

Appendix 9

Acid Sulfate Soils Management Plan

City of Canada Bay Council

Acid Sulfate Soils Management Plan

Timbrell Park Sportsfield Upgrade

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GLOSSARY OF TERMS

Abbreviation:	Definition:
ASS	Acid Sulfate Soils (including Actual Acid Sulfate Soils and Potential Acid Sulfate Soils)
AASS	Actual Acid Sulfate Soil
ASSMAC	Acid Sulfate Soil Management Advisory Committee
ASSMP	Acid Sulfate Soil Management Plan
EPA	Environment Protection Authority
NATA	National Association of Testing Authorities
PASS	Potential Acid Sulfate Soils
pH _f	Field pH with the addition of deionised water onsite
pH _{fox}	Oxidised pH with the addition of peroxide onsite
SPOCAS	Suspension Peroxide Oxidation Combined Acidity and Sulfate

1. INTRODUCTION

EDP Consultants Pty Limited (EDP) was engaged by City of Canada Bay Council (Council), to prepare an Acid Sulfate Soils Management Plan (ASSMP) for Timbrell Park located in Five Dock, NSW on Lot 7010 in DP93651 and Lot 1 in DP356799 (the site). The ASSMP has been developed for the site following a detailed site investigation (DSI) ahead of planned upgrades to the sports field.

The objective of this ASSMP is to detail management strategies to mitigate the risks posed by the Potential Acid Sulfate Soils (PASS) at the site.

2. BACKGROUND AND INVESTIGATION

The site has been historically used by the community for waste disposal, which after closure was capped and transformed into the current grassed sports field.

EDP understands Council are undertaking ongoing upgrades to Timbrell Park, which may involve excavation and earthworks disturbing acid sulfate soils (ASS). These types of works may involve, but are not limited to trenching for new light tower configurations, or excavations for OSD or irrigation tank installation beneath the ground surface to support flood mitigation and site drainage.

This management plan has been prepared as a result of the findings from a detailed site investigation (DSI) undertaken by EDP; *Detailed Site Investigation – Timbrell Park, Sportsfield Upgrade, ref S-05594.DSI.001* (EDP, 2023).

As part of the DSI, a total of 42 selected sampling locations were targeted for ASS across the site with 93 individual pH_f and pH_{fox} tests. In accordance with the National acid sulfate soils identification (WQA 2018), these samples were screened for indicators of ASS. The majority of these selected sampling locations showed strong reactions to the addition of hydrogen peroxide (oxidation) resulting in increases in temperature, lower pH readings and releases of odorous gas. These are all indicators of PASS.

A review of analytical results indicated the following:

- pH_f (pH prior to oxidation) ranged between 4.97 and 7.5;
- pH_{fox} (pH post oxidation) ranged between 0.82 and 5.66; and
- The observed reaction of soil samples varied for all samples were high, indicating a risk of acid generation in oxidised at the site.

This PASS depth generally became shallower to the northeast of the site, closer to the Parramatta River. Net Acidity (Acidity Units) exceeded the WQ Australia 2018 - Acid Sulfate Soil Guidance Action Criteria (fine materials, >1000t disturbance) in numerous samples across the site. The majority of these samples were at depths of 1 or 2m. While less prominent than deeper soils, the existence of Acid Sulfate Soils must be acknowledged across site in the upper soil profile.

The Acid Sulphate Soil layer is likely to be a result of deposited dredged material from the Parramatta River to raise the site's ground level. This layer is not considered to be natural due to the occasional anthropogenic inclusions such as tile and glass at these depths.

3. OBJECTIVES

This ASSMP was developed to assist in the effective management of the environmental and waste disposal risks associated with excavating ASS during the development works. The objectives of the ASSMP are to:

- Ensure project personnel are aware of this plan and can identify instances of ASS from visual and olfactory observations;
- Ensure appropriate control measures are adopted to protect the environment;
- Provide a framework to manage and treat ASS soils to enable off-site disposal; and
- Contingency strategies.

4. SITE INFORMATION

4.1 Site Identification

Site identification details are summarised in **Table 1**. Refer to **Figure 1** for the site layout and **Figure 2** for the distribution of ASS on site provided in **Appendix A**.

Table 1: Site Setting

Site Setting	
Site Address:	Henley Marine Drive, Five Dock, NSW
Legal Identification:	Lot 7010 in DP93651 and Lot 1 in DP356799
Local Government Area:	City of Canada Bay
Investigation Area:	Timbrell Park
Current Zoning:	RE1 – Public Recreation
Site Elevation	Relatively flat and low lying with a variation of 2 – 4 mAHD. There is a slight and even slope towards the south and the Iron Cove Creek.
Former Land Use	Vacant land used briefly as a community landfill tip area.
Current Land Use:	Park, recreational open space
Surrounding Land Use	<p>The north of the site is immediately bound by Henley Marine Drive. Beyond this lies residential housing land.</p> <p>To the east of the site, Timbrell Drive runs from north to south and makes up the site's eastern boundary. Following Timbrell Drive is the Parramatta River.</p> <p>The Iron Cove Creek makes up the site's southern boundary. The creek runs from west to east and confluent with the Parramatta River at the site's southeast corner.</p> <p>The west of the site is immediately bound by Henley Marine Drive. Beyond this lies residential housing land.</p>
Acid Sulfate Soils:	<p>The Coastal Acid Sulfate Soils Register identifies the entire site as Class 2. In a Class 2 area, Acid Sulfate Soils are likely to be found below the natural ground surface and a development consent is required for disturbance.</p> <p>The Atlas of Australian Acid Sulfate Soils identifies the site as an area with a Low Probability of Occurrence. However, immediately to the east the parramatta river is identified as an area with a High Probability of occurrence. This is where dredged material is expected to have originated.</p>
Sensitive Receptors	<p>Sensitive receptors identified within a 500 m radius of the site include:</p> <ul style="list-style-type: none"> • Underlying soil and groundwater ecosystems; • Coastal wetland proximity buffer • Site users including on-site and off-site employees, construction tradesmen and visitors; and including occupiers of commercial buildings and/or residential properties down-gradient and adjacent to the site. • Ironbark creek (670m to the west of the site)

4.2 Soil and Geology

A review of the soil landscape from NSW OEH (eSPADE 2.0) indicated that the site is located within the Disturbed Terrain landscape which is characterised by extensive human disturbance, typically in previous swamps, estuaries and wetlands.

