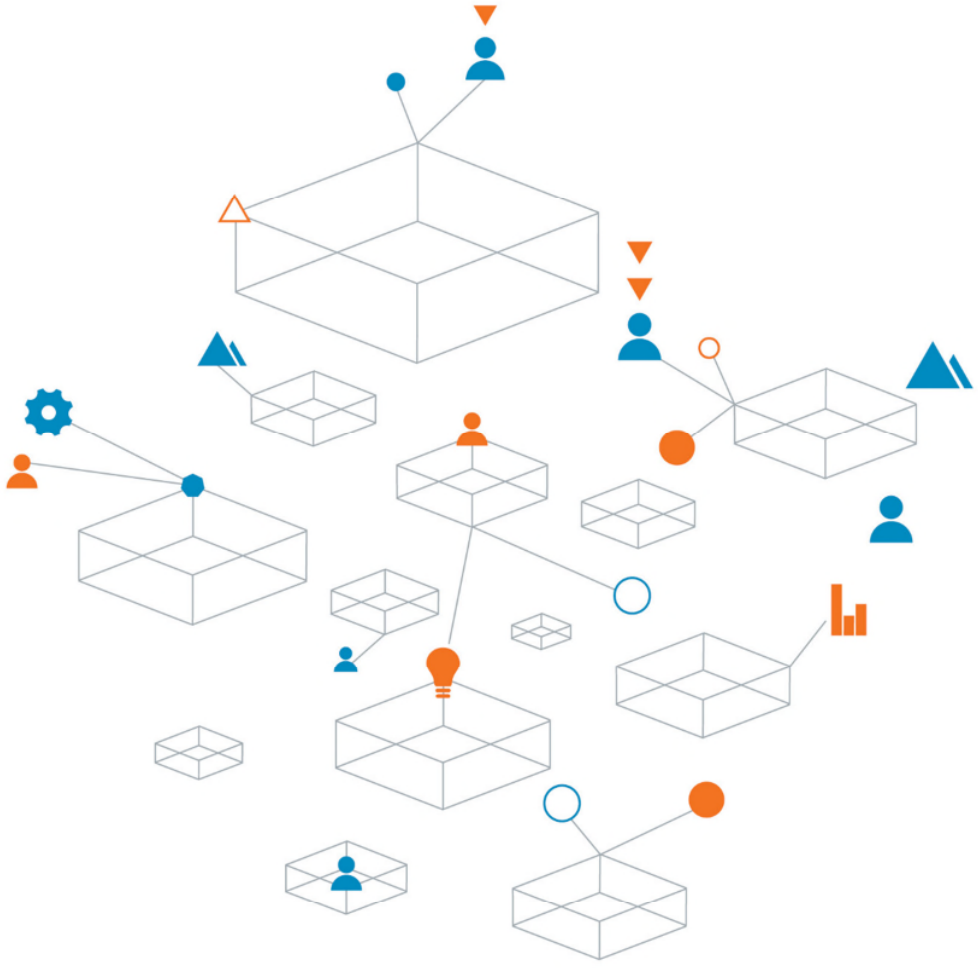
CMT Architects Australia Pty Ltd

Preliminary Acid Sulfate Soil Management Plan
921 Punchbowl Road, Punchbowl, NSW 2196

12 December 2019



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Preliminary Acid Sulfate Soil Management Plan: 921 Punchbowl Road, Punchbowl, NSW 2196

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1. Introduction

Coffey Services Australia Pty Ltd (Coffey) was engaged by CMT Architects Australia Pty Ltd (CMT) to prepare a Preliminary Acid Sulfate Soil Management Plan (ASSMP) for implementation during the redevelopment of 21 Canterbury Road, Punchbowl, NSW 2196 (the 'site'). The location of the site is shown on Figure 1 attached.

2. Background

Coffey understands that CMT propose to lodge a Development Application (DA) to Canterbury Bankstown Council for redevelopment of the site comprising

- Demolition of existing structures
- Construction of a two-storey commercial building in the south of the site including:
  - A two-storey basement with the lower level to provide car parking and storage, and the upper level to host a supermarket, seating area, storage rooms and loading zone.
  - A ground floor featuring Club Punchbowl and retail or commercial spaces.
  - A first floor with commercial spaces.
- Carparking with up to 200 spaces in the north of the site
- Landscaping around the new commercial building, site boundary and a garden area in the north-west of the site.

Development plans prepared by CMT Architects Australia Pty Ltd (CMT) are provided in Appendix A.

3. Objectives

The objective of this Preliminary ASSMP was to provide a framework to manage the potential disturbance of acid sulfate soils (ASS) and the formation of acidic leachate during excavation and redevelopment of the site.

This preliminary ASSMP was prepared in general accordance with the Acid Sulfate Soils Management Guidelines (Ahern et al, 1998b)[1] in the Acid Sulfate Soil Manual, published by the Acid Sulfate Soils Management Advisory Committee (ASSMAC)[2]. Reference has also been made to the Queensland ASS Technical Manual Soil Management Guidelines v4.0 (Dear et al 2014)[3].

This ASSMP is intended to be a dynamic document that can be updated as more information becomes available regarding the assessment of ASS at the site.

