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Acid Sulfate Soil Management Plan – Wentworth Point new High School

7 Burroway Road, Wentworth Point, NSW 2127

RobertsCo
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Terminology

AASS	Actual acid sulfate soil
ASS	Acid sulfate soil
ASSMAC	Acid Sulfate Soil Management Advisory Council
CEMP	Construction environmental management plan
EPA	Environment Protection Authority
mAHD	metres Australian Height Datum
mBGL	Metres below ground level
NEPM	National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013)
PASS	Potential acid sulfate soil
POEO	Act Protection of the Environment Operations Act 1997 (NSW)
PPE	Personal protective equipment
SPOCAS	Suspension peroxide oxidation combined acidity and sulfate
SPOS	Peroxide-oxidisable sulfur
SWL	Standing water level
SWMS	Safe work method statement
TAA	Total actual acidity
TPA	Titratable peroxide acidity
TSA	Titratable sulfidic acidity
VENM	Virgin excavated natural material
WHS	Work health and safety

1 Introduction

1.1 The project

Geosyntec Consultants Pty Ltd (Geosyntec) was engaged by RobertsCo Pty Ltd (the Client), to prepare a Construction Environmental Management Plan (CEMP) for the Wentworth Point new High School for Stage 2 of the redevelopment project, located at 7 Burroway Road, Wentworth Point, NSW (the project site). This Acid Sulfate Soil Management Plan (ASSMP) forms one of the Sub-Plans of the CEMP.

Based on review of current spatial data, the site is legally identified as Lot 1 in DP 121276305, and occupies an area of approximately 1 ha. The site is currently vacant land which has been partially capped with up to 2m of certified Virgin Excavated Natural Material (VENM). The proposed redevelopment is understood to include school buildings and open space areas within the development footprint, and is consistent with the definition of 'HIL C' as presented in Schedule B1 of National Environment Protection (Assessment of Site Contamination) Measure (1999) as amended in 2013 (NEPM 2013), which includes public open space land use and secondary schools. Stage 1 works have already occurred which included the removal of concrete slab.

This ASSMP is required to meet condition B17(d) of the SSD Conditions of Consent.

Previous investigations indicate that Potential Acid Sulphate Soils (PASS) are present within fill and the underlying estuarine sediments at depths ranging from 0.1–4.0 m below ground level (mBGL, WSP, 2015). More recent investigations indicate that PASS are likely to exist below the water table (i.e. 1.5 mBGL and below), in the darker coloured material observed (WSP, 2014a). These PASS materials are required to be managed during the earthworks.

Therefore, this ASSMP was prepared based on previous investigation results to present the management measures in general accordance with the Acid Sulfate Soil Manual (ASSMAC, 1998). Reference has also been made to the Queensland Acid Sulfate Soil Technical Manual v 4.0 (DSITIA, 2002).

This Sub-Plan should be read in conjunction with the Construction Environmental Management Plan (CEMP).

1.2 Aim

The aim of this Sub-Plan for the duration of the Stage 1 Works Package is to minimise the potential risks associated with the potential acid sulfate soil (PASS) previously identified at the Site.

1.3 Site Background

PB (2014) provides a summary of the previous acid sulfate soils testing results obtained from the site:

Results of suspension peroxide oxidation combined acidity and sulphate (SPOCAS) testing conducted during previous contamination investigations at the site concluded that potential acid sulphate soil (PASS) materials are present within fill and the underlying estuarine sediments at depths ranging from 0.1–4.0 mBGL. Further to this, assessment works completed by Parsons Brinckerhoff in June 2014, indicated that PASS were present in five locations (BH1, BH16, BH17, BH23 and BH26) analysed with SPOCAS, with significant drops in pH following the addition of peroxide and measured titratable peroxide acidity (TPA) and titratable sulfidic acidity (TSA) above

the ASSMAC (1998) action criteria. It was concluded that 'PASS are likely to exist below the water table (i.e. 1.5 m BGL and below), in the darker coloured material observed'.

1.4 Objectives

This ASSMP forms part of the Construction Environmental Management Plan.

The objectives of this ASSMP is to provide guidance on the environmental management of ASS during the remediation, excavation and construction works to be followed by the Principal Contractor and their sub-contractors, and provide appropriate mechanisms to reduce the potential on-site and off-site environmental impacts and mitigate the risks associated with the disturbance of PASS.

The following issues are addressed in the ASSMP:

- strategies for the management of PASS during development
- implementation of a soil and groundwater monitoring program; and
- contingency procedures to be implemented in the event of the failure of management strategies

This document has been prepared to give guidance on management of ASS, in accordance with the NSW Acid Sulfate Soils Management Advisory Committee's ASSMAC (1998) Acid Sulfate Soil (ASS) Assessment Guidelines.

1.5 Review and Approval

This ASSMP is to be reviewed and endorsed by the Site Auditor. Once endorsed by the Site Auditor, the ASSMP is to be submitted to Council and the NSW EPA before the certification of the works.

2 Site Information

2.1 Site Identification

A summary of Site identification details is provided below.

Table 2.1: Site Identification

Title	Details
Street Address:	7 Burroway Road, Wentworth Point, NSW (formerly 3 Burroway Road)
Property Description:	Lot 1 in Deposited Plan 1276305 (formerly Lot 202 DP1216628,Lot 204 D P 1216628 and Lot 204 DP1216628)
Current Site Ownership:	Roads and Maritime Services (RMS)
Property Size:	0.7 hecatre
Local Government Area:	City of Parramatta Council
Zoning – Existing:	B1 Neighbourhood Centre and R4 High Density Residential (Auburn LEP (2010))

2.2 Local Environmental Plan

A review of the Auburn Local Environmental Plan 2010 (ASS Map – Sheet ASS_009), which at the time of writing had not been consolidated to a new City of Parramatta Council Local Environmental Plan, indicates that the Site is located in an ASS risk Class 2 area.

