A-3 Soil and Water Management Subplan

Stage 1 – North West Transmission Developments Project

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TASMANIAN
PLANNING COMMISSION

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1. Introduction

This document is the Soil and Water Management Subplan, a subplan under the Construction Environmental Management Plan (CEMP) for Stage 1 of the North West Transmission Developments Project (NWTD) in Tasmania.

The Contractor for the Early Contractor Involvement phase is Genus Infrastructure (NSW) Pty Ltd, referred to as Genus throughout this document. Genus has developed the CEMP and subplans to address the environmental management of the project.

The CEMP should be referred to for additional context, including:

- Project details, including document control, commitments/conditions and the person accepting responsibility for the CEMP and all associated subplans, including this Soil and Water Management Subplan
- Project description
- Emergency contacts and procedures
- Potential environmental risks and impacts of the project
- Auditing and review requirements
- Glossary and abbreviations

This CEMP subplan applies to all personnel and subcontractors engaged by Genus for the duration of the contract. The CEMP and subplans will be used to develop site specific, or activity specific environmental management plans

2. Objectives

The primary objectives of the Soil and Water Management Subplan (SWMSP) are to comply with:

- Commitments in the Development Application (DA) and Environmental Impact Statement (EIS)
- Conditions of approval in Permit number MIPP-2026-01 issued under the MIDA Act
- Conditions of approval in Permit number EPBC 2022/09247 issued under the EPBC Act
- All relevant TasNetworks standards and procedures.

Contribute to meeting the requirements for the Management of Contaminated Material (Rso-2) credit and the Management of Acid Sulfate Soils (Rso-3) credit under the Infrastructure Sustainability (IS) rating v2.1 Design and As Built rating program, minimising impacts on people and the environment

Aspect specific objectives are outlined in Table 1.

Table 1 Objectives

Aspect	Objectives
Soil and water management and sediment and erosion control	To eliminate or minimise the impact on slopes associated with project works that may increase the risk of landslide hazards.
Contaminated soil	To eliminate or control risks to people and the environment from contaminated material and to maximise the use of sustainable options for the management of such material.
Hydrocarbon and hazardous substances	Safely manage the hazardous substances required onsite throughout the site works.

Aspect	Objectives
Acid sulfate soils/rock (ASS)	Avoid and minimise ASS disturbance where possible. Where disturbance cannot be avoided, manage and treat ASS to prevent damage to the receiving environment, and minimise offsite disposal.
Landslides	Eliminate, minimise or maintain the landslide risk at development sites at/to an acceptable or tolerable level, as defined by the regulatory authority for -preconstruction through to rehabilitation.

3. Reference documents

This Soil and Water Management Subplan has been prepared in accordance with the regulation and guidance documents summarised in Table 2. Table 2 also includes relevant reports that should be consulted for additional context and details on the requirements outlined in this environmental management subplan, where required.

Table 2 Reference documents

Title	Reference/link
Regulator Permits	
Major Infrastructure Project Planning Permit Granted under the Major Infrastructure Development Approvals Act 1999 and the Land Use Planning and Approvals Act 1993	Permit number: MIPP-2026-01 North West Transmission Upgrades Project - Palmerston to Hampshire Section - Final Report and permit, 10 March 2026
Environmental Protection and Biodiversity Protection Act 1999	EPBC 2022/09247
North West Transmission Developments DA/EIS information	
Ecology Baseline Characterisation and Impact Assessment (NWTD EP-DA-502)	Entura 2025. Ecology Baseline Characterisation and Impact Assessment. Remaining North West Transmission Developments, Part E – Attachments and appendices, Appendix B. NWTD EP-DA-502.
Vegetation clearance (NWTD-EP-DA-501)	TasNetworks 2025.Vegetation clearance. Remaining North West Transmission Developments, Part E – Attachments and appendices, Appendix A. NWTD-EP-DA-501.
Management Measures (NWTD-EP-DA-610)	TasNetworks 2025. Management measures. Remaining North West Transmission Developments, Part E – Attachments and appendices, Attachment 10. NWTD-EP-DA-610.
TasNetworks protocols	
Contaminated Land Standard	Contaminated Land Standard, R0002403289, TasNetworks, May 2023
Spill Response Standard	Spill Response Standard, R0002438322, TasNetworks, June 2023