A review of the NSW Seamless Geology version 2.2 (May 2022) show that the site is underlain by Hawkesbury Sandstone bedrock (Triassic). These are typically characterised as medium to coarse grained quartz sandstone, with minor shale and laminate lenses. The superficial deposits on site are identified as alluvial valley deposits of Quaternary age. This layer consists of silt, clay, lithic to quartz-lithic sand and gravel.

Based on information available Detailed Site Investigation – Timbrell Park, Sportsfield Upgrade, the fill comprises anthropogenic deposits placed over former estuarine swamps and subaqueous estuarine margins (supratidal to subtidal zone); estuarine banks and islands formed from dredge spoil.

4.3 Hydrogeology

Hydrogeological information presented in previous reports indicated that the regional aquifer below and surrounding the site includes fractured or fissured, extensive aquifers of low to moderate productivity. There are no monitoring wells within a 500m radius of the site, with the nearest monitoring well being approximately 656.6 m to the southeast. The standing water level at this monitoring well is relatively shallow, at 1.5 mbgl. Regional groundwater flow direction and rainfall is expected to be consistent with topography, flowing generally towards Iron Cove Creek. Any excess water generated from rainfall events is expected to percolate through the soil into groundwater.

5. TECHNICAL FRAMEWORK

This ASSMP has been developed in general accordance with the following documents:

- NSW Work Health and Safety Act 2011;
- NSW Work Health and Safety Regulation 2017;
- NSW EPA Waste Classification Guidelines 2014: Part 1 – Classifying Waste; and Part 4 – Acid Sulfate Soils 2014 (NSW EPA 2014);
- NSW EPA Protection of the Environment Operations (POEO) Act 1997;
- NSW EPA POEO (Waste) Regulation 2014;
- ASSMAC Acid Sulfate Soils Assessment Manual 1998 (ASSMAC Manual 1998);
- Department of Agriculture and Water Resources National Strategy for the Management of Coastal Acid Sulfate Soils 2000
- Department of Agriculture and Water Resources National Acid Sulfate Soils Guidance; National acid sulfate soils sampling and identification methods manual 2018; and
- Department of Agriculture and Water Resources National Acid Sulfate Soils Guidance; National acid sulfate soils identification and laboratory methods manual 2018

The ASS assessment criteria as based on the ASSMAC Manual 1998 which incorporates the following guidelines:

- ASSMAC Acid Sulfate Soil Assessment Guidelines 1998;
- ASSMAC Acid Sulfate Soil Planning Guidelines 1998;
- ASSMAC Acid Sulfate Soil Management Guidelines 1998;
- ASSMAC Acid Sulfate Soil Laboratory Method Guidelines 1998
- Department of Agriculture and Water Resources National Acid Sulfate Soils Guidance; National acid sulfate soils sampling and identification methods manual 2018; and
- Department of Agriculture and Water Resources National Acid Sulfate Soils Guidance; National acid sulfate soils identification and laboratory methods manual 2018

6. ASSESSMENT CRITERIA

Assessment of ASS conditions and the impacts of the proposed development were based on information provided in the Department of Agriculture and Water Resources *National Acid Sulfate Soils Guidance; National acid sulfate soils sampling and identification methods manual 2018* (DAWR, 2018a) and *National Acid Sulfate Soils Guidance; National acid sulfate soils identification and laboratory methods 2018* (DAWR, 2018b). The DAWR includes information on assessment of the likelihood that the site lies within an ASS area, the need for an ASS management plan, and the development of mitigation methods for the proposed development.

6.1 Management Plan Trigger Criteria

The guidelines provide action criteria which determine the need to prepare an ASSMP, based on the percentage of oxidizable sulfur or Total Potential Acidity (TPA), for broad categories of soil. The action criteria adopted for this ASSMP are provided in the **Table 3**.

Table 2: ASSMP Action Criteria

Type of Material		Action Criteria 1–1000 tonnes ASS disturbed		Action Criteria if more than 1000 tonnes disturbed	
Texture range. McDonald et al. (1990)	Approx. clay content (%<0.02mm)	Sulfur trail % S oxidisable (oven-dry basis) e.g. STOS or SPOS	Acid trail mol H ⁺ /T (oven-dry basis) e.g. TPA or TSA	Sulfur trail % S oxidisable (oven-dry basis) e.g. STOS or SPOS	Acid trail mol H ⁺ /T (oven-dry basis) e.g. TPA or TSA
Coarse Texture	<5	0.03	18	0.03	18
Sands to loamy sands	5 - 40	0.06	36	0.03	18
Medium Texture	>40	0.1	62	0.03	18

The action criteria for coarse textured soils (sands to loamy sands) be adopted for the site. The criteria will vary depending on the disturbance volume. At the time preparation of this plan, with works at the park involving excavations for lighting and drainage detention basins, it is assumed that greater than 1000 tonnes of material will be disturbed.

An Environmental Consultant may be needed to be engaged with to help determine if action criteria are met for other minor disturbances in specific areas of the site

6.2 Treatment Verification Criteria

DAWR, 2018b includes guidance to verify if sufficient neutralising material has been applied to soil to prevent any further acidification. In a properly ameliorated soil, the pH_{kel} will usually be greater than 6.5 and the verification net acidity will be less than zero. In the determination of verification net acidity, the acid neutralising capacity (ANC) measured in the treated soils is subtracted from that initially measured in the untreated soil.