[1] Ahem CR, Stone Y and Blunden B (1998b) Acid Sulfate Soils Management Guidelines, Acid Sulphate Soils Management Advisory Committee, Wollongbar, NSW
[2] Acid Sulphate Soil Management Advisory Committee NSW 1998, Acid Sulfate Soil Manual
[3] Dear SE, Moore NG, Dobos SK, Watling KM and Ahern CR (2002) Queensland Acid Sulfate Soil Technical Manual - Soil Management Guidelines Version 3.8

4. Scope of Works

Coffey carried out the following scope of works:

- A site walkover including gauging of accessible groundwater monitoring wells.
- A desktop study comprising a review of:
  - Development plans prepared by CMT.
  - A Detailed Site Investigation (DSI) Report prepared by Benviron Group.
  - Online maps and plans pertaining to environmental setting of the site including soil landscapes, regional geology and acid sulfate soils.
- Preparation of this Preliminary ASSMP.

5. Site Identification

Site identification details are outlined in Table 1. The location of the site is shown in Figure 1 attached.

Table 1: Site Information

Item	Description
Address	21 Canterbury Road, Punchbowl. The site is also identifiable as 921 Punchbowl Road, Punchbowl, NSW 2196
Site area	Approximately 1.8 hectares (ha)
Title identification	The legal description of the site is: • A//DP378634 • D//DP382627 • 6//DP5245 • 15//DP132440 • 14//DP132440 • 1//DP236825 The lot boundaries are shown on Figure 2 attached.
Local Government Authority	Canterbury Bankstown Council
Current land use	Commercial property (Club Punchbowl). A description of the site is provided in Section 6.

6. Site Description

A site walkover was carried out on 31 October 2019 by a Geotechnical Consultant from Coffey. The following was noted.

- A 2 to 3 storey commercial property (Club Punchbowl) was present in the south of the site, which occupied approximately 1ha. The remainder of the site was largely covered with bitumen or concrete for car parking and walkways. The perimeter of the site was partially landscaped with trees and shrubs.
- Dumped waste was evident on the boundaries of the property in the north of the site.
- A channelized stormwater channel (concrete lined) was present in the north-west of the site.
- An electricity pylon and transmission easement was present in the north-west of the site.
- Two groundwater wells were identified (BH7/GW2 and BH14/GW3) in the west and south-east of the site respectively. The wells were gauged with a dip meter which recorded depths to water of 2.49m below ground level (BGL) and 2.96m BGL respectively. The location of the wells are shown on a borehole plan in Appendix C.

A survey plan provided by CMT is provided in Appendix B. A selection of photographs taken during the site walkover are presented in Appendix D.

7. Environmental Setting

The Environmental Setting of the site is summarised in Table 2.

Table 2: Environmental Setting

Item	Information reviewed	Discussion
Topography	Survey plan provided by CMT (Appendix B).	The site is situated at an elevation of approximately 7m above Australian Height Datum (AHD). The site is generally flat.
Surface Waters	Department of Finance, Services & Innovation Hydrography dataset available through the EnviroPortal Contaminated Land WebApp[4]	A non-perennial watercourse flows southerly through the west of the site in a concrete lined channel. The watercourse flows into Salt Pan Creek approximately 0.5km south-west of the site, which is a tributary of the Georges River. Surface runoff at the site is considered likely to flow into stormwater pits or directly into the concrete lined channel, ultimately discharging into Salt Pan Creek and the Georges River.
Critical Habitats	NSW Office of Environment and Heritage Critical Habitat Register[5]	There are no Critical habitat declarations at or within 250m of the site under Sections 53-55 of the Threatened Species Conservation Act 1995.

[4] https://www.enviroportal.com.au
[5] https://www.environment.nsw.gov.au/criticalhabitat/criticalhabitatprotectionbydoctype.htm

Item	Information reviewed	Discussion
Ramsar Wetlands	Department of the Environment and Energy National Dataset of Australia's Ramsar Wetlands data set through the EnviroPortal Contaminated Land WebApp[4]	There are no registered Ramsar Wetlands at or within 250m of the site.
Regional Geology	NSW Statewide Seamless Geology data set available through the EnviroPortal Contaminated Land WebApp[4]	The site is underlain by quaternary alluvial sand.
Soil Landscapes	Department of Planning, Industry and Environment Soil Landscapes of Central and Eastern NSW data set available through Espade[6]	The site is mapped as predominantly comprising the Birrong formation, with the north-east and south-west portions of the site mapped as the Blacktown formation. The Birrong formation is dominated by silt and clay sized alluvial materials derived from the Wianamatta Group. Soil acidity increases through the soil profile from slightly acid (pH 6.0) loamy soil at the surface through to strongly acid (pH 4.5) and slightly acid (pH 5.5) light grey clays overlying shale. The Blacktown formation are characterised by shallow to moderately deep (<100 cm) Red and Brown podzolic soils on crests, upper slopes and well-drained areas; deep (150-300 cm) yellow podzolic soils and soloths on lower slopes and in areas of poor drainage. Soil acidity increases through the soil profile from slightly acid (pH 5.5 to 7.0) loamy soil at the surface through to strongly acid (pH 4.0) and moderately acid (pH 5.5) light grey clays overlying shale. Both formations are underlain by the Wianamatta Group which consists mostly of laminite and dark grey siltstone with some carbonaceous claystone, and occasional fine to medium grain lithic sandstones

[6] https://www.environment.nsw.gov.au/eSpade2Webapp#

Item	Information reviewed	Discussion
Acid Sulfate Soils Risk and Classification	Department of Planning, Industry and Environment Acid Sulfate Soil Risk and Classification data sets available through the EnviroPortal Contaminated Land WebApp[4]	A portion of the site is mapped as disturbed terrain. The site is mapped as Class 2 and Class 3 Land under the Bankstown Local Environmental Plan 2015 Acid Sulfate Soils Maps. • Acid sulfate soils in a class 2 area are likely to be found below the natural ground surface. Any works beneath the natural ground surface, or works which are likely to lower the water table, will trigger the requirement for assessment and may require management.Acid sulfate soils in a class 3 area are likely to be found beyond 1 metre below the natural ground surface. Any works that extend beyond 1 metre below the natural ground surface, or works which are likely to lower water table beyond 1 metre below the natural ground surface, will trigger the requirement for assessment and may require management.
Environmentally Sensitive Land	Department of Planning, Industry and Environment Environmental Planning Instrument data set available through the EnviroPortal Contaminated Land WebApp[4]	The site is not mapped as being land of high environmental significance.
Groundwater Dependant Ecosystems	Groundwater Dependent Ecosystems Atlas available through the Bureau of Meteorology website[7]	There are no aquatic, terrestrial or subterranean GDE's within 250m of the site.