Title	Reference/link
Waste Management Standard	Waste Management Standard, R0002883762, TasNetworks June 2025
Environmental Risk Management Standard	Environmental Risk Management Standard, R0002759377, TasNetworks, July 2025
Sediment and erosion control	
International Erosion Control Association (IECA) Best Practice Erosion and Sediment Control Guideline	International Erosion Control Association (Australasia Chapter). Best Practice Erosion and Sediment Control. Brisbane: IECA Australasia, n.d. Accessed September 3, 2025. https://connect.ieca.org/austieca/resources/resources-list/bpesc-document
Erosion and Sediment Control – The Fundamentals for Development in Tasmania	Environment Protection Authority Tasmania. Erosion and Sediment Control – The Fundamentals for Development in Tasmania. Hobart: EPA Tasmania, July 2023. Accessed September 3, 2025. https://epa.tas.gov.au/environment/water/stormwater/erosion-and-sediment-control-on-building-sites
Forest Practices Authority 2020, Forest Practices Code, Forest Practices Authority, Hobart, Tasmania.	Sections D1 and D2 - Forest Practices Code
Landslide	
AGS (2007)	Australian Geomechanics Society (2007). Landslide Risk Management Concepts and Guidelines. Australian Geomechanics Society. Australian Geomechanics Journal Vol 42 No 11 March 2007.
Contaminated soil	
Environmental Management and Pollution Control Act 1994 (EMPCA)	View - Tasmanian Legislation Online
Environmental Management and Pollution Control (Waste Management) Regulations 2020	View - Tasmanian Legislation Online
Environmental Management and Pollution Control (Controlled Waste Tracking) Regulations 2010	View - Tasmanian Legislation Online
Environment Protection Authority (EPA) Tasmania Information Bulletin No. 105 – Classification and Management of Contaminated Soil for Disposal	Environment Protection Authority Tasmania. Information Bulletin No. 105: Classification and Management of Contaminated Soil for Disposal. Hobart: EPA Tasmania, 2018. Accessed September 3, 2025. https://epa.tas.gov.au/Documents/Information%20Bulletin%20105%20-%20Classification%20of%20Contaminated%20Soils%20%28IB105%29%20V3_2018.pdf

Title	Reference/link
EPA Tasmania – Approved Management Method for the Disposal of Clean Fill Type 1 and Type 2	Environment Protection Authority Tasmania. Approved Management Method for the Disposal of Clean Fill Type 1 and Type 2. Hobart: EPA Tasmania, March 2025.
Classification and Management of Contaminated Soil for Disposal	Tasmanian EPA Information Bulletin No. 105 Classification and Management of Contaminated Soil for Disposal (v3, 2018) (IB105) (EPA Tasmania 2018).
National Environment Protection (Assessment of Site Contamination) Measure 1999, amended 2013 (ASC NEPM)	National Environment Protection (Assessment of Site Contamination) Measure 1999, amended 2013 (ASC NEPM).
PFAS National Environmental Management Plan, version 3.0	Heads of EPA Australia and New Zealand (HEPA). PFAS National Environmental Management Plan, Version 3.0. Canberra: Department of Climate Change, Energy, the Environment and Water, 2025. Accessed September 3, 2025. https://www.dcceew.gov.au/environment/protection/publications/pfas-nemp-3
Australian and New Zealand Guidelines for Fresh and Marine Water Quality	ANZG 2018, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
Water	
Australian and New Zealand Guidelines for Fresh and Marine Water Quality	ANZG 2018, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
Water Quality Guideline Values for Aquatic Ecosystems of Tasmania	EPA Tasmania. *Water Quality Guideline Values for Aquatic Ecosystems of Tasmania*. Hobart: Environment Protection Authority Tasmania. Accessed October 7, 2025. https://epa.tas.gov.au/environment/water/water-quality-guideline-values-for-tasmanian-aquatic-ecosystems. [epa.tas.gov.au]
State Policy on Water Quality Management 1997	View - Tasmanian Policy Online
Hydrocarbon and hazardous substances	
Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater	Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) Technical Report No. 10 Health Screening Levels for Petroleum Hydrocarbons in Soil and Groundwater September 2011, including errata August 2012 (Friebel & Nadebaum 2011).
ASS	