At the time of preparation of this ASSMP, an investigation has been completed to assess the ASS potential within the fill and natural materials at the site. This data should be used to determine individual, or average ANC for non-treated soils across the site. Indicative lime dosing rates will also be informed by the investigation data that has been collected

The verification net acidity equation is provided in DAWR, 2018b and is as follows.

Equation 3.3 Verification Net Acidity.

$$\begin{aligned}
 \text{Verification Net Acidity} &= \text{Potential Sulfidic Acidity} + \text{Actual Acidity} + \text{Retained Acidity} \\
 &\quad - (\text{post treatment Acid Neutralising Capacity} \\
 &\quad - \text{initial Acid Neutralising Capacity})
 \end{aligned}$$

In summary, the verification criteria for treated ASS is:

- Net acidity (using appropriate fineness factor) = Zero or negative $\text{mol H}^+ / \text{t}$
- pH_{kcl} = Greater than 6.5

7. ACID SULFATE SOIL DELINEATION AND MANAGEMENT STRATEGY OVERVIEW

7.1 Acid Sulfate Soil Occurrence

It is considered that the following soils have an elevated risk of containing PASS and should be assumed to be PASS unless further investigation confirms otherwise:

- Fill - as sand or clay but mainly sandy CLAY places. Contains some glass and tile, but appears minor; and
- Alluvial sediments consisting predominantly of dark silty clay.

PASS is suspected within the fill and natural soils from varying depths overlying bedrock to as deep as 2 m across the site.

7.2 Management Strategy Overview

ASS management will be required to prevent adverse impacts occurring to the environment and infrastructure from ASS during the proposed excavation works at the site.

Based on the nature of the works, and the identification of PASS within the soils planned for disturbance, the recommended ASS management strategy for the proposed works should be undertaken over two stages:

- Stage 1: Onsite treatment and assessment prior to off-site disposal; and
- Stage 2: Disposal of treated ASS offsite.

At time of preparation of this ASSMP, it is understood that excavated soils will be disposed offsite. However, if there is opportunity for re-use, soils which have been demonstrated to be effectively treated for ASS and do not present any other chemical or contamination risks, can be considered for re-use.

8. RESPONSIBILITIES

A copy of this ASSMP should be kept onsite at all times and anyone who will conduct work within the site or will be undertaking future works must be inducted into this ASSMP.

Table 4 provides a summary of responsibilities of interested parties onsite which relates to the project.

Table 3: Summary of Responsibilities

Position / Organisation	Report to	Summary of Responsibilities
Site Owner / Council	Regulatory Authorities (as required)	<ul style="list-style-type: none"> ▪ Engage Civil Contractor. ▪ Engage a suitably qualified environmental consultant ▪ Communicate requirements to all contractors. ▪ Review documentation provided by contractors. ▪ Review the ASSMP and any other reports developed by consultants. ▪ Ensure the ASSMP is implemented correctly. ▪ Ensure the ASSMP is available to anyone.

Position / Organisation	Report to	Summary of Responsibilities
Civil Contractor / TBC	Council	<ul style="list-style-type: none"> Must have experience in managing, treating and disposing ASS. Complete SafeWork NSW permits and notification as required. Notify landfill for acceptance of the waste and adhere to landfill requirements. Undertake ASS treatment, soil and wastewater removal in accordance with their contract and ASSMP requirements for the site. Follow instructions by environmental consultant during the works. Regularly inspect and monitor all activities for adherence to appropriate environmental standards. Undertake works in a safe and environmentally responsible manner and in accordance with legislative requirements. Management of unexpected constraints and conditions that may arise during the works.
Environmental Consultant / TBC	Council	<ul style="list-style-type: none"> Must be experienced in contamination assessments including the identification and management of ASS. Provide work, health and safety and environmental consultancy to Council. Ensure works are undertaken in accordance with this ASSMP and current legislative requirements. Provide validation testing for ASS and waste classification assessments prior to off-site disposal as required. Track all materials moving on and off-site. Undertake surface water monitoring as required.

9. STAGE 1: ASSESSMENT AND ONSITE TREATMENT PRIOR TO OFF-SITE DISPOSAL

The strategy outlines the initial assessment, onsite neutralisation, management, monitoring and validation of ASS within soils planned for off-site disposal. This strategy should be undertaken as required using the methodology outlined below.

9.1 Treatment Area Setup

Responsible Party: Civil Contractor

An appropriate assessment/treatment area must be constructed for the treatment of excavated soils. The soils are to remain within this area until the treated soils are considered appropriate to be removed off-site. The assessment/treatment area should be constructed in accordance with the *ASSMAC Management Guidelines 1998* and the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines 2014*.

Allowances should be made during construction planning to reserve sufficient land to allow for these items. **Figure 2** below shows a cross section of a typical treatment pad. It should be noted that a treatment pad established on hardstand can achieve the outcomes of that described below without excavated drains. Final designs must be developed in reference to this ASSMP and approved by the supervising environmental consultant.