Maps pertaining to the environmental setting of the site are provided in Appendix E.

[7] http://www.bom.gov.au/water/groundwater/gde/map.shtml

8. Previous Reports

Coffey was provided with a Detailed Site investigation (DSI) Report[8] prepared by Benviron Group in 2016. A review of the report, with respect to ground conditions and ASS, indicates that:

- Thirty-one boreholes (BH1 through to BH31) were drilled at the site using solid stem augers. Ground conditions across the site generally comprised a layer of fill overlying silty clay/clayey silt, underlain by shale.
- The fill was generally extended to 0.3m mBGL, however a deeper area of fill to 1.8m BGL was encountered at borehole BH22 to the east of the commercial building in the south of the site.
- The silty clay/clayey silt was encountered in each borehole. A layer of gravelly sand (between 1.8m BGL and 3.5m BGL) was also encountered in BH1 in the north of the site.
- Shale was encountered in BH1, BH7 and BH14 between 3.7m BGL (BH7) in the west of the site and 5.1m BGL (BH14) in the east of the site.
- Groundwater wells were installed in clay within three of the boreholes (BH1/GW1, BH7/GW2 and BH14/GW3). Depth to standing water in the wells was measured on the day of installation. Groundwater levels recorded were 3.4m BGL (GW2), 3.6m BGL (GW1), and 4.9m BGL (GW3). pH of the groundwater measured in the field on the day of well installation ranged between 6.47 and 6.67 pH units.
- Benviron reported that soil staining or odours were not noted during sampling.
- Field screening or analysis for ASS was not carried out as part of the DSI, however Benviron concluded that an acid sulfate soils assessment was required once proposed development plans have been finalised.

A site plan showing the locations of boreholes and monitoring well is provided in Appendix C.

[8] Benviron Group. Detailed Site Investigation (DSI). 921 Punchbowl road, Punchbowl, NSW. Prepared for Westwood Pty Ltd. Ref: E881, Revision 0, dated 8 September 2016.

9. Coastal Acid Sulfate Soils Definitions

Coastal acid sulfate soils (ASS) are commonly found in low lying coastal floodplains, estuaries, rivers and creeks. They are naturally occurring sediments rich in iron sulfides that form sulfuric acid when exposed to oxygen. Coastal ASS can include **potential** ASS (PASS) and **actual** ASS (AASS).

PASS are soils which contain iron sulfides or sulfidic material. In their undisturbed state, PASS may exhibit a pH of 4 or greater, and may be slightly alkaline. When exposed to air, the sulfides in PASS oxidise and can release significant quantities of acid. Following oxidation, the pH of these soils may fall considerably below pH 3.5.

AASS are highly acidic soils resulting from the oxidation of iron sulfides or sulfidic material present in the soil profile. AASS are formed through the disturbance of PASS, which may be a result of either natural disturbances (i.e. regional fall in groundwater levels which exposes PASS to oxygen) or human disturbances (i.e. excavating PASS, dewatering and/or dredging). AASS are typically characterised by pale yellow mottles, coating of soils with jarosite and pH of 4 or less.

10. Likelihood of Encountering ASS

Based on the proposed redevelopment, mapped geology of the site, and information presented in the DSI, Coffey considers that there is a low to moderate likelihood of encountering ASS during basement construction. At the time of preparing this Preliminary ASSMP, sampling and analysis of soil samples for ASS had not been carried out. Coffey understands that soils excavated during basement construction and earthworks will be disposed offsite.

Exposure of AASS and/or oxidation of PASS during earthworks may lead to the generation of acidic leachate. Acidic leachate can be detrimental to the environment and the quality of in ground structures and services. Materials and machinery used may be susceptible to acidic corrosion. Acidic leachate can also mobilise toxic concentrations of metals.

11. Management Plan and Procedures

11.1. Principles for Mitigating Impacts from ASS

The following is an outline of the general principles for mitigating impacts associated with ASS as per the ASSMAC (1998) guidelines[2], with notes regarding applicability to the site:

Table 1: General principles for mitigating ASS impacts

	General Principle	Site-specific application
I	Avoid land where ASS occur	Proposed excavation works may disturb ASS, as such this option is not practical.
Ii	Avoid disturbing ASS soils if present on the property and avoid lowering the water table	Proposed excavation works may disturb ASS, as such this option is not practical.
Iii	Prevent the oxidation of sulfides	Proposed excavation works may disturb ASS, as such this option is not practical.
Iv	Neutralising acid as it is produced	This option is considered practical as there is space on site for stockpiling and treatment.
V	Separate out and treat the sulfidic component (i.e. pyrite) by sluicing if this material is very sandy	This option is not considered practical due to time constraints.
vi	Immediate burial of excavated PASS below the permanent water table	This option may be suitable if PASS is encountered providing appropriate disposal approvals are obtained and logistics are viable.

