Southern Sydney Freight Line

Acid Sulfate Soils Management Plan

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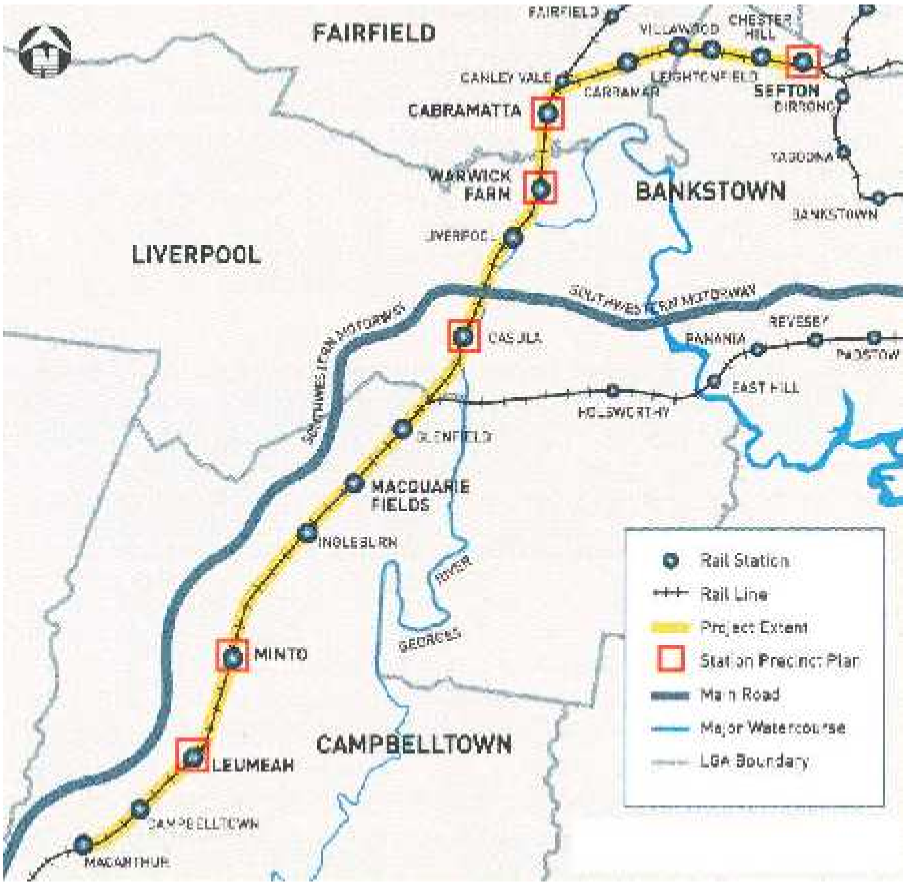
1. Introduction

The Southern Sydney Freight Project involves the construction of a new freight track approximately 36 kilometres in length adjacent to the existing Main South Line from east of Sefton Station to south of Macarthur Station. The extent of the SSFL project is shown on the site map below and lies between rail Chainage 20 km east of Sefton and rail Chainage 58.9 km south of Macarthur Station.



Connell Wagner was commissioned to prepare engineering tender design for the works. In investigating the geotechnical conditions associated with the new line, Connell Wagner carried out a geotechnical investigation, including limited Acid Sulfate Soils (ASS) field testing, the results of which are commented upon within the Geotechnical Factual Report. 1

The results obtained from the ASS testing were not conclusive. However enough evidence exists to suggest that soils within the proposed excavations of identified finite areas may contain ASS. A review of the detail design drawings indicate that the proposed works and associated structures that may potentially be affected by ASS constraints include the following:

- Cut and fill earthworks operations;
- Retaining structures;
- Bridge foundation excavations;
- Foundations for pedestrian overpasses; and
- Driven / Cut and Cover Tunnels.

This report presents an Acid Sulfate Soils (ASS) Management Plan for the project. It provides strategies aimed at testing excavated soils as construction progresses and minimising the risk associated with disturbing ASS should they be encountered. In particular, the management plan discusses:

[1] 'Geotechnical Factual Report', Southern Sydney Freight Line, Produced by Connell Wagner Pty Ltd for Australian Rail Track Corporation, April 2007, Reference 559D-015, Revision 02.