2.3 Acid Sulfate Soil Risk Map

A review of the Prospect/Parramatta River 1:25,000 Acid Sulfate Soils Risk Map indicates that the Site is classified as 'Disturbed Terrain' that includes filled areas that occur during the reclamation of low-lying swamps for urban development. Other activities that result in the classification of a disturbed terrain include dredging, heavy ground disturbance through urban development and/or construction of dams or levees.

2.4 Site Conditions

The site condition reports are summarised below in Table 2.2.

Table 2.2: General Site Conditions

Title	Details
Topography:	The Site is relatively level at an elevation of less than 10 metres Australian Height Datum (mAHD) and has been subjected to historical filling associated with land reclamation which has altered the original topography.
Superficial Geology:	Based on the Sydney Geological Series Sheet 9130, the Site is underlain by man-made fill comprising dredged sand and mud, demolition rubble and/or industrial and household waste (up to 2.4 mBGL). The fill is underlain by Quaternary Age alluvial deposits (1–4.8 mBGL). Ferruginous and humic cementation may occur in places and shell layers are common. Highly weathered, grey sandstone was encountered at one borehole location at 4.4–4.8 mBGL.
Depth to Groundwater:	Depth to groundwater ranges between 0.6 mBGL to 3.7 mBGL, and standing water levels (SWL) ranged between 0.5 mAHD and 2.7 mAHD.
Flow Direction:	Groundwater flows northwest and northeast towards the Parramatta River and Homebush Bay respectively.

2.5 Previous ASS Investigations

The Site, as a portion of Wentworth Point Peninsula Park Project, has been subject to a number of historical ASS investigations. A list of most relevant reports is provided below:

- WSP 2009a, Acid Sulfate Soil Management Plan Harbour Radio Pty Limited (2GB) Burroway Road, Homebush Bay, NSW.
- WSP 2009b, Environmental Site Assessment Harbour Radio Pty Limited (2GB), Burroway Road, Homebush Bay, NSW.
- GHD, 2012, Additional Contamination Assessment – Stage 1 Area, incorporates results from the 2010 detailed site investigation.
- Parsons Brinckerhoff (PB) 2014, Proposed management of acid sulfate soils prepared for the Wentworth Point Development.
- WSP 2014, Soil Contamination Assessment Burroway and Hill Road, Wentworth Point Development, HomebushBay, NSW 2127.
- Parsons Brinckerhoff (PB) 2015, Detailed Remediation Action Plan – Infrastructure Delivery, Wentworth Point Development.

3 Extent of Management

3.1 Proposed Redevelopment

The proposed works will include the removal and remediation of surrounding soil of several USTs approximately 3m bgl. It will also include excavation, pile soil and inground service trenching.

Site layout for the site is provided as Appendix A, which indicate the areas requiring excavation.

The proposed remediation works for the infrastructure delivery include the bulk excavation of specific cut-to-fill areas to depths that may extend up to 3.0 mBGL (WSP, 2015). Based on the proposed excavation depth, indicative volumes of soil to be disturbed, and the Site located in an area of high occurrence of ASS materials at or near the ground surface, any materials that are excavated and suspected of containing PASS and/or ASS should be assessed and managed according to management measures and mitigation strategies discussed in the following sections.

3.2 Assessment Criteria

The following assessment criteria for field and laboratory testing have been developed with reference to the ASSMAC guidelines (1998).

ASS are usually found in estuarine environments up to 10 mAHD and generally consist of clays and sands containing pyritic material. The field indicators of ASS include:

- iron staining on any drain surfaces
- unusually clear or milky green water discharging from the site
- jarosite horizons or mottling due to iron in the subsurface
- corrosion of concrete or steel structures
- presence of any sulfurous odours.

Analytical results are assessed against the following criteria taken from ASSMAC (1998). Action criteria are based on texture and clay content of the soil being analysed and the total volume of soil to be disturbed. For the purpose of this plan the adopted action criteria is conservatively applied for coarse texture soils, based on the natural soils encountered including clay, sand and sandy clay. As the potential amount of ASS requiring excavation is unknown both the criteria for 1 to 1,000 tonnes disturbed and for >1,000 tonnes disturbed have been considered; for coarse soils the criteria are the same for both categories. Table 3.2 outlines the assessment criteria.

Table 3.2: Adopted Action Criteria

Analyte	Units	Action Criteria (Coarse Soils)	
		1 to 1,000 tonnes disturbed	>1,000 tonnes disturbed
S_{POS}	%	0.03	0.03
TTA + TPA	mol H^+/T	18	18
TSA	mol H^+/T	18	18

S_{POS} – Peroxide-oxidisable sulfur
TAA – Total actual acidity
TPA – Titratable peroxide acidity
TSA – Titratable sulfidic acidity

4 ASS Management Strategy

The following sections outline management measures and mitigation strategies to be undertaken to manage areas where potential or actual ASS materials are present at the Site.

General construction environmental management for the proposed works is presented in the CEMP. This ASSMP provides specific information for the management of ASS at the site and is a sub-plan to the CEMP.

4.1 ASS General Management Strategies

There are a range of control and management measures available when dealing with the possible disturbance of ASS. Such measures can be implemented individually or jointly as part of a combined approach.

PB (2014) summarises the following general strategies as outlined in ASSMAC (1998):

- Avoidance – where ASS areas are avoided altogether (total avoidance) or development activities are adjusted so that the more severe areas are left undisturbed (partial avoidance).
- Oxidation prevention – ASS are innocuous if they are not allowed to oxidise. Oxidation can be prevented by avoidance, water table control, in situ capping, or removal and burial below the water table.
- Acid neutralisation – acid present or produced by oxidation in the soil can be controlled by the addition of alkaline agents such as agricultural lime for example.
- Leachate treatment – where the sulfidic content of the soil is very low (quantity), deliberate oxidation with leachate collection and treatment might be appropriate. This method is generally only applicable to sands, given the lengthy drying times for clay, and would require pilot trials prior to implementation.
- Disposal to landfill – the ASS may be removed and disposed of at an appropriate landfill facility. Untreated ASS would require treatment as a contaminated soil for the purpose of transport and disposal.