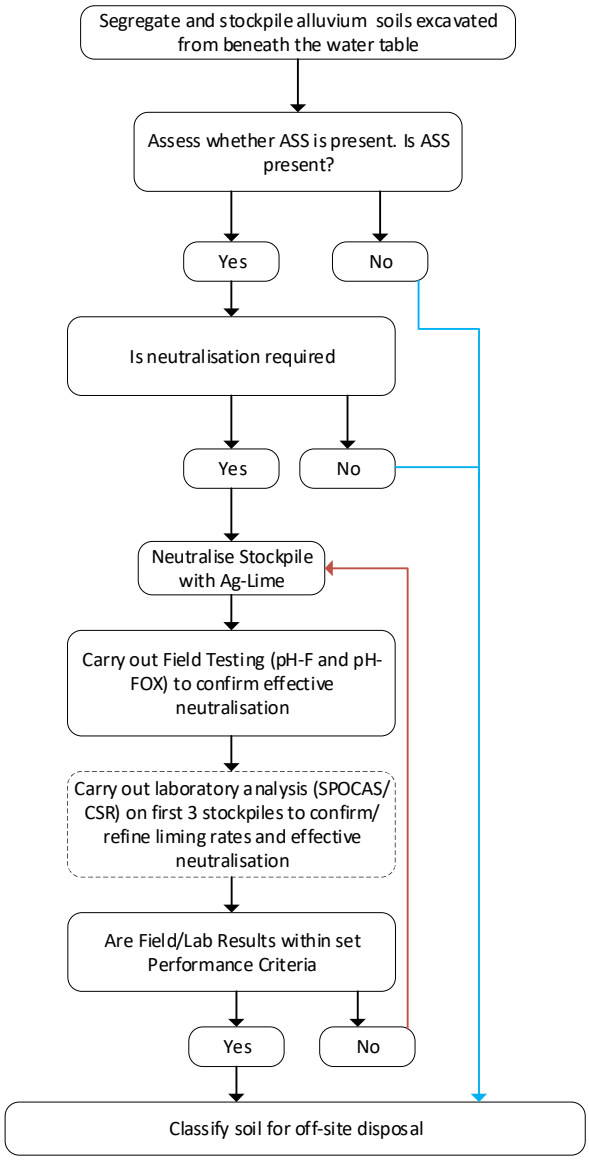
11.2. General

In the absence of in-situ analytical results for ASS, Coffey recommends the following is carried out during earthworks:

1) Groundwater management during dewatering.
2) Surface water monitoring prior to, and during excavation and treatment of ASS.
3) Segregate and stockpile alluvium/estuarine which is excavated from the site during earthworks.
4) Assess whether ASS is present.
    a) If AASS is present:
        i) Neutralise the AASS.
        ii) Test the neutralised AASS at an appropriate rate to confirm neutralisation has been achieved.
        iii) Dispose of treated and validated AASS at an appropriately licenced landfill facility.
    b) If PASS is present, either dispose of the PASS at an appropriately licenced landfill facility or:
        i) Neutralise PASS
        ii) Test the neutralised PASS at an appropriate rate to confirm neutralisation has been achieved.
        iii) Dispose of treated and validated PASS at an appropriately licenced landfill facility.

Soils requiring off-site disposal will be required to be classified in accordance with the NSW EPA Waste Classification Guidelines (2014) prior to offsite disposal.

The flow chart overleaf summarises the process, the procedures for which are discussed further in the following sections.


Segregate and stockpile alluvium soils excavated from beneath the water table
Assess whether ASS is present. Is ASS present?
Yes
No
Is neutralisation required
Yes
No
Neutralise Stockpile with Ag-Lime
Carry out Field Testing (pH-F and pH-FOX) to confirm effective neutralisation
Carry out laboratory analysis (SPOCAS/ CSR) on first 3 stockpiles to confirm/ refine liming rates and effective neutralisation
Are Field/Lab Results within set Performance Criteria
Yes
No
Classify soil for off-site disposal

11.3. Dewatering

Dewatering during basement excavation will require preparation of a dewatering management plan (DMP). Approvals to access and discharge water will need to be obtained from the relevant authorities (i.e. WaterNSW, Council and Sydney Water).

If dewatering exceeding 24 hours is required, such activity may result in drawdown of the groundwater table in the surrounding area. The lowering of the groundwater table may enhance oxidation of potential acid sulfate soils in the area.

The contractor should install and/or employ appropriate groundwater control systems to minimise the ingress of groundwater into the excavation such that the surrounding groundwater table will be maintained. The surrounding groundwater level should be monitored regularly by the contractor. The contractor should also endeavour to minimise the length of dewatering where possible.

If dewatering is required, it may be undertaken using a spear point and pump system or other method where appropriate. The water should be pumped into a temporary holding tank for monitoring prior to discharge. Based on the monitoring results, if the water is assessed to be acidic, the water should be treated as per Section 11.7 of this report.

11.4. Surface Water Monitoring

The water within the stormwater channel which passes through the site shall be monitored for pH to assess potential impacts on water quality. Baseline monitoring shall be carried out prior to excavation. Monitoring shall also be carried out during earthworks and during treatment of ASS and abstracted water at the site. Monitoring shall be carried out daily using a calibrated pH meter from at least three (3) locations (upstream site boundary, middle of the channel, and downstream site boundary) by a competent person. Results shall be recorded on field sheets. Recommendations shall be sought from an appropriately qualified and environmental consultant if the pH of the water is not recorded within the range of 6.0 to 8.5 pH units.