Title	Reference/link
Australian National Acid Sulfate Soils Guidance	Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.
Tasmanian Acid Sulfate Soil Management Guidelines	McDonald, D., & Tasmania Department of Primary Industries, Parks, Water and Environment (2009). Tasmanian Acid Sulfate Soil Management Guidelines. Hobart, Tasmania: Department of Primary Industries, Parks, Water and Environment.
QLD ASS Technical Manual	Dear SE, Williams KM, McElnea AE, Ahern CR, Dobos SK, Moore NG, and O'Brien LE 2024, Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines, Version 5.1, Department of Resources and Department of Environment, Science and Innovation, Queensland.
NWTD Appendix Q	Remaining North West Transmission Developments, Appendix Q – Contaminated land and acid sulfate soils assessment report (2025).
Vegetation disturbance	
Forest Practices Code 2020	Forest Practices Authority. *Forest Practices Code*. Hobart, Tasmania: Forest Practices Authority, 2020. ISBN 978-1-921527-63-0. Forest Practices Code
Related subplans	
Flora and Fauna Management Subplan	NWTD Construction Environment Management Plan.
Biosecurity Management Subplan	NWTD Construction Environment Management Plan.
Vegetation Rehabilitation Management Subplan	NWTD Construction Environment Management Plan.
Watercourse Crossing Management Plan	NWTD Construction Environment Management Plan.

The Waste Management Subplan under the CEMP includes management measures for the reuse and recycling of resource outputs, these measures, are not repeated in this Soil and Water Management Subplan, except for when onsite treatment is applicable.

4. Induction and training

Training and awareness requirements, including record keeping, are covered in Section 8 of the CEMP. The aspects of this management subplan that need to be addressed in these forums are specified below.

Table 3 Induction and training

Induction/ training	Details	Frequency
Site induction	– A one off NWTD - Genus Project Induction to be conducted during the onboarding process that includes an overview of the CEMP and	Prior to site access and renewed

Induction/ training	Details	Frequency
	this Subplan, highlighting key environmental management requirements and procedures. – Site inductions will be location specific and only include specific requirements for that location and tasks, this could include (PIC) Person in Charge - Induction and issue of Access Authority (Permit). – All workers will have electronic access to the CEMP, this Subplan and other relevant environmental management documents.	annually or if significant changes are made to the induction.
Weekly toolbox	In addition to daily toolbox meetings that focus on safety issues and site activities, a weekly toolbox meeting with a greater focus on environmental issues will be conducted. Topics can include, but are not limited to: – Environmental incidents and non-conformances with this Subplan. – Unexpected finds, stop work orders, off-limits areas and planned management strategies. – Planned works that have a high potential for dust and sediment generation. – Known issues or risks pertaining to stormwater management. – Weather forecast and impacts on earthworks activities. – The status of waste classification testing and identified risks or contamination in stockpiles. – Planned materials movements and volumes or materials being moved. – Specific liming rates. – Spill response procedures, including the use of spill kits and containment measures, ensuring awareness of potential hazards associated with the materials they are handling.	Weekly, topics change based on specific site activities.
Specialised training	Additional training for personnel involved in activities with higher landslide risks, or environmental risk such as. when remediating significant amounts of contamination or hazardous substances or confined space entry.	As needed based on the task.

5. Responsibility

Responsibilities in relation to the implementation of the Soil and Water Management Subplan are presented in Table 4.

Table 4 Responsibilities for SW Management Subplan

Role	Responsibility
Environmental Manager	– Oversight of the implementation of the Soil and Water Management Subplan. – Ensure there are adequate resources and infrastructure to implement soil and water management measures. – Oversight of waste management, treatment, movement and/or where appropriate reuse. For example, Potential Acid Sulfate Soils (PASS), and their compliance with this Soil and Water Management Subplan. – Oversight of waste tracking data from Contractors and staff, providing detailed data on soil and water movement on or around site. Quantities, type of material (inc. contaminants of potential concern, contamination level [both soil and water], ASS/PASS status etc.)and end destinations must be recorded. – Oversight of a Suitably Qualified Professional developing site-based Site Contaminated Management Plans (SCMP) and ASS Management Plans (ASSMP). – Oversight of implementation of these site-specific plans in coordination with the Construction Manager.
Sustainability Manager	– Oversight of documentation to provide evidence for the ISC rating process, ensuring adequate records are kept meeting the requirements of the Rso-2 and Rso-3 credits. – Monitoring of performance targets, working with the Environmental Manager on adaptive management measures, where required, to meet performance targets.