- Construction activities likely to impact on ASS;
- Treatment methods should ASS be encountered;
- Monitoring requirements; and
- ASS treatment reporting requirements.

1.1 Consultation process with Stakeholders

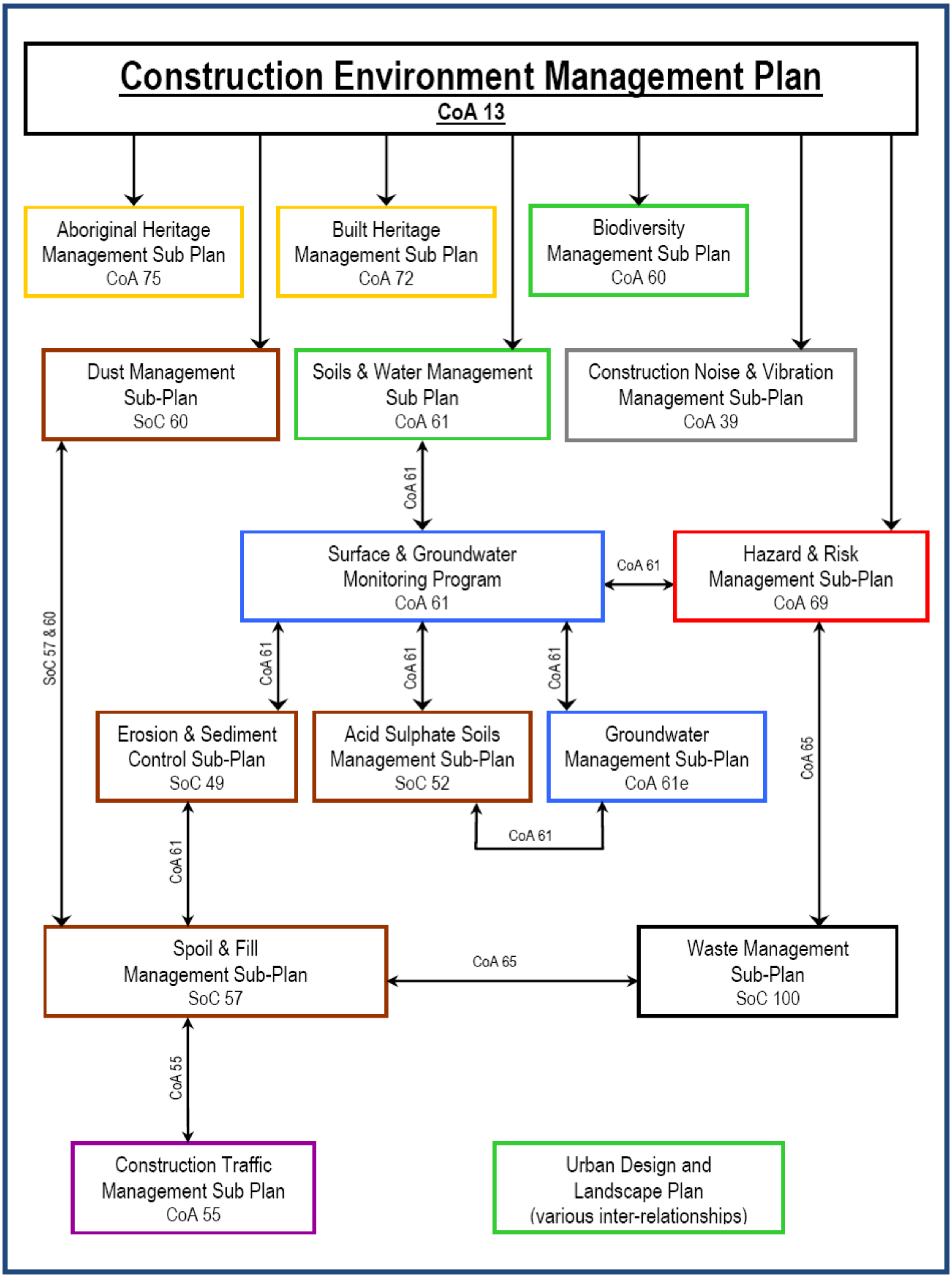
Consultation with stakeholders is detailed in the Construction Environmental Management Plan. Feedback received from Councils and Agencies has been included in this plan.