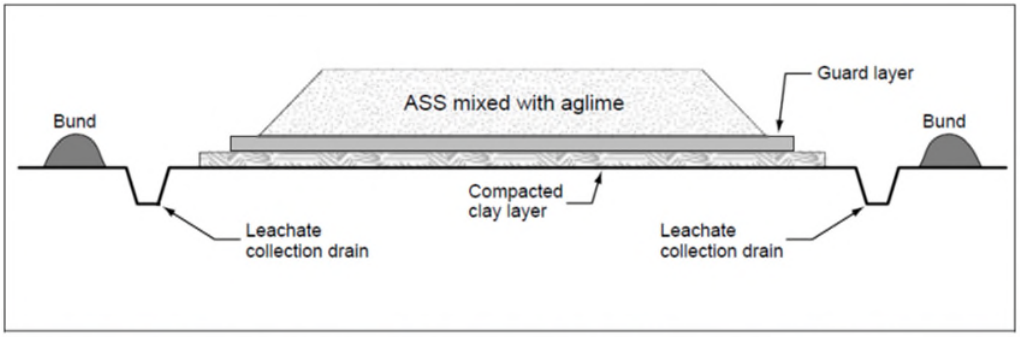
11.5. Assessment and Treatment of ASS

11.5.1. Segregation

A suitably qualified and experienced consultant or earthworks contractor shall oversee excavations. Alluvium soils excavated shall be stockpiled on a treatment pad for further assessment and treatment (if required) prior to off-site disposal.

11.5.2. Treatment Pad

Alluvium/estuarine deposits generated during earthworks shall be placed on a specially prepared treatment pad for treatment and validation/waste classification assessment. The design of the treatment area should consider the construction methodology and staging to ensure that sufficient area is available for staged excavation, treatment and stockpiling. The image below shows a cross section of a typical treatment pad from Dear et al (2014)[3].



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

The assessment/treatment areas shall:

- Be large enough to accommodate the volume of soil requiring treatment. Stockpiles of soil shall be kept as small as possible (typically 25m^3) and preferably not exceed 100m^3.
- Be prepared on relatively flat ground to reduce the risk of potential instability issues and runoff.
- Comprise an impermeable layer such as hardstand, high-density polyethylene (HDPE) sheeting or compacted clay (0.3 – 0.5-metre-deep), covered with a guard layer of compacted crushed limestone or agricultural lime (at a rate of 5kg of agricultural (Ag) lime/m^3) to neutralise downward seepage. If an impervious pad has not been established, an apron of fine lime (bunded and at least 300mm thick) should be applied as precautionary measure.
- Bunds, trenches and/or catchpits should be installed around the treatment pad to contain stormwater/leachate runoff. Drains and inner bund slopes should be lined with an impervious material and covered with a layer of ag-lime applied to neutralise possible leachate migrating from the stockpiled material. Capping of stockpiles should be considered if PASS is to be stored for longer than two weeks.

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.

11.5.3. ASS Assessment

Coffey recommends that an in-situ acid sulfate soils investigation is carried out prior to earthworks commencing to assess whether acid sulfate soils are present and provide recommendations for refining this preliminary ASSMP if required. Alternatively, Coffey recommends that the following is carried during earthworks to assess for the presence of acid sulfate soils:

- Collection of soil samples and analysis of ASS comprising:
  - Analysis of representative soil samples at a laboratory for ASS using the Suspension Peroxide Oxidation – Combined Acidity and Sulfate (SPOCAS) suite or Chromium Reduceable Sulfur (CRS) method. Laboratory methods shall be National Association of Testing Authorities (NATA) accredited. Sampling shall be collected and analysed at the following frequency for each sampling event: 1/25m^3 for stockpiles up to 100m^3 with a minimum of 3 samples per stockpile.
  - Field screening (for PH_F and PH_{FOX}) may be carried out in conjunction with SPOCAS/CRS analysis.
- Field and laboratory analytical results shall be compared to the following assessment/action criteria (as adopted from the ASSMAC guidelines[2] for disturbance of less than 1000 tonnes of soil) to assess whether ASS is present which requires neutralisation:
  - Soil pH (pH_F) must be in the range 6.0 to 8.5;
  - Oxidised pH (pH_{FOX}) must be greater than 3; and
  - Net acidity of analysed samples shall be less than or equal to:
    - 18 mol H+/tonne (0.03% S) for coarse textured soil.
    - 36 mol H+/tonne (0.06% S) for medium textured soil.
    - 62 mol H+/tonne (0.1% S) for heavy textured soil.
  - If the above assessment criteria are not met, neutralisation and validation will be required.
- Preparation of an assessment report/letter which summarises the fieldwork and laboratory analysis carried out; observations made; compares the field and laboratory results against the nominated assessment/action criteria; and provides a conclusion on whether ASS is present and recommendations for neutralisation and/or off-site disposal. An effective liming rate shall also be recommended, if neutralisation is considered to be required.

Acid sulfate soils assessments shall be carried out by an appropriately qualified and experienced environmental consultant.

11.5.4. ASS Neutralisation

Excavated ASS requiring neutralisation shall be carried out within the treatment bays by application of a neutralising agent. Neutralisation shall occur as soon as reasonably practical after excavation.

Selecting neutralising agents

The most common ASS neutralising method involves the addition of sufficient quantities of a neutralising agent to neutralise acid as it is produced from the gradual oxidation of the ASS. The following factors should be considered when selecting neutralising agents:

- Neutralising value (NV) and effective neutralising value (ENV);
- Solubility;
- pH, chemical constituents, moisture content, contaminants or impurities;
- Grades of lime, fineness rating or particle size;
- Purchase price per tonne, delivery costs and size of a full load; and
- Spreading and mixing costs.