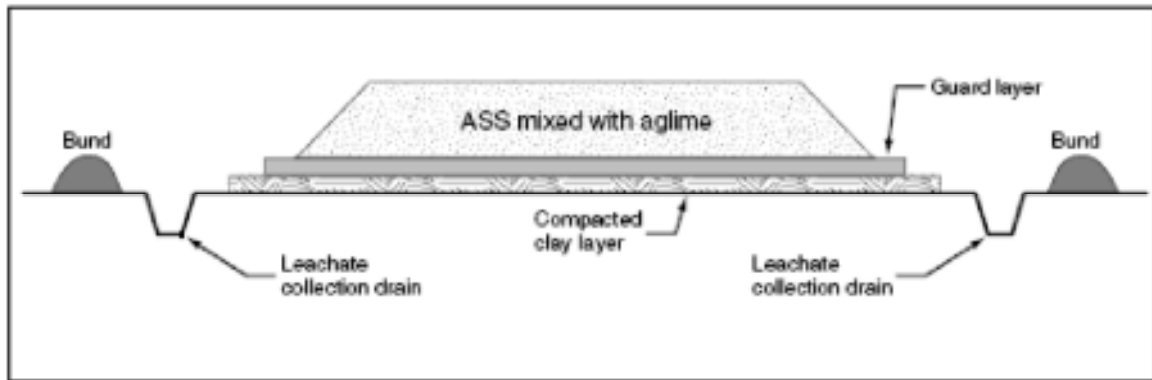


Figure 1 Schematic cross-section of a treatment pad, including clay layer, guard layer, leachate collection system and containment with bunding

The assessment/treatment area should be prepared as follows:

- Prepare a treatment pad of appropriate area for the volume of soil to be treated/stored. The pad should be prepared on relatively level or gently sloping ground to minimise the risk of any potential instability issues.
- It is recommended that the ASS treatment area must be constructed on hardstand or a similar impervious layer such as high-density polyethylene (HDPE) sheeting, and shall be within a portion of the site that does not lie in a natural drainage line.
- Apply a guard layer of fine agricultural lime (ag-lime) over the impervious layer, to neutralise downward seepage. This guard layer should be applied at a rate of 5 kg of ag-lime/m² per vertical meter of fill. The guard layer should be re-applied following removal of treated soils prior to addition of untreated ASS.
- Liming pads should be bunded with onsite soils not classified as PASS and a perimeter drain excavated to collect and contain leachate. The bunds should be preferably constructed of low permeability soil (i.e. clay) or, where suitable soil is not available, hay bales covered with impermeable plastic, with bunds at least 0.3 m high around the entire stockpile/treatment area. The drain and inner bund slopes should have a layer of ag-lime applied to neutralise any possible leachate migrating from the stockpiled material.

It should be noted that alternate methods for establishing an appropriate assessment/treatment area may be considered due to practicality constraints onsite. This would be subject to achieving the required treatment standard to the satisfaction of a suitably qualified environmental consultant.

9.2 Assessment and Treatment Process

9.2.1 Assessment

Responsible Party: Environmental Consultant

As EDP has already identified PASS within the site within the DSI, this step of assessment is considered to be have been accomplished. If any further assessment is required, it should be undertaken in accordance with DAWR, 2018a Table 6.1 – Minimum soil sampling densities for ASS investigations as shown in Figure 2 below.

Table 6.1 Minimum soil sampling densities for ASS investigations.

Type of disturbance	Extent of site	Sample point frequency
Small volumes (< 1000 m ³) – prior to disturbance	Volume of disturbance (m ³)	Number of boreholes
	< 250	2
	251–500	3
	501–1000	4
Large volumes (> 1000 m ³) – prior to disturbance	Project area (ha)	Number of boreholes
	< 1	4
	1–2	6
	2–3	8
	3–4	10
	> 4	10 plus 2 per additional hectare
Linear	Width and volume	Intervals (m)
	Minor ¹	100
	Major ²	50
Existing stockpiles & verification testing	Volume (m ³)	Number of samples
	< 250	2
	251–500	3
	1000	4
	> 1000	4 plus 1 per additional 500 m ³

Figure 2 Minimum Soil Sampling Densities

9.2.2 Treatment

Responsible Party: Civil Contractor

The treatment process should involve the following:

- Removal of non-ASS overburden (i.e possible non-ASS fill) from the soils containing ASS to the satisfaction of a suitably qualified environmental consultant;
- Transport ASS material requiring treatment to the assessment/treatment area;
- Manage ASS during stockpiling and treatment to minimise dust and leachate generation (eg. by covering, or lightly conditioning with water). If wet weather prevails, stop works and cover the stockpiled material with a HDPE sheeting to reduce the formation of leachate;
- Limit the surface area of the ASS exposed to oxygen by forming relatively high-coned stockpiles;
- Material must be treated as soon as practical. Several treatment areas may be required for stockpiling and treatment, depending on the quantity of ASS material excavated;
- Spread the ASS onto the guard layer in a layer of 0.2 to 0.3 m thickness. When spreading the first soil layer, care should be taken not to churn the lime guard layer;
- Let the ASS dry to facilitate lime mixing (if too wet, then adequate mixing of lime cannot be undertaken);
- Apply ag-lime (refer to **Section 9.4**) to the stockpiled soil, at the indicative liming rate in **Section 9.4** and harrow/ mix thoroughly prior to spreading the next layer;
- Continue the spreading/liming/mixing cycle. This can be done one layer at a time, or with multiple ASS layers placed on top of each other;
- Assess the success of the treatment using validation testing in accordance with **Section 9.5**;
- If validation sampling indicates that additional neutralisation is required, add additional lime and mix;
- When validation testing indicates that lime neutralisation is complete in accordance with **Section 9.3**, then the stockpiled soil may be assessed for waste classification purposes;
- Undertake waste classification assessment and dispose off-site in accordance with **Section 10**;
- Management of leachate and wastewater in accordance with **Section 11.1**.

It is possible that excavation of both acidic and ASS will be required for the proposed development. The excavated soils should be stockpiled such that the acidic soils are segregated from the ASS and that these soils are also segregated from non-ASS.

Additionally, stockpiles of ASS should be kept moist to minimise oxidation, prior to lime treatment. They should be covered to prevent rainfall leaching through the stockpile and possibly creating acidic runoff and be located as far away as possible from any sensitive receptors (e.g. waterways, drainage channels etc.)