Role	Responsibility
	– Oversight of Suitably Qualified Professional developing site-based Site Contaminated Management Plans and ASS Management Plans (with the Environmental Manager).
Construction Manager	– Implementation of the management measures related to construction activities. – Be familiar with this Soil and Water Management Subplan and the requirements during demolition and construction works to avoid, and minimise ASS, and to treat/rebury ASS in accordance with regulations. – Supervise on-site compliance with ASS and non-ASS segregation requirements and provide feedback to Environmental Manager on ways to improve effectiveness of measures. – To implement any site-specific measures developed under an ASSMP for sites identified as high risk, or following chance find of ASS. – Be familiar with this Soil and Water Management Subplan and the requirements during demolition and construction works to avoid and minimise disturbance of contaminated soil. – Supervise on-site compliance with contaminated soil and non-contaminated fragments segregation requirements and provide feedback to Environmental Manager on ways to improve effectiveness of measures. – To implement any site-specific measures developed under an SCMP for sites identified as high risk, or following chance find of contaminated material. – Oversight of the implementation of landslide mitigation measures for towers, construction pads and associated infrastructure (including access roads) presented in both: • Appendix G – Landslide Risk Assessment Report (1 of 2), March 2025, NWTD-EP-DA-507. • Appendix H – Geomorphology and geology assessment report, March 2025,

Role	Responsibility
	NWTD-EP-DA-508.
Site Supervisor	– Implementation and maintenance of the management measures related to site controls.
Waste transporters (including controlled waste transporters)	– To collect waste as per contractual arrangements. – To undertake segregation, transportation, handling and processing activities in accordance with relevant waste management legislation and regulations (Environmental Management and Pollution Control Act 1994 and Environmental Management and Pollution Control (Controlled Waste Tracking) Regulations 2010). – If there is a change in the end destination for any material, notice must be provided in writing to the Environmental Manager. Recommended changes must be documented and approval sought. – To undertake waste tracking requirements – documenting the date, quantity (in tonnages or cubic metres), and the end destination for each material stream as well as type of material (inc. contaminants of potential concern, contamination level [both soil and water], ASS/PASS status etc.).
Suitably Qualified Professionals	– To develop Site Contaminated Management Plans and ASS Management Plans where there is a risk of disturbance of contaminated material or ASS, or following a chance find of contamination or ASS. – Have the following qualifications, as per IS Rso-2 and 3 requirements, a professional who holds qualifications for the assessment of site contamination as required by the regulatory authorities in individual states and territories. – Tasmanian EPA recognises the CENVP (Certified Environmental Practitioner) certification for site contamination assessment.
All Workers	– Are responsible for implementing strategies and procedures prescribed in this Subplan, as applicable to their work activities.

6. Performance criteria

Performance in relation to the implementation of the Soil and Water Management Subplan are presented in Table 5.

Table 5 Performance criteria for Soil and Water Management Subplan

Subject matter	Objective	Performance criteria
Sediment and erosion control	Implement erosion and sediment management to avoid or minimise impacts to the receiving environment	– Minimise loss of sediment by rainfall-runoff and wind activity to existing adjoining properties as much as practical. – Compliance with all controls outlined for sediment and erosion control management.
Landslide	Eliminate, minimise or maintain the landslide risk at development sites at/to an Acceptable or Tolerable level, as defined by the regulatory authority	– Implementing the appropriate site-specific management recommendations provided in both: • Appendix G – Landslide Risk Assessment Report (1 of 2). • Appendix H – Geomorphology and geology assessment report to reduce the residual risk and residual significance of impact.
Contaminated soil and water	Minimise risk to people and the environment from disturbance of contaminated soil	– 100% induction of employees and contractors to the CEMP. – No releases of spoil to the environment beyond the working area and/or designated stockpile area. – No release of contaminated water into the environment – No incidents in breach of CEMP or specific Site Contamination Management Plan requirements with respect to spoil handling, remediation or disposal. – No adverse feedback or incident reporting from the local community.

Subject matter	Objective	Performance criteria
	Maximise sustainable management options for spoil management	– Maximise separation of contaminated material and clean material during construction works. – Wherever risk assessment shows acceptable risk, reuse soil on-site. – Where disposal is required due to the type or extent of contamination or lack of reuse opportunity, all waste materials are to be disposed of at a facility with the appropriate licences to receive. Handling, transport and disposal must be undertaken in compliance with all regulatory requirements.
Water	Avoid or minimise impacts to the receiving environment	– Water quality in the receiving waterways does not exceed water quality discharge criteria and action trigger levels for the relevant catchment area or shows no variation with upstream concentrations at the works site during construction works.
Hydrocarbons	Safely manage the hazardous substances required onsite throughout the site works	– Store and handle hazardous waste appropriately as per the management controls. – Manage all spills in accordance with the adaptive plan. – All refuelling of vehicles and plant has been conducted offsite where possible. – If refuelling was required onsite, no refuelling has occurred within 50m of waterways or riparian zones and documentation demonstrating the use of portable bunds and hydrocarbon mats has been provided to the environmental manager.
ASS	No ASS mobilisation into the receiving environment	– No incidents involving the disturbance of ASS that go unmanaged/untreated.