It is considered that avoidance of PASS/ASS is not viable as the proposed excavation is anticipated to extend to a depth greater than 1.5mbgl.

Therefore, the most feasible management strategies are summarised as follows:

- For PASS generated from the landward section of the launching channel, the material can be treated by addition of an alkaline agent such as agricultural lime. The treated PASS can then be reused in other parts of the site or the wider Wentworth Point redevelopment (where possible). The treated PASS can only be placed beneath the proposed capping layer to be constructed as part of the overall Wentworth Point development. No treated PASS can be placed below the water table.
- Dewatering associated with the works to be undertaken within the cofferdam and the excavation required as part of the launching channel construction may result in the exposure of PASS.

5 Testing and Management Procedures for Acid Sulfate Soils

As part of the development works will involve the excavation of PASS/ASS, the management strategy to be adopted for the site during the excavation and construction works in order to mitigate the impacts of PASS/ASS on the surrounding environment will include the following steps:

- Appoint a suitably qualified person to manage the acid sulfate soil issues during the earthworks
- Minimise the amount of PASS/ASS required to be excavated
- Excavate and stockpile spoil in separate layers based on geological units and moisture content (i.e., saturated or dry) and reinstate spoil in the same order to ensure that PASS remain saturated.
- Reinstate PASS/ASS under the water table with 16 hours of excavation works (where possible)
- Undertake monitoring and laboratory testing of excavated soils (mainly based on visual assessment, field testing and laboratory testing) to assess the potential presence of acid generating potential during excavation activities and establish liming rates
- Excavated PASS/ASS can be managed through either offsite disposal or on-site treatment
- Manage and monitor dewatering activities to minimise the ingress of groundwater into the excavation and to maintain the groundwater table in the area.

In the case of the exposed sediments within the cofferdam, the material will undergo in-situ cement-lime mixing to increase the geotechnical specification of the sediments. This should reduce the potential for acid generation. Further testing is required to be undertaken to assess whether additional liming is required prior to onsite reuse or offsite disposal.

5.1 Training and Responsibilities

The Principal Contractor should appoint a suitably qualified person who will be responsible for managing ASS at the site during the proposed remediation, excavation and construction works. It is expected that daily attendance to the site will be required to facilitate soil sampling required under this ASSMP.

The appointed person should be familiar with:

- This ASSMP
- Council and other relevant statutory requirements
- Recognition of PASS and ASS
- ASS testing and treatment procedures
- Onsite management of ASS activities
- The NSW ASSMAC Guideline

The classification of ASS/PASS during excavation should be carried out by personnel trained in the identification of ASS and be based on visual classification and the field peroxide test. If required, a suitably qualified environmental consultant should be engaged to assist or train the Principal Contractor in the identification of acid sulfate soils and sampling and analysis.

5.2 Bulk Earthworks

Given the heterogeneity and chemical composition of fill soils, highly variable nature of the Quaternary alluvium beneath the Site, and the nature of the proposed site works, avoidance of ASS materials is not considered viable. Staged excavation works should be implemented in the areas PASS/ASS have been identified. Care should be taken during the bulk earthworks to minimise disturbance of groundwater and prevent oxidation of soils below groundwater table.

- Where potential or actual ASS is required to be excavated, the following considerations should be taken into account (ASSMAC, 1998):
- Where the sulfidic layer is <0.5 m deep, these areas should ideally be left undrained with minimal disturbance (i.e. generally these areas are best left waterlogged).
- Where the sulfidic layer is between 0.5 and 2.0 m deep, drainage and excavation should only be attempted in accordance with a properly designed management plan:
  - if the sulfidic layer is 0.5 to 1 mBGL, excavation should be limited to areas less than 0.3 mBGL
  - if the sulfidic layer is 1 to 1.5 mBGL, excavation should be limited to areas less than 0.5 mBGL
  - if the sulfidic layer is more than 1.5 mBGL, excavation should be limited to areas no greater than 1 mBGL.
- Where areas are 'scalded' or degraded and devoid of vegetation, no further drainage or excavation should be undertaken. Remediation strategies should be developed.

Prior to excavation works, the following controls and management measures should be implemented to manage the PASS/ASS at the Site.

Table 4.1: Management of ASS materials prior to excavation works

Title	Details
Wash Bays	Wash bays should be installed at the site to minimise off-site tracking of contaminated materials by machinery. Wash bays should be used prior to trucks/machinery leaving the Site or when moving from an excavation area to a clean area of the Site. Leachate controls should be employed around wash bays to minimise the spread of contamination. These should include collection of runoff.
Staged Excavation Planning	Staged excavation works should be implemented in the areas PASS/ASS have been identified by laboratory analysis of soil samples or are suspected, to minimise the risks posed to the environment and to minimise oxidation of in situ materials. To achieve this, the excavation area should be excavated systematically as a series of smaller 'cells' rather than one large area. Where ASS materials are left in situ as the uppermost layer and exposed (i.e. not saturated), areas should be either capped with clean virgin excavated natural material (VENM) or concrete as soon as possible prior to moving to the next area. Ideally, the optimum 'cell' size should be calculated based on the area that can be completed (including capping works) in a single day. Prior to commencement, a works schedule should be prepared indicating when each area will be excavated and capped. Areas should be marked out prior to the excavation works taking place.

5.3 Management Options for ASS/PASS

Where PASS is excavated, excavated PASS materials may be managed by one (or a combination) of the following methods:

- neutralisation of PASS materials where reuse on-site above the water table is required (Option A)
- reburial of excavated PASS materials below the water table (Option B) and

- disposal of excess treated/untreated PASS material to a licensed off-site facility where it cannot be reused on-site (Option C).

Management options for ASS/PASS have been outlined and evaluated in the following table.