9.3 Neutralising Materials for Soils

Responsible Party: Civil Contractor and Council

An appropriate neutralising agent must be selected for the works. Ag-lime is the preferred neutralisation material for the management of ASS. Ag-lime comprises calcium carbonate (CaCO_3), typically made from limestone that has been finely ground and sieved to a fine powder. Ag-lime with a purity of 95% or better should be used (i.e. $\text{ENV} \geq 95$, where ENV is the effective neutralising value, a term used to rate the neutralising power of different forms of materials relative to pure, fine CaCO_3 which is designated $\text{ENV} = 100$). The ag-lime should be fine and dry, as texture and moisture can also decrease the ENV.

9.4 Lime Application Rate

Responsible Party: Civil Contractor and Environmental Consultant

The amount of lime required for treatment of ASS material must be estimated based on the laboratory analytical results.

Based on the results of the Chromium Reducible Sulfur suite, a liming rate was calculated (kg of CaCO_3 /tonne of soil), detailing the volume of lime required to neutralise the acidity present within the soils, based on total and potential acidity as well as the acid neutralising capacity of the soils.

It should be noted that the acid production will vary both horizontally and vertically through the ASS profile due to the variability of natural systems. The liming rate to be calculated from the analytical results should therefore be considered as a 'starting point', and pH monitoring should be conducted during treatment to assess the progress of the neutralisation and need for additional mixing and/or addition of ag-lime.

Within the DSI the associated liming rates ranged from 0 to 52 kg of CaCO_3 per tonne of soil with average of 6.8 kg CaCO_3 per tonne of soil. However EDP considers that a recommended liming rate of 10 kg CaCO_3 per tonne of soil is appropriate. If the liming rate being used is not proving effective it may be necessary to increase the lime dose per tonne. See Appendix C for more information on contingency procedures in the event that the liming rate being used is ineffective.

Material will only be considered to have been successfully treated when all soil has been validated in accordance with **Section 6.2**. If an alternate neutralising product is used, a specific dosing rate will need to be calculated.

A useful online liming rate calculator provided by the Western Australian Government, Department of Environment Regulation can be used for updating liming rates if more analytical data becomes available during the works.

Liming Rate Calculator: <https://www.der.wa.gov.au/your-environment/acid-sulfate-soils/67-lime-rate-calculations-for-neutralising-acid-sulfate-soils>

For material remaining in-situ, an application of lime should be applied by dusting the top surface of the soil following excavation. The intent is to form a narrow crust of neutralised soil to prevent significant acid generation. However excessive amounts of lime should not be applied to prevent altering the chemistry of the receiving waterbody. It should be noted that in-situ material does not require validation, however ongoing monitoring may be required for soil and water parameters at the site.

9.5 Validation Testing

Responsible Party: Civil Contractor and Environmental Consultant

A suitably qualified environmental consultant must conduct all validation inspections and validation sampling required during the treatment works. The validation assessment should be conducted progressively throughout the bulk excavation works, following the neutralisation and blending of each stockpile of material. The validation assessment shall be undertaken as follows:

- A visual and olfactory assessment to determine that indicators of ASS such as monosulfidic black ooze (MBO), unripe muds, peat or peat soils, coffee rock or sulfurous/hydrogen sulfide odours:
- During and following neutralisation, the stockpiled soils can undergo pH screening to provide an indication of that the appropriate quantities of lime have been added and the soils have been suitably mixed/blended
- NATA accredited laboratory testing. The preferred laboratory testing method is the Chromium Reducible Sulfur suite, and should be undertaken at a frequency of at least 1:250 m³ from within the treated material with a minimum of 2 samples, to validate the lime neutralisation:
 - Validation sampling locations to be selected on:
 - Systematic sampling (gridded) pattern;
 - Visual inspection for indications of ASS during site inspection; and
 - Accessibility of the proposed sampling location.
 - Validation samples shall be collected using the following methodology:
 - Soil samples will be recovered from a minimum of 0.3 m beneath the soil surface of the stockpile utilising hand equipment;
 - Nitrile gloves will be used during sampling, with a change of gloves between each sampling location;
 - Soil samples will be collected in sampling containers provided by the analysing laboratory, ensuring sufficient sample is collected for the required analysis;
 - All containers will be clearly labelled with unique sample identification; and
 - All samples will be stored on ice prior to dispatch and during transportation to the nominated laboratory under chain of custody procedures.
- Compare the validation results with the verification criteria given in **Section 7.1**. If all results meet the verification criteria, the ASS will be considered to have been successfully treated and may be disposed off-site to an appropriately licensed waste facility following the procedures outlined in **Section 10**.
- Further treatment and verification testing of the soil will be required if the verification criteria are not met, or there is sufficient rationale to confirm the adequate treatment of soil.
- Analytical results are to be compiled into a ASS stockpile validation report and incorporated into this ASSMP.

10. STAGE 2: OFFSITE DISPOSAL OF TREATED ACID SULFATE SOILS

Responsible Party: Civil Contractor and Environmental Consultant

Following successful treatment of ASS, the environmental consultant must undertake chemical assessment of the soils, or alternatively review the available chemical data for the soils for comparison against NSW EPA 2014 criteria in order to facilitate off-site disposal. All testing must be undertaken in accordance with the Remedial Works Plan.

Stockpiled materials will need appropriate storage onsite while waste classification or ASS verification testing is undertaken. As a minimum, each stockpile will need to be maintained and secured within the assessment/treatment area and covered with weighted HDPE sheeting to prevent leachate generation whilst awaiting waste classification assessment results.

Prior arrangements should be made with the waste facility to ensure that it is licensed to accept the waste. The waste facility should be informed that the PASS has been treated in accordance with the neutralising techniques outlined in this ASSMP and that the waste has also been classified in accordance with NSW EPA 2014.