Preferred neutralising agent

There are many types and sources of neutralising agents. Calcium carbonate ($CaCO_3$), in the form of finely crushed limestone or 'Ag-lime', is the most commonly used neutralising agent for the treatment of ASS. Grade 1 Ag-lime (which passes through a 1mm sieve) is the preferred neutralising agent for treatment of PASS for this project as it:

- Is readily available;
- Has a relatively high neutralising value (NV) of 80% to 100% (on a dry matter basis);
- Its fineness makes it more efficient at neutralising acidity;
- Has a pH in the range pH 8.5 to 9.0, making it acceptable from a WHS perspective, and reducing the risk of environmental harm from excess alkalinity (i.e. pH 'overshoot')
- Has a low solubility in water so it can provide acid buffering capacity over a sustained period of time.

The ag-lime should be fine and dry, as texture and moisture can also decrease the ENV. Successful treatment of disturbed PASS is based on the effective incorporation of the neutralising material into the soil.

The NSW Fertilizers Act requires liming materials to be labelled. Labelling has to include

- Neutralising Value;
- Calcium and magnesium percentages (good quality lime has 37–40% calcium);
- The form of calcium and magnesium (carbonate, oxide or hydroxide); and
- Fineness.

If this information is not on the lime bag, or on the invoice if you buy bulk lime, consider buying another product.

Liming Rates

The liming rate shall be recommended by the environmental consultant carrying out the assessment of ASS based on the SPOCAS/SCR testing results. Liming rates may be refined based on analytical results as excavation works proceeds and additional monitoring and analytical data becomes available. 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 available at: https://www.der.wa.gov.au/your-environment/acid-sulfate-soils/67-lime-rate-calculations-for-neutralising-acid-sulfate-soils.

Liming Procedure

The following procedures (or other equivalent) shall be carried out during treatment:

- Excavated and segregated ASS shall be kept moist to limit oxidation, prior to treatment and neutralisation with lime. Progressive neutralisation will be required to manage the staged construction program which will reduce the area required for treatment.
- ASS shall be spread in thin (<200 - 300mm) layers directly on top of the guard layer within the treatment bay. When spreading the first soil layer, care should be taken not to churn the lime guard layer.
- Plant should not traffic directly on the stockpile in order to prevent uncontrolled vertical mixing.
- Ag-lime shall be added (as per recommended liming rate) either by hand or light weight truck followed by aerating and mixing using light weight rotovators or similar equipment. Additional lime will be required if monitoring results indicate that appropriate neutralisation has not been achieved. Conversely the liming rate may decrease if monitoring suggests over-liming is occurring.
- Continue the spreading/liming/mixing cycle. This can be done one (1) layer at a time, or with multiple ASS layers placed on top of each other.
- Verification sampling and testing should be undertaken in accordance with Section 12.1 to verify the neutralisation treatment. Depending on the results of testing, reapplication of lime may be necessary to gain adequate neutralisation.

The base and walls of excavations with exposed ASS should be dusted with approximately 1 kg/m^2 to minimise the potential for acidification.

11.6. Soil Verification Criteria

The effectiveness of soil neutralisation activities needs to be validated to confirm that an appropriate amount of neutralising material has been thoroughly mixed with the soil prior to disposal. The following shall be carried out when excavating and treating ASS:

- Daily inspection of liming operations.
- Field screening (field pH (pH_F) and field peroxide pH (pH_{FOX}) tests) to verify the neutralisation treatment and confirm oxidation of acid generating soils is not occurring. Field screening for PH_F and PH_{FOX} shall be carried out onsite using a calibrated pH meter and 30% hydrogen peroxide. Alternatively, PH_F and PH_{FOX} may be analysed at a laboratory. Samples shall be field screened at the following frequency for each sampling event: 1/25m^3 for stockpiles up to 100m^3 with a minimum of 3 samples per stockpile.
- Collection and analysis of representative soil samples using the SPOCAS suite or CRS method may be used to supplement field screening if there is uncertainty in the field test results. Laboratory methods shall be NATA accredited. Samples shall be collected and analysed at the following frequency for each sampling event: 1/25m^3 for stockpiles up to 100m^3 with a minimum of 3 samples.

The following verification criteria should be met to confirm effective neutralisation of soils:

- The neutralising material has been thoroughly mixed with the soil;
- Soil pH (pH_F) must be in the range 6.0 to 8.5;
- Oxidised pH (pH_{FOX}) must be greater than 3; and
- Net acidity of analysed samples (if carried out) shall be less than or equal to:
  - 18 mol H+/tonne (0.03% S) for coarse textured soil.
  - 36 mol H+/tonne (0.06% S) for medium textured soil.
  - 62 mol H+/tonne (0.1% S) for heavy textured soil.

If the above verification criteria are not met further treatment and verification/monitoring will be required.

11.7. Water Treatment

Groundwater pumped out of excavations during dewatering and leachate water generated during the treatment of ASS shall be collected in a leachate collection system. which may comprise an acid-resistant holding tank (i.e. a Chemically Enhanced Primary Treatment (CEPT) or low permeability pond, for assessment and treatment (if required) prior to offsite disposal.

The leachate collection system should be designed to accommodate the anticipated volumes of water during ASS management and dewatering. This design will be influenced by the treatment methodology, staging program and preference for offsite disposal.

If groundwater or leachate water is proposed to be discharged to stormwater (with regulatory consent), concentrations of analytes shall meet all imposed regulatory and permit requirements, and also be less than freshwater trigger threshold values for the protection of aquatic ecosystems (slightly to moderately disturbed ecosystems) provided in the ANZG (2018) Water Quality Guidelines[9].

