leachate and water migration is not occurring onto exposed soils or into surface water drainage channels at the site. If these activities identify a source of the increased acidity, remedial actions will be implemented to prevent the further occurrence of acidification at the site.

If these activities do not identify the source of the added acidity, or alternatively, if conditions are not corrected by the addition of lime, consideration may be required to the construction of a subsurface limestone treatment trench along the site boundary to neutralise groundwater prior to movement off-site. The design of such a barrier will be highly dependent upon the stage of the disturbance works at the site and extent of the acidic plume identified in this section of the site. Disturbance works within the ASS area should not recommence until the barrier has been installed to limit the generation of additional acidic groundwater.

8. Conclusions

While currently there is no data to identify the occurrence of ASS/PASS at the site, previous investigations have reported potential for ASS/PASS within natural soils at depth based on soil physical properties. In the event that the additional investigation works at the site as identified in this ASSMP identify the presence of PASS then this ASSMP provides a methodology to manage the risks associated with the proposed activities which when successfully implemented will minimise the environmental risks associated with disturbance of the ASS materials.

9. Limitations

This report has been prepared for use by the client who has commissioned the works in accordance with the project brief only, and has been based in part on information obtained from the client and other parties.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS&G, and should not be relied upon by other parties, who should make their own enquires.

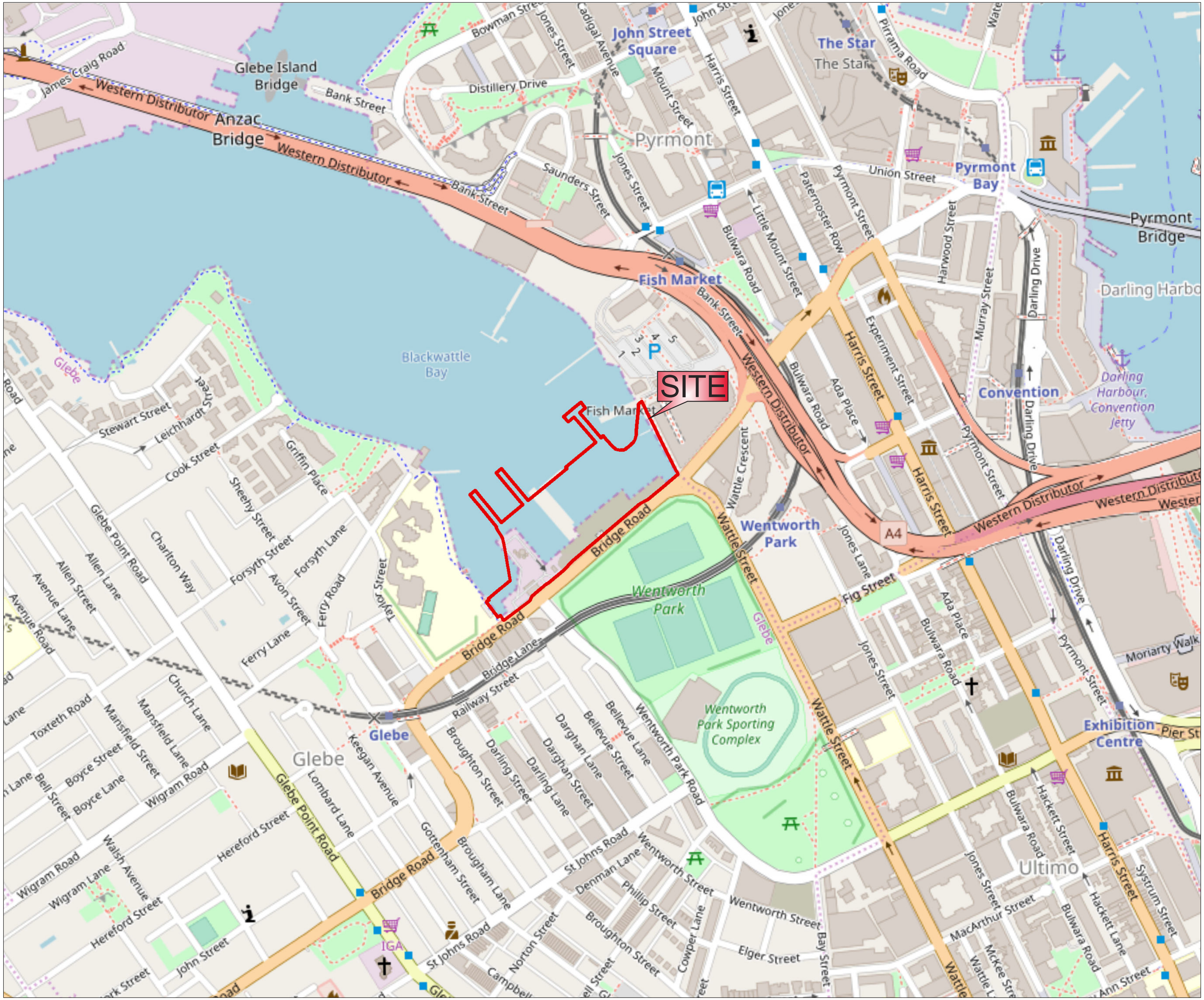
Sampling and chemical analysis of environmental media is based on appropriate guidance documents made and approved by the relevant regulatory authorities. Conclusions arising from the review and assessment of environmental data are based on the sampling and analysis considered appropriate based on the regulatory requirements.