Subject matter	Objective	Performance criteria
	Minimise ASS offsite disposal	– Accurately track and measure ASS treatment and reuse through a waste tracking system. – At least 85% of ASS diverted from licensed landfill (through applying an avoidance, reduce, retain or treatment and reuse hierarchy) with at least 50% retained/reused on site in accordance with the ASSMP. – Note that this target is only for ASS with no other contamination present.

7. Management controls

Sections 7.1 to 7.7 below provides management controls to support the achievement of performance criteria, objectives, and responsibly minimise risk of environmental harm.

Watercourse crossings and associated erosion, sediment, audit and monitoring requirements are managed under the Watercourse Crossing Management Plan. This plan provides the overarching erosion and sediment control standards applied to works outside of watercourse crossings.

7.1 Overarching

Table 6 Summary of soil and water management controls - overarching

Item	Specific control	Reference	Responsibility
Pre-construction			
SW1.1	**Site selection** During the detailed design, finalise siting for each tower, access track, temporary construction worksite and infrastructure within existing disturbed areas wherever possible. For example,	Forest Practices Code, FPA (2020) CM020 CM031	Design Manager

Item	Specific control	Reference	Responsibility
	use existing tracks and clearings to reduce disturbance of soils and vegetation. Laydown areas shall not be established in areas designated as a potential ecology constraint, a potential cultural heritage constraint or a potential geo-conservation constraint as set out in 215878NW_CC_R01_F001_GIS and 215878NW_RFP2.pdf.	CM033 CM034 CM037	
Construction			
SW1.2	**Track construction** - Permanent access tracks required for the ongoing maintenance and operation of the transmission or distribution network, will be constructed in accordance with the FPC 2020 Class 4 all weather track design specifications. - Where practicable, temporary access tracks will be constructed in a way that minimises the impacts to topsoil through means such as laying geo-textile underlay and utilising large aggregate gravels.	Forest Practices Code (FPC) 2020 CM062	Construction Manager
SW1.3	**General Site Management** - Appropriate spill kits will be available during all construction activities (Oil & Fuel, Aquatic, General purpose - Materials are not to be stockpiled within 50m of a waterway or drainage lines. - Disturbed areas are to be reinstated with indigenous soils and vegetation debris, where this cannot be met,	TasNetworks Spill Response Standard, 2023	

Item	Specific control	Reference	Responsibility
	areas will be rehabilitated in accordance with the rehabilitation management subplan - Soil/ground compaction and disturbance will be to the smallest practical extent for all works.		
SW1.4	**Stockpile management and soil integrity (uncontaminated materials - topsoil)** Maintain topsoil integrity (structure and fertility) during and following ground disturbing activities by, as a minimum, implementing the following controls: – Prevent soil compaction through use of defined access tracks, and by minimising property access to essential vehicles only. – Strip, salvage and stockpile soil to preserve soil horizons. – Limit topsoil stockpiles to 2 m in height or 4 m in width to maintain aerobic and biologically active conditions. – Maintain adequate separation between topsoil and subsoil stockpiles to avoid mixing. – Reinstate soil horizons when backfilling excavations. – Compact backfill to at least 85% of in-situ soil strength of surrounding soils or as required by design standard. – Profile (crown) backfill to allow for settlement. – Install breaks in topsoil and subsoil stockpile windrows at least every 50 m or at strategic locations to allow runoff, vehicles, stock or wildlife to cross. If appropriate, deep rip compacted soils to at least 300 mm depending on soil structure and composition and prepare for	CM022 CM061	Construction Manager