Notwithstanding any regulatory requirements, water with a pH less than 6.5 or greater than 8.5 would not be suitable for discharge to the surrounding environment and would require treatment prior to discharge. For off-site disposal to a licenced facility, confirmation with the proposed receiving facility shall be carried out to ascertain the requirements for sampling and analysis.

As required, acidic water generated from any excavation and management of ASS should be dosed with agricultural lime. Hydrated lime (pH 12) or magnesium hydroxide (pH 12) may also be used, however, these agents are more soluble than agricultural lime and it is therefore possible to easily overdose water resulting in pH levels which exceed the limits imposed for off-site discharge. Owing to these considerations, agricultural lime (pH 8.2) is the preferred neutralising agent for acidic leachate and pit water. It is also considered to be the safer and cheaper option. A pH adjust can be obtained for alkaline waters using a 40% sulphuric acid buffer.

Lime should be added in accordance with the dosing rates presented in Table 2 in order to achieve a target pH of 6.5-8.5 (based on lower and upper limits for NSW lowland rivers outlined in the ANZECC Guidelines 2018[10]). Rates apply to 1 mega litre (ML) of low-salinity acid water. It should be noted that the dosing rates should be adjusted for the neutralisation value (NV) of the lime used.

Table 2: Quantity of pure neutralising agent required to raise pH to 7.0 for 1 ML of low salinity acid water (Ref: ASSMAC Guidelines 2018)

Measured water pH	Lime required to neutralise 1 ML (kg pure $CaCO_3$)
0.5	15,824
1.0	5,004
1.5	1,600
2.0	500
2.5	160
3.0	50
3.5	16

[9] ANZG 2018. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia

[10] Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). National Water Quality Management Strategy. Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000).

Measured water pH	Lime required to neutralise 1 ML (kg pure $CaCO_3$)
4.0	5
4.5	1.6
5.0	0.5
5.5	0.16
6.0	0.05
6.5	0.016

The following general procedures should be followed for treatment of acidic water, if required:

- Hydrated lime (or equivalent) shall be added to the water at a rate assessed from the results of the field testing. The alkali should be added to the leachate as a slurry. Mixing of the slurry is best achieved using an agitator.
- Following treatment, the water shall be sampled and tested for contaminants of potential concern as well as pH, turbidity, electrical conductivity, chloride, sulfate ions, and heavy metals, to assess disposal options. Additional parameters may also need to be assessed if stipulated on any site-specific licences, permits or approval conditions.

12. Record Keeping and Reporting

Monitoring, testing and reporting of soil and groundwater during PASS management should be carried out in accordance with good industry practice, and in compliance with relevant regulations and regulator endorsed guidelines. It is recommended that a liming register and waste tracking/disposal register is compiled by the contractor carrying out PASS management including, but not limited to:

- Date(s) of works involving management and monitoring of PASS;
- Weather conditions;
- Neutralisation / treatment processes undertaken;
- Liming rates used;
- Field and analytical results;
- Calibration records and equipment used;
- Photographs;
- Site Plans;
- Material descriptions;
- Volumes and/or weighed mass;
- Waste classifications
- Waste transport certificates and truck registrations.
- Where treated PASS has been disposed, including disposal dockets, the address and Environmental Protection Licence (EPL) number.

The contractor shall also maintain a record of any environmental or WHS issues, and any related corrective and preventive action taken.

13. Waste Classification and Off-site Disposal of ASS

13.1. Treated ASS

The ASS may be disposed of to an appropriately licensed landfill once verification criteria (outlined in Section 11.6 if this report) have been met and waste classification has been carried out. The liming register and field and analytical results shall be sent to the landfill to confirm their acceptance of the treated ASS.

The waste classification and disposal should be undertaken in accordance with relevant standards and requirements, including the NSW EPA Waste Classification Guidelines 2014 (including Part 1: Classifying waste, and Part 4: Acid sulfate soils).

It is envisioned that the following process will apply to minimise potential delays on site:

1. In-situ waste classification of ASS is carried out prior to excavation.
2. ASS is excavated, stockpiled and treated.
3. Verification testing confirms performance criteria is met.
4. Environmental Consultant prepares a waste classification report for each treated batch/stockpile. The report shall include the results of the in-situ waste classification assessment, field screening and laboratory analytical results for verification, and the liming register.
5. Treated ASS is transported and disposed off-site at an appropriately licenced facility.

13.2. Untreated PASS

PASS may be able to be disposed of at an appropriately licenced landfill facility without neutralisation taking place. Part 4 of the NSW EPA Waste Classification Guidelines indicates that PASS may be disposed of in water below the permanent water table, provided:

- This occurs before they have had a chance to oxidise, i.e. within 24 hours of excavation; and
- They meet the definition of ‘virgin excavated natural material’ (VENM) under the Protection of the Environment Operations Act 1997, even though they contain sulfidic ores or soils.

Further assessment by an appropriately qualified and experienced environmental consultant would be required to be carried out to assess whether PASS is present and whether the material meets the definition of VENM (except that it contains sulfidic soils). Furthermore, confirmation from the receiving landfill would be required for their acceptance of the PASS prior to off-site disposal. Coffey notes that there are strict requirements regarding the handling and disposal of PASS including, but not limited to:

- Keeping the PASS wet at all times.
- Transporting the PASS to the landfill within 16 hours.
- Disposal within 8 hours of receipt at the landfill.

14. Contingency Plan

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 outlined in Table 3.