1.2 Integration with other Sub-Plans in the CEMP

This Acid Sulphate Soils Management Plan (ASSMP) must be read in conjunction with the other related sub-plans that form part of the CEMP. The ASSMP is part of the **Surface and Groundwater Monitoring Program** as required by CoA 61. Other related sub-Plans that must be read in conjunction with this ASSMP include:

1) Soil and Water Management Sub-Plan
2) Erosion and Sediment Control Sub-Plan
3) Groundwater Management Sub-Plan
4) Spoil and Fill Management Sub-Plan
5) Hazard and Risk Management Sub-Plan
6) Waste Management Sub-Plan

All of these Sub-Plans, making up part of the CEMP, are interrelated in accordance with the following Sub-Plan Structure Diagram (following page):


Construction Environment Management Plan
CoA 13
Aboriginal Heritage Management Sub Plan CoA 75
Built Heritage Management Sub Plan CoA 72
Biodiversity Management Sub Plan CoA 60
Dust Management Sub-Plan SoC 60
Soils & Water Management Sub Plan CoA 61
Construction Noise & Vibration Management Sub-Plan CoA 39
CoA 61
Surface & Groundwater Monitoring Program CoA 61
CoA 61
Hazard & Risk Management Sub-Plan CoA 69
SoC 57 & 60
CoA 61
CoA 61
CoA 61
Erosion & Sediment Control Sub-Plan SoC 49
Acid Sulphate Soils Management Sub-Plan SoC 52
Groundwater Management Sub-Plan CoA 61e
CoA 65
CoA 61
CoA 61
Spoil & Fill Management Sub-Plan SoC 57
CoA 65
Waste Management Sub-Plan SoC 100
CoA 55
Construction Traffic Management Sub Plan CoA 55
Urban Design and Landscape Plan (various inter-relationships)

2. Background to Acid Sulfate Soils

2.1 What are acid sulfate soils

ASS are sediments from the Holocene epoch (i.e. greater than 10,000 years ago) that contain iron sulphide that, when exposed to oxygen, generate sulphuric acid and reduce the soil and water pH. The formation of ASS typically occurs in low-lying coastal areas where iron rich sediments can interact with sulfate from seawater, organic matter and sulfate-reducing bacteria. These conditions are usually limited to mangroves, salt marsh vegetation or tidal areas, and the bottom of coastal rivers and lakes. However, flooding and stormwater erosion can redistribute ASS throughout the floodplain. ASS can mobilise metal ions such as iron and aluminium, particularly from clay soils into the groundwater system. In water bodies, low pH, high aluminium levels and low oxygen levels due to oxygenation of iron precipitates can result in a high toxicity environment, detrimental to aquatic life.

ASS comprises both “actual acid sulfate soils” (AASS) or “potential acid sulfate soils” (PASS) depending upon the degree of oxidation of iron sulphides. AASS are soils that have been exposed to air and have oxidised, creating a soil with a pH of 4 or less. PASS are soils that have not yet been exposed to air and have a pH of 4 or more, that when oxidised has the potential to reduce to a pH of 4 or less.

2.2 Assessing the presence of acid sulfate soils

When works involving the disturbance of soil or a change of groundwater levels are proposed in coastal, estuarine or fluvial environments, assessment should be carried out to confirm whether ASS are present and whether the proposed works will disturb these soils. The Acid Sulfate Soils Manual[2] (ASSM), outlines procedures for the assessment of the presence of AASS or PASS.