Table 4.2 Management options for ASS/PASS

Option	Details	Evaluation of Applicability
Option A: Treatment of PASS and on-site reuse	PASS is excavated and neutralised with lime. The treated material will be re-used on site above the water table with adequate capping.	This option is suitable for PASS materials excavated above/below water table to be used for raising the levels for the development.
Option B: Reburial of excavated PASS materials below the water table	Excavated PASS materials may be re-used on-site by burying the materials in an area of the site located below the water table.	This option is suitable for saturated PASS materials (below water table) and not suitable for fill materials.
Option C: Disposal of excess treated/untreated PASS material to licences off-site facility	A waste classification is assigned for the off-site disposal of PASS to a licensed offsite facility.	Potential option for situations of limited spatial area for treatment or volume of excavation larger than treatment / reburial capacity.

5.4 Preferred Option for Management of ASS/PASS

As outlined in the table above, the most viable and therefore the preferred option for managing ASS/PASS during the proposed site works is Option A (Treatment of PASS and on-site reuse) in coupled with Option B (Reburial of excavated PASS materials below the water table). The management procedure for both options is outlined below.

5.4.1 Treatment of PASS and on-site reuse (Option A)

During bulk earthworks, where PASS materials are to be reused on-site in areas not saturated or more than 16 hours after excavation, these materials must be treated prior to reuse.

The procedures outlined in the following table should be implemented for this option:

Table 4.3: Management procedures for Option A – Treatment and on-site reuse

Procedure	Details
Step 1: Lime Selection and Liming Rate Adoption	The most common material used to neutralise acidic sediments is agricultural lime (aglime as CaCO3). Aglime (pH 8.2) is the safest and cheapest neutralising agent (Manual, 1998). Based on the results from the assessment undertaken along Burroway Road (WSP, 2014), the liming rate would be between 0.04 tonnes of lime per tonne of disturbed soil and 0.12 tonnes of lime per tonnes of soil. These rates are based on the average and maximum Peroxide-oxidisable sulfur (SPOS) from the assessment. Appendix B provides the neutralising calculations worksheet from ASSMAC (1998) which can be used to determine the appropriate dosing rates based on laboratory data from any ASS identified during the works. When estimating lime requirements in accordance with ASSMAC (1998) guidelines, a safety factor of at least 1.5 to 2 times the weight/volume should be applied to allow for inefficient mixing of the lime and its low reactivity. In addition, the purity and effective neutralising values also needs to be included in the estimation of lime requirement, as specified in ASSMAC (1998).
Step 2: Set up Treatment Area/s	Treatment must be undertaken on a developed hardstand area or suitable engineered pad or limed pad. The hardstand area would require appropriate drainage controls to ensure that any runoff is collected. The limed pad should be at least 100mm thick and this thickness should be maintained for the duration of treatment works. The purpose of this guard layer is to minimise the risk of acidic water leaching from the base of the treatment area into the groundwater.

Procedure	Details
	Dependent upon the rate of spoil generation, several bunded treatment areas may be necessary for stockpiling and treatment. An earthworks strategy should be prepared to ensure that sufficient space is available on site to accommodate treatment of the PASS.
Step 3: Spoil Management	Stockpiles containing PASS materials should be placed to minimise environmental impact from any leachate. ASSMAC (1998) indicates that the design of stockpile(s) should include the following controls: • all stockpiles to be bunded to retain any water run-off from the treated materials • establish leachate collection and treatment systems including an impervious pad on which to place the stockpile • if an impervious pad has not been established under the stockpile, as a precautionary measure, an apron of fine lime should be applied below the stockpile when stockpiling materials for any length of time • minimise the surface area exposed to oxidation – consider using some form of artificial capping if storage is for longer than a few weeks • minimise the amount of water infiltration – consider using some form of artificial capping • establish diversion banks upslope to prevent run-on water • establish sediment control structures to ensure sulfidic material is not eroded – consider using some form of capping. To manage spoil effectively and meet the above requirements, excavated materials should be stored in a designated area at each site and reused or disposed of off-site as soon as possible following excavation with appropriate management procedures.
Step 4: Excavation & Handling	PASS disturbed during development works should be immediately transferred to the designated treatment area and spread out in 150 mm to 300 mm thick layers. If possible the layers should be allowed to dry in order to aid the mixing process. The layers should then be interspersed with the appropriate amount of lime to aid in the effective mixing of lime and soil. Lime should be applied to the excavated material within the treatment area as soon as possible. If circumstances prevent the spreading and treatment of the material, the surface area of the stockpile should be minimised by forming a relatively high coned shape and avoiding 'spreading-out' of the stockpile. This will limit the surface area exposed to oxidation. Water infiltration should be minimised by covering the stockpile during wet weather. This will limit the formation and transport of acid leachate due to rainfall. The stockpile should be bunded to prevent erosion of the PASS and any movement of potentially acid leachate. Upstream surface runoff water should also be diverted around the stockpile.
Step 5a: Lime Treatment	An excavator or other suitable equipment (as deemed appropriate by the excavation contractor) should be used to thoroughly mix the lime through the soil. Alternatively use of a pug mill may be considered dependent upon the volume of soil to be treated in a timely fashion. Monitoring should be undertaken by qualified personnel to ensure the mixing is undertaken to a suitable extent as neutralisation success relies on effective mixing of the neutralising agents and soil.
Step 5b: Lime Buffer	Establishing a 'lime buffer' at the face of any recent excavation which exposes ASS by sandbagging the face and incorporating lime under and in the sandbags so that the acid leachate flows through the sandbags; backfilling the face with clean fill mixed with lime/sand mix; and excavating a trench behind the face and incorporating a lime/sand mix or barrier so that the acid leachate/water must pass through. Insoluble coatings and preferred pathways may limit the effectiveness of lime buffers.
Step 5c: Capping	To minimise the generation of acids, open excavations where the uppermost exposed layer contains PASS materials should be capped as soon as possible or left saturated. If capping is necessary, one (or a combination) of the following capping options should be used: • cap with clean, imported VENM (tested to ensure it meets the appropriate criteria for imported VENM materials) • cap with re-used soil from on-site (tested to ensure it is within the adopted site assessment criteria and does not contain ASS) • cap with concrete. Capping should occur within 16 hours to minimise the environmental risks associated with acid generation. Where concrete or other building materials are to be placed directly in contact with PASS or AASS, appropriate materials should be chosen that are resistant to the long-term effects of sulfate and sulfuric acid which may be produced by the soils.
Step 6: pH Testing and Monitoring	The pH of the soil should be checked using the test method(s) outlined in the ASS Manual 1998 (Methods 21A and or 21Af) to confirm that PASS have been neutralised by lime addition. If required, additional lime should be added to the soil and additional mixing undertaken. Following treatment with lime the pH of the soil should be in the 5.5 to 8.5 range.