Table 3: Contingency strategies

Event	Contingency measures
Effective neutralizing value (ENV) is not provided with the neutralising agent	One sample per 500 m^3 of lime applied should be sampled and analysed for calcium carbonate equivalence by a NATA accredited laboratory to determine the ENV of the material.
Treated soil verification criteria are exceeded	If pH_F and pH_{FOX} results of treated soil samples are outside the acceptable thresholds,additional time maybe required before retesting to allow neutralisation to take place, samples may be collected and analysed by the laboratory (i.e. SPOCAS/CRS). Further lime treatment of soils may also be required. If the laboratory results of treated stockpile samples are outside the acceptable criteria, further lime treatment of soils should be undertaken prior to disposal. If leachate and run-off exceed the performance criteria, neutralisation of the leachate and run-off to achieve the performance criteria should be undertaken prior to release to the environment.
Prolonged rainfall	If wet weather prevails, stop works and cover the stockpiled material with a HDPE sheeting to reduce the formation of leachate

15. Work Health and Safety

Each individual involved in earthworks and management of PASS will be responsible for complying with all relevant Work Health and Safety (WHS) legislation, regulations and guidelines. Safety documentation including but not limited to WHS plans and Safe Work Method Statements (SWMS) shall be prepared and implemented by each contractor relevant to the works being carried out.

Hazardous chemicals or compounds typically associated with treatment and management of ASS include:

- Acidic soils
- Lime (or similar dosing agent).

Potential risks to personnel associated with these compounds, if present at the site, include:

- Ingestion of hazardous chemicals or soil or liquids;
- Dermal (skin) contact with hazardous chemicals or contaminated soil or liquids
- Inhalation of dust or aerosols containing hazardous chemicals or contaminants.

15.1. Incident and Emergency Response

There is a potential for incidents and emergency response requirements relating to ASS issues, in particular pollution of surrounding areas and waterways from acid contamination.

Emergency response procedures should include:

- Immediate containment of acid run-off from stockpiles or areas of excavation.
- Communication between project manager, site managers, supervisors and contractors detailing pollution incident requiring response/action.
- Site inspection to assess extent of severity of the emergency/incident.
- Notification of relevant regulatory agencies detailing type, extent of potential impacts and remediation requirements.
- Investigation 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.

15.2. Training and Awareness

Coffey recommends that an appropriately trained person is appointed to take responsibility and oversee the management of ASS during earthworks at the site. This person could be the Site Foreman trained in ASS management. The appointed person should be familiar with:

- The management procedures outlined in this Preliminary ASSMP;
- Council and other relevant statutory requirements;
- Recognition of ASS;
- ASS testing and treatment procedures; and
- Onsite management of ASS, including implementing management procedures.

If required, a suitably qualified environmental consultant should be engaged to assist with and/or train the appointed contractor in managing the ASS issues and activities.

All personnel working on site should complete a site induction prior to entering site to ensure adequate environmental training as required. The induction should incorporate activities required to manage ASS issues, in addition to detailing procedures to be used during the disturbance of ASS.

15.3. Restricted Access Signage

Access to excavation areas shall be restricted by a perimeter fence. Signs should be erected to notify personnel of the presence of excavations on the site.

The following signage should be erected if lime is used containing calcium oxide:

> *WARNING*
>
> *Avoid contact with eyes and skin.*
> *The dust from this product may irritate the eyes and skin.*
> *Avoid inhaling dust.*
> *Do not swallow product.*

Some lime material may contain heavy metals such as cadmium, mercury or lead. The following limits of impurities have been set by industry with a tolerance of 10% in excess of standards:

- cadmium – 10 mg/kg
- lead – 100 mg/kg
- mercury – 2 mg/kg

For limes containing more than 1 mg/kg cadmium, 0.2 mg/kg mercury or 20 mg/kg lead, the following warning applies:

> *WARNING*
>
> *Continued use of this product may result in (cadmium, mercury, lead) residues in excess of the Maximum Permissible Concentration (MPC) in plant and animal products and may also result in accumulation of these* residues in soils.

15.4. Personal Protection

Personnel should take measures to avoid coming into direct contact with ASS and neutralising agents. Workers are to ensure that soil, groundwater or leachate are not ingested or swallowed and that direct contact with skin is avoided. Personnel should wear the following PPE at a minimum:

- Steel-capped boots.
- Safety vest.
- Hard hat meeting AS/NZS1800-1998 requirements when working within the site
- Hearing protection meeting AS/NZS1270-2002 requirements when working around machinery or plant and equipment if noise levels exceed exposure standards
- Dust masks meeting AS/NZS1715-2009 requirements when handling and administering neutralising agents for ASS
- Safety glasses or goggles with side shields meeting AS/NZS1337-2010 requirements as necessary (particularly when neutralising ASS)
- Disposable latex gloves for personnel involved in soil or water sampling and the handling of neutralising agents.

16. Limitations

This report should be read in conjunction with the attached “Important information about your Coffey Environmental Report” attached to this report.

This Preliminary ASSMP is prepared based on the current level of understanding of the site and the proposed development. It should be reviewed and updated progressively as the results of additional investigation is carried out.

The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of this site at all points.

This plan has been prepared based on preliminary information regarding ASS at the site based on borehole information presented in the DSI report. The actual subsurface conditions encountered during the project could differ from that relied on for this report.

This plan does not address geotechnical or contamination issues.

Important Information about your Coffey Environmental Report

Figures

Appendix A - Development Plans

Appendix B - Survey Plans

Appendix C – DSI Borehole Location Plan

Appendix D - Photographs

Appendix E - Environmental Setting Plans