II. WATER MANAGEMENT

II.1 Leachate and Wastewater Management

Responsible Party: Civil Contractor

Given the presence a shallow groundwater table and the likelihood of the acidic and ASS being saturated during excavation, it is expected that dewatering will be required and that leachate will be generated from stockpiled soils. Given the suspected presence of acidic and ASS, it is possible that the leachate / groundwater may have an adverse impact on the environment, if untreated. Any leachate / groundwater generated must be collected for subsequent monitoring and treatment as required. The following is recommended:

- Eliminate need for dewatering, where possible.
- Minimise the time and volume of dewatering (i.e. staged dewatering and excavation over relatively short durations), if undertaken.

The pH of leachate water or water extracted during dewatering operations should be monitored and adjusted prior to discharge. Adjustment of pH should be undertaken if discharge water falls outside the discharge quality limits specified for discharge to the sewerage or stormwater system (subject to regulatory approval) or the land via evaporation/infiltration. The pH levels should also be compared to background levels of nearby waters.

The amount of neutraliser required to be added to the discharged leachate/groundwater can be calculated from the equation below:

$$\text{Alkali Material Required (kg)} = [(M_{\text{Alkali}} \times 10^{-\text{pH initial}}) / 2 \times 10^3] \times V$$

Where: pH initial = initial pH of leachate

V = volume of leachate (litres)

M_{Alkali} = molecular weight of alkali material (g/mole)

The alkali should be added to the discharged leachate/groundwater water as slurry. Mixing of the slurry is best achieved using an agitator. Leachate water collected from bunded areas and stockpiles (in catch ponds), and extracted groundwater should be neutralised as necessary before release. Calcined magnesia (magnesium hydroxide, burnt magnesite, or magnesia) is the recommended neutralising agent as it produces a two-step reaction, which proceeds rapidly at acidic pH and slows down as higher pH is approached, and hence reduces the potential for over neutralisation to occur. Furthermore, whilst ag-lime is well suited to the treatment of soils, it does not readily dissolve in water and is limited in effectiveness of adjusting the pH of water. Hydrated lime ($\text{Ca}(\text{OH})_2$) is more soluble than ag-lime making it more suited to treating water, but it has a high pH value (pH ~12). Therefore, if hydrated lime is to be used to treat water, then it should be added incrementally with care and thoroughly mixed to prevent overshooting the desired pH. As a guide, the approximate quantities of hydrated lime provided in **Table 4**, would be required to neutralise acidic water.

Table 4: Recommended Approximate Liming Rates for Water

Water pH	Water Extraction Rate		
	2 m ³ /hr	5 m ³ /hr	10 m ³ /hr
2	0.74	1.85	3.7
3	0.074	0.185	0.37
4	0.0074	0.0185	0.037
5	0.00074	0.00185	0.0037
6	0.000074	0.000185	0.00037

Notes: Liming rates are for hydrated lime (kg of $\text{Ca}(\text{OH})_2$)

11.1.1 Water Discharge Criteria

Notwithstanding any additional regulatory requirements placed on water disposal by Water NSW or NSW EPA or through licensed discharge criteria, it is recommended that Council's Policy for the Discharge of Liquid Trade Waste and Septic Waste to the Council's Sewerage System and the ANZECC 2000 criteria are met before discharging any water, leachate or groundwater to the environment, as detailed in **Table 5**.

Table 5: Water Discharge Criteria

Indicator	Sewer	Stormwater	Land Application
pH	7.0 – 9.0	6.0 – 8.0	6.0 – 8.0 (or within background levels)
Total suspended solids (TSS)	300 mg/kg (600 mg/L) ²	25 mg/L	NA
Visible oil & grease	NA	None visible	None visible
Total dissolved solids (mg/L)	1,000	10,000	1,000

Notes:

1. Field measurement of turbidity may be substituted for TSS subject to regulatory approval. Correlation of Turbidity to TSS is dependent on site specific factors and it is recommended that if turbidity is to be monitored then the relationship should be established at the commencement of the monitoring programme. Notwithstanding, an initial approximate correlation of turbidity to TSS would be 0.5 NTU approximates 1 mg/L TSS.

2. It is understood that concentration up to 600 mg/L may be accepted by GCC for some sites.

12. REPORTING

ASSMAC Manual 1998 or DAWG, 2018a does not require formal reporting of ASS management however, it is important to keep records of the management and validation process to show compliance with the guidelines. A record of management, treatment, monitoring, validation and disposal of ASS should be maintained by the Civil Contractor and provided to Council and should include the following details:

- Date(s) of works involving ASS;
- Location/area and depth of excavated ASS;
- Waste facility location and copy of licence;
- Where relevant for neutralisation of ASS, an ASS stockpile validation report should be prepared which includes:
 - Neutralisation process undertaken;
 - Liming rate utilised;
 - Results of analytical testing and comparison to acceptance criteria;
 - Neutralised ASS disposal (landfill) location; and
- Tonnages of material treated/disposed and waste dockets.

13. CONSULTATION AND COMMUNICATION

All project personnel, subcontractors and consultants will receive training in both Council and their personal environmental obligations during the inductions and toolbox talks.

All project personnel will undergo a general project induction prior to commencing work with Council. This will include an ASS component to reinforce the importance of management and the measures that will be implemented to address ASS issues at the site.

Site inductions and toolbox talks will highlight the specific environmental requirements and activities being undertaken at the site. These will be based on the measures outlined in the specific Safe Work Method Statements. Examples of topics that should be covered during project induction and toolbox talks include:

- Location and planned disturbance of ASS at the site;

- Management procedures in place for handling and treating ASS impacted soils;
- Site set up and location of ASS treatment areas; and
- Unexpected discovery of ASS.