Limited sampling and laboratory analyses were undertaken as part of the investigations undertaken, as described herein. Ground conditions between sampling locations and media may vary, and this should be considered when extrapolating between sampling points. Chemical analytes are based on the information detailed in the site history. Further chemicals or categories of chemicals may exist at the site, which were not identified in the site history and which may not be expected at the site.

Changes to the subsurface conditions may occur subsequent to the investigations described herein, through natural processes or through the intentional or accidental addition of contaminants. The conclusions and recommendations reached in this report are based on the information obtained at the time of the investigations.

This report does not provide a complete assessment of the environmental status of the site, and it is limited to the scope defined herein. Should information become available regarding conditions at the site including previously unknown sources of contamination, JBS&G reserves the right to review the report in the context of the additional information.

Figures



Legend:

Job No: 54578

Client: UrbanGrowth NSW

Version: R02 Rev 2	Date: 27-Mar-2019
Drawn By: RF	Checked By: JR

Scale 1:8,000

0 100 200
metres

Coor. Sys. GDA 1994 MGA Zone 56

1A-1C Bridge Road
Glebe, NSW

SITE LOCATION

FIGURE 1

File Name: 54578_01

Legend:

- New Sydney Fish Market Development Footprint
- Cadastral Boundary
- Approximate Land Area
- Approximate Seawall Extent

Proposed Landuse

- Fish Market Building Envelope
- Public Domain
- Approximate Fish Market Basement Footprint

JBS&G

Job No: 54578

Client: UrbanGrowth NSW

Version: R02 Rev 2 | Date: 27-Mar-2019

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Scale 1:2,000

0 25 50
metres

Coor. Sys. GDA 1994 MGA Zone 56

1A-1C Bridge Road
Glebe, NSW

SITE LAYOUT

FIGURE 2

File Name: 54578_02
Reference: Near Map - http://www.nearmap.com.au/. Imagery - 18-01-2018.

Legend:

- New Sydney Fish Market Development Footprint
- Approximate Land Area
- Approximate Seawall Extent

Proposed Landuse

- Fish Market Building Envelope
- Public Domain
- Approximate Fish Market Basement Footprint

Sample Locations

- BAYS MARKET DISTRICT - EIS (2017)
- BAYS MARKET DISTRICT - EIS (2010b)
- BAYS MARKET DISTRICT - EIS (2010c)
- BAYS MARKET DISTRICT - PB (2009)
- BAYS MARKET DISTRICT - Umwelt (2008)
- Soil Sampling / Monitoring Well - JBS&G 2015

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Scale 1:2,000

0 25 50
metres

Coor. Sys. GDA 1994 MGA Zone 56

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Glebe, NSW

HISTORICAL SAMPLE LOCATIONS

FIGURE 3

File Name: 54578_03
Reference: Near Map - http://www.nearmap.com.au/. Imagery - 18-01-2018.

Legend:

- New Sydney Fish Market Development Footprint
- Approximate Land Area
- Approximate Seawall Extent

Proposed Landuse

- Fish Market Building Envelope
- Public Domain
- Approximate Fish Market Basement Footprint

Proposed Sample Locations

- Groundwater and Ground Gas Monitoring Well Location
- Soil Sample Location
- Sub-Slab Vapour Sample Location

Sample Locations

- BAYS MARKET DISTRICT - PB (2009)
- Soil Sampling / Monitoring Well - JBS&G 2015

JBS&G

Job No: 54578

Client: UrbanGrowth NSW

Version: R02 Rev 2	Date: 27-Mar-2019
Drawn By: RF	Checked By: JR

Scale 1:2,000

0 25 50
metres

Coor. Sys. GDA 1994 MGA Zone 56

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Glebe, NSW

PROPOSED SAMPLE LOCATIONS FOR DATA GAP ASSESSMENT

FIGURE 4

File Name: 54578_04
Reference: Near Map - http://www.nearmap.com.au/. Imagery - 18-01-2018.

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