Procedure	Details
Step 7: Re-use on Site	Following treatment and validation, treated PASS materials could be re-used on site above groundwater table for raising the ground level. Treated PASS should not be spread over sensitive areas (e.g. mangroves) or directly adjacent to waterways. The area where the treated PASS is going to be placed should be cleared. The area should be dusted with lime. The neutralised PASS should then be spread across the placement area in layers. Care should be taken not to disturb the underlying soil. On completion, the surface of the neutralised PASS should be dusted with additional lime prior to capping. A suitable capping layer should be placed over the neutralised PASS. The finished surface should be turfed or paved to minimise the potential for erosion.

5.4.2 Reburial of excavated PASS materials below the water table (option B)

The procedures outlined in the following table should be implemented for this option:

Table 4.4: Management procedures for Option B – Reburial below the water table

Procedure	Details
Step 1: Excavation & Reburial	This mitigation strategy may involve reburial of the excavated PASS materials as quickly as possible prior to acid generation by over-excavation (in a staged approach) to provide capacity for disposal of the PASS materials at the bottom of a constructed void preferable below a permanent water table. Cut and fill budget should be prepared to ensure that there is adequate capacity to maintain the PASS materials in anaerobic conditions in the void. This must be done within 16 hours of excavation works to avoid acid generation. If the material is to remain exposed at the surface, it should be capped (refer Table 4.3). If the material is required to be stored for longer than 16 hours, then it must either be: • placed in a temporary holding area where it remains saturated (either below the water table in another area of the site or in an artificial saturated area filled with water). As a safety measure, some lime should usually be added and the water needs to be monitored and treated if the pH drops below 6.5. • treated as per Option A.
Step 2: Treatment (subject to duration of PASS materials exposed to oxygen)	As per Table 4.3.

5.5 Alternative Management Option for ASS/PASS

Option C – Disposal of excess treated/untreated PASS material to a licensed off-site facility is considered as an optional management strategy for situations of limited spatial area for treatment or volume of excavation larger than treatment/reburial capacity encountered.

5.5.1 Disposal at a Licensed Landfill (Option C)

If excavated PASS materials cannot be re-used on site, they should be disposed of at a suitably licensed waste facility. Excavated soils containing ASS should be disposed of in accordance with the NSW EPA (2014) waste classification guidelines, as follows:

- For VENM containing PASS (pH of 5.5 or more):
  - the materials must be kept wet at all times during excavation and subsequent handling, transport and storage
  - the receiving landfill must be licensed by the NSW EPA to dispose of PASS below the water table
  - the materials must be received at the receiving landfill within 16 hours of being dug up.

- For Actual ASS (AASS, pH of 5.5 or less) or PASS that has dried out, undergone any oxidation of its sulfidic minerals or is not VENM:
  - the materials must be treated (neutralised) on-site through liming, mixing and testing to ensure that the mixing of lime materials is successful. Monitoring of pH should be carried out regularly during and after the neutralisation procedure to establish the effectiveness of the treatment
  - following neutralisation, testing should be undertaken to classify the treated material in accordance with the NSW EPA (2014) Waste Classification Guidelines - Part 1: Classifying Waste (2014) and Waste Classification Guidelines Part 4: Acid Sulfate Soils (2014), and the excess treated materials should be disposed to an NSW EPA licensed landfill facility.

The receiving landfill must be licensed by the EPA to accept the class of waste as per the classification. The landfill should be informed prior to receiving the waste that the material contained ASS and was treated in accordance with the neutralising techniques outlined in ASSMAC (1998).

Information should be recorded/filed for each batch of material tested and disposed of off-site. This should include the origin of material, the volume, a description of the materials, laboratory results and disposal certificates.

The costs associated with the off-site disposal can be significant and should be assessed at an early stage of the project to avoid significant future unexpected additional costs.

The procedures outlined in the following table should be implemented for this option:

Table 4.5: Management procedures for Option C – Disposal at a Licenced Landfill

Procedure	Details
Step 1: Contact Landfill	Prior to commencement of excavation works, the landfill should be contacted and the necessary approvals should be obtained for disposal.
Step 2: Excavation & Handling	Natural soil classed as PASS should be excavated/disturbed in stages. PASS must be kept wet at all times during excavation and subsequent handling, transport and storage until they can be disposed of safely.
Step 3: pH Testing	The pH of the soil should be checked using the test method(s) outlined in the ASS Manual 1998 (Methods 21A and or 21Af). The pH of each load and the time of extraction should be recorded and forwarded to the landfill. If the pH is less than 5.5 then the material is not suitable for disposal and Option A should be implemented.
Step 4: Transport for VENM containing PASS (pH of 5.5 or more) **OR**	Provided that the pH of the excavated PASS is not less than 5.5, PASS material can be loaded onto trucks and transported immediately to the landfill. Prior to burial the landfill will check the pH of each load. Any loads that do not meet the acceptance pH criteria will be turned away.
Step 4: Treatment for AASS/PASS (pH of 5.5 or less)	As per Table 4.3.
Step 5: Waste Classification and Disposal	Following neutralisation, testing should be undertaken to classify the treated material in accordance with the NSW EPA (2014) Waste Classification Guidelines and the excess treated materials should be disposed to a NSW EPA licensed landfill facility.

6 Groundwater Management

Some dewatering may be required given the proposed remediation works for the infrastructure delivery include the bulk excavation of specific cut-to-fill areas to depths that may extend up to 3.0 mBGL (WSP, 2015).