Item	Specific control	Reference	Responsibility
	revegetation. On farmland, refer to Soil Management: A Guide for Tasmanian Farmers (Hamlet 2002) and any relevant property management plans negotiated with landholders for guidance on suitable depths, moisture levels and tine spacing.		
SW1.5	**Stockpile management (uncontaminated materials - subsoil)** Manage soil stockpiles by: – Not stockpiling soil within excavation safety buffers (also referred to as 'zone of influence'). – Not stockpiling soil on or above unstable slopes (i.e. steep slopes, near slopes that show obvious signs of landslip or erosion) o FPA defines unstable areas as sites susceptible to one of the forms of mass soil movement or accelerated soil erosion as a result of the interaction of such factors as steepness, soil properties, parent and surface geology and position in the landform. – Not stockpiling soil within machinery exclusion zones as defined in Table 7 of the Forest Practices Code 2020. – Not stockpiling soil within 20 m of sinkhole margins or recommended buffers in accordance with the guidelines presented in the Forest Practices Authority 'Forest Operations Around Sinkholes'. – Not stockpiling soil on flood plains or areas subject to flooding. – Designing and locating stockpiles to avoid diversion or ponding of overland surface water flows.	CM022 (current version to be downloaded from WWW at https://www.fpa.tas.gov.au/__data/assets/pdf_file/0005/225356/Sinkhole_guidelines_FPA_January_2014.pdf). (FPA, 2014)	Construction Manager

Item	Specific control	Reference	Responsibility
	– Protecting stockpiles with natural fibre geofabric material (or grasses, if maintained for more than six months), temporary erosion and sediment controls and limiting the height of soil stockpiles. – Placing soil stockpiles on uphill side of excavations or trenches. – Bunding or similar measures to control any erosion from soil stockpiles.		
SW1.6	**Drilling activities** Use only non-toxic, non-oil based, PFAS[1]-free and biodegradable drilling fluids and additives during geotechnical or other drilling activities, consistent with Minimum construction requirements for water bores in Australia (NUDLC 2020). Synthetic drilling fluids will be avoided in preference to naturally occurring benign and biodegradable materials such as bentonite. Drilling fluids will be contained in closed circuit systems or contained on site in appropriately constructed sumps. Drilling fluids will be buried on site (if permitted by relevant authorities) or removed to an approved waste facility.	CM065	Construction manager
Post-construction			
SW1.7	**Rehabilitation** Implement a rehabilitation strategy that restores a stable, self-sustaining landform capable of supporting the pre-existing or	Forest Practices Code, FPA, 2020 CM018 Vegetation Rehabilitation	

[1] PFAS – per- and poly-fluoroalkyl substances

Item	Specific control	Reference	Responsibility
	agreed future land use, in alignment with property management plans and vegetation rehabilitation management subplan. The plan will include, at minimum: – Material Retention and Management: Retain vegetation, slash, and chipped materials for reuse in rehabilitation. These materials must be stockpiled separately from topsoil and subsoil, away from existing vegetation and watercourses, and protected to preserve seed viability and organic content. – Landform and Drainage Restoration: Reconstruct or replicate original landforms and drainage patterns to maintain hydrological function and landscape integrity. – Erosion and Sediment Control: Apply erosion and sediment control measures until rehabilitation and revegetation are successfully established. – Progressive Revegetation: Initiate revegetation of disturbed areas as soon as practicable to reduce exposure to erosion and prevent weed colonisation. – Interim Stabilisation Measures: Where immediate revegetation is not feasible, stabilise soils using hessian, mulch, or approved soil binders (e.g. tackifiers). – Protection of Reinstated Areas: Use mulch or geofabric to protect reinstated areas that are vulnerable to erosion. – Native Vegetation Recovery: Promote natural regeneration in disturbed native vegetation areas by spreading clearing residue to encourage seed dispersal and protect emerging plants. Where residue is	Management Subplan	

Item	Specific control	Reference	Responsibility
	unavailable or regeneration is incomplete, undertake seeding or infill planting using endemic native species. – Farmland Rehabilitation: Restore farmland in accordance with landholder agreements and documented property management plans. – Vegetation on easements: In areas where natural regeneration is unsuccessful and not classified as farmland, revegetate with low-growing endemic native species that stabilise soil while maintaining required electrical safety clearances. – Remediate and validate soils at temporary construction and maintenance sites for known or suspected contamination in accordance with applicable environmental standards. – Rehabilitate landforms in a manner that minimised the introduction of weeds or other biosecurity hazards. – Initial site stabilisation must occur within XX days of construction being completed		
SW1.8	**Evaluate effectiveness of control measures** The monitoring requirements in Section 9 will evaluate the effectiveness of the control measures.	CM018 CM052	Environmental Manager