Preliminary assessment is based on desk study of geological and ASS risk maps, field indicators of soil and water characteristics and field screening tests of soil and water samples. Soil pH can provide a quick indication of the likely presence of AASS. Field pH readings less than or equal to 4 indicate the presence of AASS. To test for PASS that contains unoxidised sulphides, a solution of 30% hydrogen peroxide is used to rapidly oxidise the sulphide, resulting in the production of acid with a corresponding drop in pH.

Depending on the outcome of the preliminary assessment, further sampling and testing may be required. The principal analytical method is through Peroxide Oxidation Combined Acidity and Sulfate (POCAS) testing.

The Action criteria in the ASSM triggering the need for an ASS management plan are based upon:

- the percentage of oxidisable Sulphur;
- total potential acidity (TPA);
- the amount of material to be disturbed (less than or greater than 1000 tonnes); and
- material type (sand, loam or clay).

If one or more of the ASSM action criteria is exceeded then an ASS management plan must be prepared.

[2] ‘Acid Sulfate Soils Manual’, NSW Acid Sulfate Soils Management Advisory Committee, August 1998.

3. Acid Sulfate Soils Investigation

3.1 Site information

The 1:25,000 Acid Sulfate Soils Risk Map for Liverpool[3], indicates two areas intersecting with the freight line route, potentially contain ASS. These areas are recognised as the crossing of Prospect Creek (approximate kilometerage 26+160 to 26+250), and the area adjacent to Georges River north of Liverpool Station (approximate kilometerage 31+480 to 31695). These areas will be further referred to as areas potentially containing ASS for the remainder of the report. An excerpt of the ASS risk map for the area is shown on Figure 1 (see end of document).

3.2 Fieldwork

The geotechnical investigation, carried out between November 2006 and February 2007, involved drilling 46 boreholes spread across the entire alignment.

Boreholes drilled within areas potentially containing ASS[4], included boreholes BH403 and BH404 at Prospect Creek, and boreholes BH12, BH13, BH108 and BH109 adjacent to George's River, north of Liverpool Station, copies of these logs are presented within Appendix C.

The boreholes were excavated to depths ranging between 12.60 to 14.77m (BH403 and BH07 respectively) at Prospect Creek, and depths between 20.24 to 24.0m (BH13 and BH12 respectively) at Georges River. Disturbed samples were collected at regular depth intervals. A Geotechnical Engineer from Connell Wagner was on site to log the borehole profile, complete the ASS field screening tests, and record groundwater seepage and water levels when encountered. Field-testing, sampling and storage were carried out in accordance with ASSM[2].

3.2.1 Subsurface conditions

Reference to the borehole logs in the Geotechnical Factual Report[1] and Appendix C of this report is recommended for a detailed description of the subsurface conditions and ground water conditions encountered.

3.2.2 Field indicator testing

A number of samples were selected for field indicator testing of ASS within the boreholes noted in Section 3.2 above. All testing was in accordance with ASSM[2].

None of the field indicator tests returned positive results to either AASS or PASS and hence no samples were sent to the laboratory for confirmatory POCAS testing.

3.3 Conclusions

The results of the ASS testing undertaken during the Geotechnical Investigation are not deemed to be conclusive proof of the existence or absence of ASS (conclusive evidence to the presence of ASS consists of both positive field tests and positive laboratory POCAS tests). However, the ASS risk Map[3] clearly indicates the possibility of ASS being encountered in the two areas noted in Section 3.1 above. It is therefore recommended that all soils excavated in these areas are considered to be ASS and managed in accordance with this management plan.

Activities requiring attention include pile foundation construction, ground improvement under abutment embankments, and ground anchoring.

[3] 1:25,000 'Acid Sulfate Soils Risk Map' for Liverpool, Department of Land and Water Conservation, Edition Two, December 1997.

[4] Refer to Section 3.1 of the report for definition of 'areas potentially containing ASS'.