The procedure for managing groundwater seepage and dewatering during development works is outlined in the following table:

Table 6.1: Management procedure for dewatering

Procedure	Details
Step 1: Minimise the depth of dewatering	Where possible the depth of dewatering should be minimised to reduce the generation of ASS and/or acidic conditions. Excavation and dewatering works should be staged over short durations to reduce the time and volume of PASS exposed to oxidation.
Step 2: Approvals for Groundwater Disposal	Reference should be made to the local council, NSW Office of Water/WaterNSW, Sydney Water and other relevant authority's approval requirements for further information in relation to disposal of water to either the sewer or stormwater systems.
Step 3: pH Testing and Neutralisation	Water pumped from the excavation should be placed in a portable tank, or appropriate holding facility, where samples can be obtained for testing. The water should be in the pH range of 6.5 to 8.5 (NSW Government, 2009). If the pH is outside of this range, treatment will be necessary prior to disposal. Based on the disposal option chosen for the development, additional screening for contaminants may be required by the relevant authorities prior to disposal.
Step 3: On-going groundwater monitoring	In the event that extended pumping of water is necessary during the construction period, the level and quality of the groundwater should be monitored on a regular basis over the entire construction period. The pH should be measured and recorded on a regular basis. Immediate advice is to be sought from an experienced consultant if the pH at any location is not within 10% of the initial pH at the commencement of pumping. If required, corrective action should be taken as soon as possible. Laboratory analysis will be required on water samples as part of the corrective action to assess the quantity of neutralising agents required if treatment is necessary. The groundwater monitoring program refer to Section 7.

7 Monitoring Program

The overall objective of monitoring is to measure the effectiveness of the proposed strategies in achieving the desired outcomes. Monitoring will assist in identifying and addressing any non-conformances and providing information for implementing corrective actions within an appropriate timeframe. Table 6.1 outlines the monitoring program during the works.

Table 6.1: Monitoring Program

Procedure	Details
General	Monitoring of ASS control/management procedures including excavation methods, spoil management measures, and dewatering and groundwater management should be undertaken. ASS pollution incident response investigations, including management and/or remediation measures, should be prepared as required.
Soil Monitoring Program	The following will constitute the soil monitoring program during the works: • Field pH measurements of all materials excavated should be taken and logged to provide broad coverage of the excavated material types encountered. One sample should be collected per 25 m^3 of excavated soil materials for on-site pH testing. • Field pH readings of 4 or less will indicate that ASS are present with oxidising sulfides, readings of greater than 4 but less than 5.5 indicate that the soils are acidic and may be the result of limited oxidation of sulfides. • Where soils are required to be limed, materials should be tested to ensure that the neutralisation process has been successful. Field testing should be undertaken at a rate of one per 50 m3, if changes in liming rates or material are observed additional samples should be collected. Laboratory testing (SPOCAS or chromium suite) should be undertaken at a rate of 25% of field samples to confirm the results. • For waste disposal: - material is pre-classified as PASS material as per the NSW EPA (2014) waste classification guidelines providing it is delivered to the receiving waste facility within 16 hours of excavation - if soil is not delivered to the waste facility within 16 hours it will require liming and testing to ensure that the material has been successfully neutralised and to classify the material as per the NSW EPA (2014) waste classification guidelines. Information should be recorded and filed for each batch of soil tested. Information should include the origin of the material, the volume, a description of the materials, laboratory results and disposal certificates (where appropriate).
Water Monitoring Program	The following will constitute the water monitoring program during the works: • Any pumped water from the excavations and runoff collected will be stored in retention basins or fully contained tanks on-site. • Water samples should be representative of the stored water and may require sampling from different depths, particularly if the water has been stored long enough to allow it to settle. • Water stored in basins/tanks should be tested for metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel and zinc) and cations and anions to characterise the water quality. In addition, the water should be tested for physical parameters on-site including dissolved oxygen, electrical conductivity, pH, reduction/oxidation potential, temperature and turbidity. • If runoff is stored separately to any pumped water, the requirement for site runoff can be met via the following water quality criteria being tested for and met prior to off-site discharge of collected runoff: - total suspended solids not greater than 1,500 mg/L - pH between 6.5 and 9.0 - iron not greater than 500 µg/L - aluminium not greater than 5 µg/L for pH <6.5, not greater than 100 µg/L for pH >6.5 - no visible oil or grease film. ASSMAC (1998) provides water quality performance criteria to be met for the discharge of water into the environment are summarised, as summarised below.

Procedure	Details		
	Water Quality Indicator	**Fresh water**	**Marine Water**
	pH	6.5-9.0	<0.2 pH unit change
	Iron (total)	500 µg/L	Not applicable
	Total dissolved solids	<1500mg/L	>1500mg/L
	Aluminium	5 µg/L for pH <6.5	Not applicable

8 Contingency Plan

8.1 Incident and Emergency Response

There is a potential for incidents and emergency response requirements relating to ASS issues, particularly pollution/contamination of surrounding areas and waterways from acid contamination. The contractor is to have appropriate incident reporting mechanisms (including near miss reporting) and these are incorporated into the Site work health and safety (WHS) plans and CEMP. Some issues that may arise unexpectedly include:

- interception of existing unknown AASS and/or PASS identified through field inspections/measurements or observed adverse reactions with flora and/or fauna (including site workers and public)
- inclement weather or incorrect management practices causing erosion and transportation of AASS and/or PASS materials off-site from stockpiles and active construction excavations.

The emergency response procedures will include:

- immediate containment of acid runoff from stockpiles or areas of excavation by bunding
- communication between the project manager, site managers, supervisors and contractors detailing the pollution incident requiring response/action
- site inspection to assess extent of severity of the emergency/incident
- based on the assessed severity of the incident by Roads and Maritime, the project manager will determine the need to notify regulators potentially including the NSW EPA; notifications should detail the type and extent of potential impacts and remediation requirements
- monitoring and/or management of incidents which may include soil or groundwater sampling and analysis, spill clean-up, investigation materials, correction of erosion control measures and remediation of affected area (if required)
- incident reporting detailing all investigation and remediation actions taken and remediation results carried out
- environmental incidents will be reported immediately to the site supervisor who will contact the project manager. All incidences will be investigated and the appropriate course of action will be taken to address the issues. Serious environmental incidents will be reported to the NSW EPA.