7.2 Sediment and erosion control

Table 7 Summary of soil and water management controls – sediment and erosion control

Item	Specific control	Reference	Responsibility
Pre-construction			
SW2.1	**Catchment risk assessment** For planning stormwater and sediment controls, each proposed disturbance activity requires a case-by-case assessment to determine the most effective control measures. The site-specific measures will be documented and agreed with landowners. The assessment should consider: – A hydrological assessment of the amount of runoff produced – Annual estimated soil loss due to erosion – Catchment area – Duration of disturbance – Proximity to any drainage line or watercourse The IECA specifies erosion risk ratings based on annual average rainfall. Overall, the transmission line corridor carries a high risk of erosion and requires the implementation of appropriate erosion management controls as specified in this table.	BPESC IECA (2025), CM032	Environmental Manager
SW2.2	**Track design** All permanent access tracks will be designed and constructed in accordance with the FPC 2020 class 4 requirements.	Forest Practices Code, 2020, FPA CM028 CM033	Design Manager Construction Manager

Item	Specific control	Reference	Responsibility
	General considerations for track design are outlined below. – Limit erosion through the appropriate design of access tracks. – Utilise established tracks within the vicinity of the site in preference to constructing new tracks. – Where new access tracks are necessary for transmission line works, route and construct in a manner that considers erosion and landslide risk and manages stormwater appropriately. – Design access tracks to avoid steep slopes and erosion hazards, drainage line crossings, rock outcrops and swamps. – Locate access tracks at a sufficient distance from waterways to allow for vegetative sediment control. – Align access tracks to follow the contour of the land/and or ridgeline to minimise cut and slope batters. – Where batters will be required with a height greater than 1.5 m, slope stabilisation controls will need to be implemented, including but not limited to the following: ○ Cover the slope using a biodegradable mesh. ○ Revegetation, including the application of spray seed or hydro mulch.	CM060 CM072	

Item	Specific control	Reference	Responsibility
	○ Install drainage features such as crowning, trackside catch drains and culverts. ○ Inspect the effectiveness of the erosion controls. ○ Re-grading of the slope where necessary. ○ Place cross drains every 20 m to 90 m along the access track, depending on the road grade and soil erodibility. Design and construction of access track watercourse crossings is managed under the approved Watercourse Crossing Management Plan (WCMP).		
SW2.3	**Soil loss rate** The amount of soil lost due to erosion has implications for the size of any sediment ponds and the scale of stormwater and erosion control measures. Given the linear nature of the transmission line and its associated access tracks, it may not be necessary or practical to construct sediment ponds at every location. However, where a sediment pond is required or a large, exposed area is anticipated to generate large quantities of sediment, the soil loss rate should be calculated for the catchment to determine the appropriate scale of stormwater and erosion control measures.	BPESC IECA (2025), CM073	Environmental Manager

Item	Specific control	Reference	Responsibility
	The following actions should be implemented to reduce soil loss: – Reducing the size of the disturbance. – Avoiding disturbances on steep slopes. – Maintaining or installing surface cover.		
SW2.4	**Sediment controls** Plan for primary sediment controls suitable for the type of sediment present on-site: – Small particles/fine grain soils (Type 1 Controls) comprising clay, silt, and fine grain soils may require one or more of the following: sediment ponds, filtration systems, or a flocculant. – Medium particles (Type 2 Controls) comprising silt and Sand between 0.045 and 0.14 mm in diameter may require mulch berms or a rock filter dams. Mulch berms are a simple solution for sheet flow, while Rock filter berms require direction of channelised flow through an aggregate or geofabric filter. – Coarse Particles (Type 3 Controls) comprising sand may require sediment fences or vegetated buffer zones for sheet flow. Concentrated flow will need to pass through a rock filter dam or be directed into a sediment pond.	Erosion and Sediment Control – the fundamentals for development in Tasmania (TEER & DEP, 2023).	Construction Manager