4. Acid Sulfate Soils Management Plan

4.1 Options for mitigating impacts from ASS

Table 4-1: Typical acid sulfate soil mitigation measures

Mitigation Measures	Objectives	Associated Action
Avoidance	Minimise the potential exposure of acid sulfate soils	Avoid construction work in disturbed areas
Oxidation prevention	Minimise the time of exposure	Stockpile and cover excavated material
Leachate collection and treatment	Determine the level of acidity in soils	Contain leachate in appropriately designed containment ponds, extract regularly for treatment off-site in accordance with the ASSM[2]
Acid neutralisation	Mix soils with lime to reduce acidity	Mix excavated soil material and surfaces with lime at a rate, as specified by laboratory POCAS testing
Construction materials	Minimise corrosion	Select corrosion resistant construction materials
Monitoring	Determine the fluctuation of acidity	Monitor pH levels in surface trench water throughout construction and annually at relevant locations along the route
Approval	Implement effective mitigation measures	Obtain approval of a detailed acid sulfate soil management plan

The Project's Environmental Manager will be responsible for ensuring that all Construction Contractors, and their relevant site managers, working in locations where ASS may occur are following these mitigation measures and associated procedures.

For this specific project, the hierarchy of risk control for ASS is as follows:

1. Avoid construction in land where ASS occur;
2. If this is not possible, then avoid disturbing land where ASS are present;
3. If this is not possible, then prevent oxidation of the sulphides; and
4. If this is not possible, then allow oxidation of the sulphides, but neutralise the acid as it is produced.

Since only limited areas are considered to be at risk of containing ASS, it is proposed that a testing regime of excavated soils be put in place to detect the presence of ASS.

Where encountered, the ASS and groundwater will require neutralisation of the acid as it is produced. A mitigation strategy based on this assumption is presented within Section 4.3.

4.2 Proposed testing regime

In attempting to minimise the impact on construction activities, it is proposed to implement a field indicator testing regime for all excavations within potentially containing ASS[4].

All excavated soils are to be placed in a treatment / containment area on the day of excavation. The treatment and containment area shall consist of a bunded area with impermeable sides and base to contain any possible leachate produced. The size of the containment area will be a function of the contractor's production rate and method of construction.

Field indicator tests shall be undertaken on the stockpiled soils at a rate of one test for every 10 tonnes or part thereof to assess whether ASS are present. If the field indicator tests reveal a positive ASS result (refer to Appendix A for field indicator test methodology), POCAS testing should be undertaken at a rate of one test per 5 tonnes or part thereof to determine lime neutralisation dosages. POCAS tests shall be undertaken by a NATA registered testing laboratory.

4.3 Proposed mitigation strategy

This strategy, for soils and groundwater, is summarised in the following sections. These should be supplemented by reference to the ASSM[2]. The Project's Environmental Manager will be responsible for ensuring that all Construction Contractors, and their relevant site managers, working in locations where ASS may occur are following this mitigation strategy and associated procedures.

4.3.1 Soils treatment

Excavated spoil identified as ASS shall be spread out within the containment area, in a maximum 0.3m deep layer, over a thin bed of lime, and allowed to dry. Once dried, a layer of lime should be placed over the excavated ASS and a rotary hoe (or similar) shall be used to mix in the lime and aerate the soil (to allow oxidation). Lime dosage rates are to be determined from the POCAS test results using Table 4.5 of the ASSM[2] (See Appendix B).

On completion of lime neutralisation, POCAS tests shall be undertaken at a rate of two tests per 10 tonnes or part thereof (the rate is to be reassessed following the initial results). Once the pH is above 5.5 and the sulphur and acid trail are below the levels specified in Table 4-2, soil can be considered neutralised and suitable for reuse in approved areas or for removal from site to an approved location.