8.2 Non-Conformance Preventative and Corrective Action

In the event of a non-conformance, the source and nature of the event will be investigated, the effectiveness of the existing controls reviewed and modified where practical, and necessary strategies will be implemented to minimise further impacts.

Prior to undertaking any remediation or excavation, a safe work method statement (SWMS) will be prepared that defines safe procedures to protect the health and safety of personnel. The SWMS will include the following:

- all workers will wear personal protective equipment (PPE) that may include breathing apparatus, protective overalls, gloves, safety boots and hard hat
- decontamination facilities made available to ensure workers are free of any contamination prior to leaving the workplace
- ASS areas are separated from the remaining activities by appropriate fencing and signage. Access to the site is restricted only to personnel directly involved in the works.

9 References

ASSMAC 1998, Acid Sulfate Soil Manual.

Browns Smart Consulting 2014, Road Bulk Earthworks Plan

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Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines.

National Environment Protection (Assessment of Site Contamination) Measure 1999 (as amended 2013).

NSW EPA 2017, Guidelines for the NSW Site Auditor Scheme (3rd edition).

NSW EPA 2014, Waste Classification Guidelines, Part 1: Classifying waste.

NSW EPA 2014, Waste Classification Guidelines, Part 4: Acid Sulfate Soils.

NSW EPA 1995, Sampling Design Guidelines.

NSW EPA 1997, Guidelines for Consultants Reporting on Contaminated Sites.

Parsons Brinckerhoff (PB) (2015) Proposed Management of Acid Sulfate Soils prepared for the Wentworth Point development, Ref: 2207004B-CLM-LTR-002 RevB.

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Thiess Pty Ltd (2014) Environmental Management Plan Homebush Bay Sediments, 6 November 2014. Final

WSP 2009a, Acid Sulfate Soil Management Plan Harbour Radio Pty Limited (2GB) Burroway Road, Homebush Bay, NSW.

WSP 2009b, Environmental Site Assessment Harbour Radio Pty Limited (2GB), Burroway Road, Homebush Bay, NSW.

WSP 2014a, Soil Contamination Assessment Burroway and Hill Road, Wentworth Point Development, Homebush Bay, NSW 2127.

WSP 2014b, Proposed management of acid sulfate soils.

WSP 2015, Detailed Remediation Action Plan – Infrastructure Delivery, Wentworth Point Development.

10 Limitations

This report has been prepared by Geosyntec Consultants Pty Ltd ("Geosyntec") for use by the Client who 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 findings of this report are based on the scope of work outlined in Section 1. The report has been prepared specifically for the Client for the purposes of the commission, and use by any explicitly nominated third party in the agreement between Geosyntec and the Client. No warranties, express or implied, are offered to any third parties and no liability will be accepted for use or interpretation of this report by any third party (other than where specifically nominated in an agreement with the Client).

This report relates to only 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. This report should not be reproduced without prior approval by the Client, or amended in any way without prior written approval by Geosyntec.

Geosyntec's assessment was limited strictly to identifying environmental conditions associated with the subject property area as identified in the scope of work and does not include evaluation of any other issues.

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 investigation.

This report does not comment on any regulatory obligations based on the findings. This report relates only to the objectives stated and does not relate to any other work conducted for the Client.

The absence of any identified hazardous or toxic materials on the site should not be interpreted as a guarantee that such materials do not exist on the site.

All conclusions regarding the site are the professional opinions of the Geosyntec personnel involved with the project, subject to the qualifications made above. While normal assessments of data reliability have been made, Geosyntec has not independently verified and assumes no responsibility or liability for errors in any data obtained from regulatory agencies, statements from sources outside of Geosyntec, or developments resulting from situations outside the scope of this project.

Geosyntec is not engaged in environmental assessment and reporting for the purpose of advertising sales promoting, or endorsement of any client interests, including raising investment capital, recommending investment decisions, or other publicity purposes. The Client acknowledges that this report is for its exclusive use.

Attachment A Figures

LEGEND

Site Boundary

This product has been created to support the main report and is not suitable for other purposes. Image courtesy of Nearmaps