14. ENVIRONMENTAL INCIDENT & COMPLAINTS MANAGEMENT

Details of all complaints received or incidents must be recorded on the Complaint/Incident Record Form provided in the site Environmental Management Plan, with the information to be recorded to include, as a minimum:

- Date and time that the complaint was received, or the incident occurred;
- The name, address and contact details of the person making the complaint, or reporting the incident;
- The name of the person who received the complaint, or received notification of the incident;
- A brief description of the issue; and
- A summary of the actions implemented to address the complaint/incident, including the dates that these actions were implemented and the signature of the persons responsible for resolving or rectifying the issue.

15. SITE SUPERVISION

Site supervision during excavation/earthworks must be undertaken by an appropriately qualified environmental consultant or personnel appropriately trained and competent in the identification of ASS. Supervision is required to ensure that the excavated materials are appropriately handled and that materials different to those encountered during the in-situ investigation onsite are assessed. It is envisaged that written instruction would be issued to the site personnel at the completion of each inspection that would identify the materials encountered during excavation and the appropriate treatment or handling procedures required.

As part of the site supervision the environmental consultant or competent person shall be responsible for monitoring excavations, truck loading and recording the truck movements and load characteristics. Load information shall be verified by comparison with tip dockets. A daily record containing the following information must be prepared:

- Details of unusual materials or odours encountered during excavations;
- pH meter calibration details;
- Location and results of pH monitoring (where undertaken);
- Details of accidents or incidents on the site;
- Details of any environmental issues and any related corrective and preventive action taken;
- Details of any visitors relation to environmental or health issues;
- Details of contractors engaged for the removal of waste;
- Record of soil volumes excavated, truck movements including destination/source, volumes of material exported/imported to the site;
- Daily site diagrams showing the location of stockpiles, excavations and sediment controls; and
- Records of soil sampling locations.

16. DOCUMENTATION AND RECORD KEEPING

All relevant documentation will be maintained by Council. The documentation to be maintained may include (but not be limited to):

- Staff and contractor inductions provided as **Appendix E** of this ASSMP;
- NSW EPA Waste Transport Certificates;
- Transportation dockets for excavated soil removed from the site, with a summary of these to be included on the materials tracking forms provided as **Appendix F** of this ASSMP;
- Soil classification documentation that relates to any soil that requires further investigation and sampling during the course of the excavation works;
- Ongoing management requirements for material to remain in-situ;
- Stockpile validation and classification records; and
- Complaints/incidents register.

STATEMENT OF LIMITATIONS

This document has been prepared in response to specific instructions from the client to whom the report has been addressed. The work has been undertaken with the usual care and thoroughness of the consulting profession. The work is based on generally accepted standards, practices of the time the work was undertaken. No other warranty, expressed or implied, is made as to the professional advice included in this report.

The report has been prepared for the use by the client and the use of this report by other parties may lead to misinterpretation of the issues contained in this report. To avoid misuse of this report, EDP advises that the report should only be relied upon by the client and those parties expressly referred to in the introduction of the report. The report should not be separated or reproduced in part and EDP should be retained to assist other professionals who may be affected by the issues addressed in this report to ensure the report is not misused in any way.

EDP is not a professional quantity surveyor (QS) organisation. Any areas, volumes, tonnages or any other quantities noted in this report are indicative estimates only. The services of a professional QS organisation should be engaged if quantities are to be relied upon.

Reliance on Information Provided by Others

EDP notes that where information has been provided by other parties in order for the works to be undertaken, EDP cannot guarantee the accuracy or completeness of this information the client therefore waives any claim against the company and agrees to indemnify EDP for any loss, claim or liability arising from inaccuracies or omissions in information provided to EDP by third parties.

Recommendations for Further Study

The industry recognised methods used in undertaking the works may dictate a staged approach to specific investigations. The findings therefore of this report may represent preliminary findings in accordance with these industry recognised methodologies. In accordance with these methodologies, recommendations contained in this report may include a need for further investigation or analytical analysis. The decision to accept these recommendations and incur additional costs in doing so will be at the sole discretion of the client and EDP recognises that that the client will consider their specific needs and the business risks involved. EDP does not accept any liability for losses incurred as a result of the client not accepting the recommendations made within this report.

Appendix A: Figures

FIGURE AI: OVERVIEW OF SITE LOCATION



Appendix B: Acid Sulfate Soil Definitions and Potential Impacts

ACID SULFATE SOILS DEFINITIONS

ASS are naturally occurring sediments containing iron sulfides, primarily pyrite, commonly deposited in alluvial and estuarine environments. The occurrence of ASS is associated with areas or regions that have previously been or are currently estuarine environments. Due to changes in sea level or geomorphologic changes to the coastal systems, these sediments are often overlain by terrestrial sediments.

When ASS are exposed to air (e.g. due to excavation or dewatering), the oxygen reacts with iron sulfides in the sediment, producing sulfuric acid. This acid can be produced in large quantities and is highly mobile in water. The process can also release iron and other metals present in the soils.

The sulfuric acid (and metals) can drain into waterways causing severe short and long-term socioeconomic and environmental impacts, including damage to man-made structures and natural ecosystems.

ASS can either be classified as AASS that have already reacted with oxygen to produce acid, or PASS. AASS and PASS are often found in the same profile, with AASS generally overlying PASS horizons.

PASS are soils containing iron sulfide that have not been exposed to oxygen (e.g. soils below the water table). The field pH of these soils in the undisturbed state is 4 or more and is commonly neutral or slightly alkaline. However, they pose a considerable environmental risk when disturbed, as they will become more acidic when exposed to air and oxidised.

POTENTIAL IMPACTS OF ACID SULFATE SOILS DISTURBANCE

The generation of AASS can result in the release of sulfuric acid and iron into the soil and surrounding waters. This in turn can release aluminium, nutrients and heavy metals (particularly arsenic) stored within the soil matrix. Once mobilised in this way, the acid, metals and nutrients can seep into waterways, killing fish, other aquatic organisms and vegetation.