Table 4-2: Action criteria based on ASS analysis for three broad texture categories

Type of Material		**Action Criteria**			
		1-1000 tonnes disturbed		**> 1000 tonnes disturbed**	
Texture	**Approx Clay Content** *(%<0.002 mm)*	**Sulfur Trail** % $S_{oxidisable}$ (*oven-dry basis*) eg: S_{TOS} or S_{POS}	**Acid Trail** mol H+ / tonne (*oven-dry basis*) eg: TPA or TSA	**Sulfur Trail** % $S_{oxidisable}$ (*oven-dry basis*) eg: S_{TOS} or S_{POS}	**Acid Trail** mol H+ / tonne (*oven-dry basis*) eg: TPA or TSA
Coarse *Sands to loamy sands*	≤5	0.03	18	0.03	18
Medium *Sandy loams to light clays*	5 – 40	0.06	36	0.03	18
Fine *Medium to heavy clays and silty clays*	≥40	0.1	62	0.03	18

Source: Table 4.4 – ASSM - 1998

Treated soils that do not meet the pH, Sulphur trail & Acid trail criteria must be retreated with the required extra lime dosage and retested until they meet the test criteria.

Allowance should be made for the storage of additional lime on site in case areas of ASS that require high lime dosages are encountered.

The containment / treatment area should be of adequate size, and contain appropriate equipment to ensure testing / treatment can keep up with the excavation works. If site constraints limit the available space for treatment / stockpiling areas, disposal to landfill (with ASS classed as contaminated soil) may need to be considered.

Prior to discharge, any leachate generated from the treatment / containment areas shall be contained, monitored and treated in accordance with the methodologies outlined in Section 4.3.2 below.

4.3.2 Water testing, containment and treating

The areas identified as potentially containing ASS are located directly adjacent to waterways, construction activities such as boring pile holes and deep excavations are likely to intersect groundwater (with reference to water levels within the adjacent waterways).

Containment, testing and treatment of all groundwater extracted by dewatering, and leachate produced in soil treatment, are expected to be feasible and practicable.

Water from any dewatering process, as well as leachate of ASS stockpiles and treatment areas shall be contained on site in separate catchponds. The leachate/dewatering should be tested for pH (by simple field indicator tests) immediately after rain and prior to discharge. pH should be between 6.5 and 8.5 and testing should be undertaken at a rate of 1 test per 5,000 litres.

If pH is not between 6.5 and 8.5, then treatment of the water by lime neutralisation will be required. (Refer to Appendix B and ASSM[2] for further details).

Once the testing indicates the pH of the leachate / groundwater is between 6.5 and 8.5, the water can be considered neutralised and suitable for discharge (in accordance with all relevant Authority requirements).

Treated water that does not meet the criteria as listed above must be retreated and retested until they meet the test criteria.

The containment/treatment catchponds should be of adequate size, and contain appropriate equipment to ensure testing/treatment can keep up with the works as well as allow for additional water inflow from rainfall. Should the volume of leachate being produced exceed the rate of testing / treatment, then the program must be modified to allow sufficient treatment.

4.4 Training requirements

The site contractor and other relevant staff must be trained in the recognition of ASS. A suitably experienced consultant will provide an induction briefing to all contractor employees engaged in activities associated with the disturbance and / or treatment of ASS and ASS leachate. It will be the responsibility of the Project's Environmental Manager to ensure that this Training is conducted.

4.5 Reporting

Monitoring reports should be prepared by the site construction contractor and presented to Australian Rail Track Corporation and/or their nominated Environmental Manager at nominal fortnightly periods during excavations within potential ASS areas.

These reports should include:

- Volumes of excavated soils within ASS areas;
- Results of field indicator testing;
- Areas requiring lime dosages (if encountered) and records of the work;
- Location of treated soils; and
- Any contingency actions required and records of their implementation.

5. References

1. ‘Geotechnical Factual Report’, Southern Sydney Freight Line, Produced by Connell Wagner Pty Ltd for Australian Rail Track Corporation, April 2007, Reference 559D-015, Revision 02.

2. ‘Acid Sulfate Soils Manual’, NSW Acid Sulfate Soils Management Advisory Committee, August 1998.

3. 1:25,000 ‘Acid Sulfate Soils Risk Map’ for Liverpool, Department of Land and Water Conservation, Edition Two, December 1997.

Figures

Figure 1: ASS Risk Map Excerpt

Appendix A

Field indicator test methodology

Appendix B

Table 6.2 from ASSM for lime to soil dosages

Section 7.1 from ASSM for lime to water dosages

Appendix C

Explanatory Notes

Relevant borehole logs