Approx. 50 m

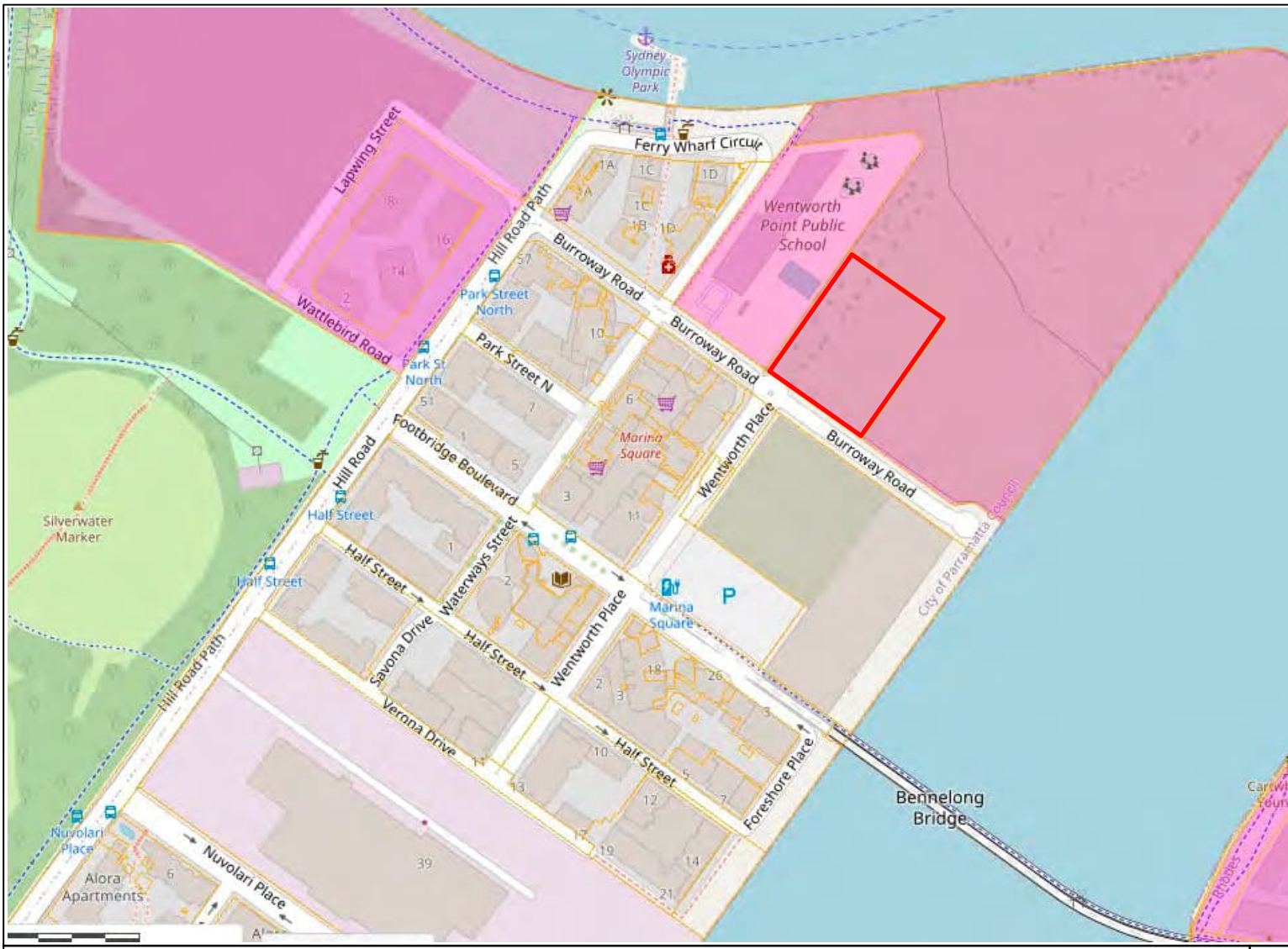
Datum: GDA 1994 MGA Zone 56 - AHD

Fig

Site

Clie

Job



LEGEND

Site Boundary

Acid Sulfate Soils

- NA
- Class 1
- Classes 2 & 2a
- Class 2b
- Class 3
- Class 4
- Class 5

Approx. 50 m

Datum: GDA 1994 MGA Zone 56 - AHD

This product has been created to support the main report and is not suitable for other purposes. Image courtesy of SEED NSW

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Site

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Attachment B Liming Rate Table

TABLE 4.5 Treatment categories and lime required to treat a weight of disturbed acid sulfate soils – based on soi

The tonnes (t) of pure fine lime required to fully treat the total weight/volume of ASS can be read from the table at the intersection of th sulfur analysis (column). Where the exact weight or soil analysis figure does not appear in the heading of the row or column, use the ne using factors from Table 4.6).

Disturbed soil	**Soil Analysis - Oxidisable Sulfur (S %)** or equivalent TPA/TAA									
(tonnes)	***0.03***	***0.06***	***0.1***	***0.2***	***0.4***	***0.6***	***0.8***	***1***	***1.5***	***2***
1	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	0.1
5	0.05	0.05	0.05	0.05	0.1	0.1	0.2	0.2	0.4	0.5
10	0.05	0.05	0.05	0.1	0.2	0.3	0.4	0.5	0.7	0.9
15	0.05	0.05	0.1	0.1	0.3	0.4	0.6	0.7	1.1	1.4
20	0.05	0.1	0.1	0.2	0.4	0.6	0.7	0.9	1.4	1.9
25	0.05	0.1	0.1	0.2	0.5	0.7	0.9	1.2	1.8	2.3
35	0.05	0.1	0.2	0.3	0.7	1.0	1.3	1.6	2.5	3.3
50	0.1	0.1	0.2	0.5	0.9	1.4	1.9	2.3	3.5	4.7
75	0.1	0.2	0.4	0.7	1.4	2.1	2.8	3.5	5.3	7.0
100	0.1	0.3	0.5	0.9	1.9	2.8	3.7	4.7	7.0	9.4
200	0.3	0.6	0.9	1.9	3.7	5.6	7.5	9.4	14.0	18.7
500	0.7	1.4	2.3	4.7	9.4	14.0	18.7	23.4	35.1	46.8
750	1.1	2.1	3.5	7.0	14.0	21.1	28.1	35.1	52.7	70.2
1,000	1.4	2.8	4.7	9.4	18.7	28.1	37.5	46.8	70.2	93.6
2,000	2.8	5.6	9.4	18.7	37.5	56.2	74.9	93.6	140.5	187.3
5,000	7.0	14.0	23.4	46.8	93.6	140.5	187.3	234.1	351.2	468.2
10,000	14.0	28.1	46.8	93.6	187.3	280.9	374.6	468.2	702.3	936.4

L	**Low treatment**: (<0.1 t lime). Apply 0.05 t (1 bag) or 0.1 t (2 bags) of lime to prevent some soil acidity from the ASS disturbance.
M	**Medium treatment:** (>0.1 to 1 t lime).
H	**High treatment**:(>1 to 5 t lime).
VH	**Very High treatment:** (>5 tonne lime).

A detailed management plan is required if disturbing > 1,000 tonnes of ASS (oxidisable S ≥0.03 %S or equivalent TPA or TAA.)

Lime rates are for pure fine $CaCO_3$ using a safety factor of 1.5. A factor that accounts for Effective Neutralising Value is needed for commercial grad

An approximate volume (cubic m) can be obtained by dividing weight (tonne) by bulk density (t/m^3).