Additionally, low levels of impact include reduced hatching, decline in growth rates, skin and health impacts for aquatic life. The potential impact on water leaching activities also include change in pH of soil and water, changes to water quality and changes to the hydraulic regime. Soil texture or sediment particle size distribution also affects the potential impacts of exposing ASS. Coarse-textured sulfidic sands are particularly vulnerable to rapid oxidation due to their relatively higher permeability and negligible buffering capacity. Water also moves through coarse material quickly, which may create large volumes of contaminated leachate.

AASS exposure can result in medium to long-term changes in soil chemistry. Changes in soil chemistry may affect the water quality of the tidally influenced area, resulting in reduced biodiversity and potentially death of flora and vegetation.

As the works will involve the disturbance of PASS adjacent to Brisbane Waters, the implementation of the controls detailed in this plan are required to minimise the potential acid generating impacts of the soils associated with the planned works at the site. Particular care should be taken with allowing air to penetrate sandy sediments as they have little buffering capacity. These materials can oxidise and leach very rapidly.

ACID SULFATE SOILS MAPPING

The Department of Land and Water Conservation has prepared Acid Sulfate Soil Risk Maps for the coastal areas in NSW that predicts the distribution of acid sulfate soils based on an understanding of the factors that led to their formation reinforced by extensive soil surveying. The Acid Sulfate Soil Risk Maps have also been converted into Acid Sulfate Soil Planning Maps for use with Local Environmental Plans.

The Acid Sulfate Soil Planning Maps establish five classes of land based on the probability of acid sulfate soils occurrence and the type of works that might disturb them. The five classes in the Acid Sulfate Soils Planning Maps are shown in the table below.

Acid Sulfate Soil Risk Classes

Class of land pertaining to ASS	Nature of works requiring ASS Assessment
1	<ul style="list-style-type: none"> Any works
2	<ul style="list-style-type: none"> Works below natural ground surface Works by which the water table is likely to be lowered
3	<ul style="list-style-type: none"> Works beyond 1 m below natural ground surface Works by which the water table is likely to be lowered beyond 1 meter below natural ground surface
4	<ul style="list-style-type: none"> Works beyond 2 meters below natural ground surface Works by which the water table is likely to be lowered beyond 2 meters below natural ground surface
5	<ul style="list-style-type: none"> Works within 500 meters of adjacent Class 1, 2, 3 or 4 land which are likely to lower the water table below 1 m AHD on adjacent Class 1, 2, 3 or 4 land

Review of the City of Sydney's Acid Sulfate Soils Risk Map indicated that the site exists within unclassified land.

Appendix C: Contingency Procedures

CONTINGENCY PROCEDURES

In the event of a non-conformance, the source and nature of the event should be investigated, the effectiveness of the existing controls reviewed and modified where practical, and necessary strategies implemented to minimise further impacts. Contingency strategies for stockpiles and water quality exceeding performance criteria are outlined in the table below.

Contingency strategies for stockpile treatment and water quality exceeding performance criteria

Item	Event	Contingency Measures
Stockpile Treatment	ENV is not provided with the neutralising material.	Representative sampling of the neutralising agent should be conducted and analysed for calcium carbonate equivalence by a NATA accredited laboratory to determine the ENV of the material.
	Stockpile validation acceptance criteria are exceeded.	If pH_f and pH_{fox} and laboratory results of treated soil validation samples are outside the acceptable thresholds, further lime treatment of soils should be undertaken.
	Soils encountered during excavation works are not representative of the soils previously identified.	The soils should be treated as containing sulfidic components and assumed to be ASS unless sampling and analysis confirms otherwise.
Water Quality	Leachate or water generated from / in contact with ASS, exceed water quality performance criteria.	Cease discharging and assess control measures. Adjust lime treatment rates or other additives (such as flocculants) if required.
	EC, floatable matter and colours in the receiving water exceed performance criteria.	Cease discharging and assess control measures. A suitable treatment method such as aeration and/or filtration should be employed.

Appendix D: Unexpected Finds Protocol

IDENTIFICATION AND MANAGEMENT OF UNEXPECTED CHEMICAL CONTAMINATION AND/OR ACID SULFATE SOILS

ACID SULFATE SOILS

Should unexpected ASS be uncovered during the excavation works (i.e. the identification of soil displaying characteristics of the identified ASS geological units), the following steps should be followed:

- Cease works in the vicinity of the uncovered ASS;
- The workers identifying the unexpected ASS shall inform Aqualand of the suspected ASS;
- Appropriately stockpile the soil within an area designated for ASS;
- If necessary, use physical barriers to shelter and prevent runoff to environmentally sensitive features (i.e. Parramatta River, vegetated areas etc.);
- Assume the soil is ASS until an assessment is conducted;
- Engage a suitably qualified environmental consultant to undertake an environmental assessment of the affected area and provide further advice; and
- Further remedial works may be required or additional control measures in order to maintain a safe work zone.

CHEMICAL CONTAMINATION

Unexpected chemical contamination or ASS may potentially be uncovered during excavation works.

Should unexpected chemical contamination be suspected during the excavation works (i.e. the identification of odorous or stained soil) the following steps should be followed:

- Cease works in the vicinity of the uncovered contamination;
- Inform the site foreman of the suspected contamination;
- Use a physical barrier to isolate the area;
- Assume the soil is contaminated until an assessment is conducted;
- Commission a suitably qualified environmental consultant to undertake an assessment to determine the next stage of works; and
- Further remedial works may be required or additional control measures in order to maintain a safe work zone.

Appendix E: Induction Records

ACID SULFATE SOIL MANAGEMENT PLAN INDUCTION RECORD

[illegible]

Appendix F: Materials Tracking Record



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