Item	Specific control	Reference	Responsibility
SW2.5	Plan for sediment control measures that have sufficient capability for the size of the site: – Type 3 measures are suitable for sites less 1,000 m2 in area. – Type 2 and 3 measures may be required for sites that are 1,000 - 2,500 m2 in area. – Type 1, 2 and 3 measures may be required for sites >2,500 m2 in area.	Erosion and Sediment Control – the fundamentals for development in Tasmania (TEER & DEP, 2023).	Construction Manager
SW2.6	Plan for secondary sediment control measures that serve as backups to primary controls. These secondary measures may include sediment socks or coir logs, sandbags, and geofabric filters over drain grates. Effective planning requires a site-specific understanding of: – The presence and location of drains, waterways, and roadways. – Existing vegetation and terrain features. – The suitability of each control type for the site's conditions.	Erosion and Sediment Control – the fundamentals for development in Tasmania (TEER & DEP, 2023).	Construction Manager
SW2.7	**Site specific erosion and sediment control plans** Prepare site specific Erosion and Sediment Control Plans (ESCPs) General ESCPs for NWTD will be incorporated into the overarching environmental control plans (ECPs) whereby all erosion and sediment (ERSED) controls	Erosion and Sediment Control – the fundamentals for development in Tasmania (TEER & DEP, 2023). Forest Practices Code 2020, sections D1 and D2. Appendix D provides an example.	Environmental Manager

Item	Specific control	Reference	Responsibility
	will be marked on the project GIS platform and individual site maps will be available to supervisors through either Field Maps on their tablets or in hard copy. Where there is a requirement for a control such as a sediment basin, a detailed drawing of the design will be made available to the construction teams.		
Construction			
SW2.8	**Reduce erosion risk factors** – Use existing or established access tracks where practicable. – Avoid or minimise ground disturbing activities during wet weather conditions, where practicable. – Minimise soil exposure during construction to reduce the potential for erosion. – Cap erosion-prone sections of access tracks with aggregate, reduce sediment-laden runoff. – Avoid or minimise vegetation clearing on unstable slopes and riparian zones to limit surface water runoff ingress and erosion. – Vegetation clearance (including tree stumps) to be undertaken in accordance with the Forest Practices Code 2020 to minimise unnecessary disturbance of retained vegetation and soils.	Forest Practices Code, FPA, 2020 CM033 BPESC IECA 2025	Construction Manager

Item	Specific control	Reference	Responsibility
	– Divert surface water runoff around construction sites and towards sediment controls.		
SW2.9	**Erosion reduction during land clearance** – Limit vegetation clearance to the area required for necessary plant, excavations, construction activities and stockpiled materials. – Adhere to the pre-marked clearance extent – Undertake earthworks within a timeframe as close as practicable to the required works on the transmission line. – Limit the size of excavations and bare areas as practicable for the proposed works.	Forest Practices Code, FPA 2020 CM033 CM034	Construction Manager
SW2.10	**Stabilisation of cleared ground** All bare areas and stockpiles that are exposed for greater than 24 hours must be stabilised with one or more of the following control measures as a minimum: **Dry weather** – Surfaces are compacted and smoothed with a roller. – Stockpiles are compacted and smoothed or other suitable machinery. – Water is applied as required to reduce dust mobilisation.	CM033 CM052	Construction Manager

Item	Specific control	Reference	Responsibility
	– Where water is applied, sediment controls are implemented in downslope locations. This may include sediment fencing, sediment socks, and mulch berms. **Wet weather** – Surfaces and stockpiles are sprayed with a biodegradable geopolymer. – Surfaces and stockpiles are covered using a biodegradable geofabric or mesh. – Where contamination is suspected, bare areas and stockpiles are covered with plastic sheeting to prevent water ingress and mobilisation of contaminants – Bare areas and stockpiles are sprayed with grass seed or hydro mulch where works necessitate longer term exposure.		
SW2.11	**Limit the transport of sediment onto roads** – Rumble grids or wheel wash stations at access gates/sites where there is the potential to track soils and dust onto nearby roads. – There is to be no visible dust or sediment is observed on roads and offsite areas.	CM033 CM052	Construction Manager
SW2.12	**Capture entrained sediment** – Install temporary sediment controls at construction sites to prevent erosion and sedimentation. Controls may include, but are	CM033 Erosion and Sediment Control – the fundamentals for development in Tasmania (2023)	Construction Manager

Item	Specific control	Reference	Responsibility
	not limited to drain socks, geofabric covers, straw bales, fibre rolls, sediment fences, table drains with sediment traps or rock linings, sediment ponds, etc. – Design and implement controls in accordance with the Environmental Protection Authority (EPA) Tasmania Soil and Water Management Fact Sheet 14 – Sediment Fences & Fibre Rolls and other relevant guidelines.		

7.3 Landslide

Table 8 Summary of soil and water management controls - landslide

Item	Specific control	Reference	Responsibility
Pre-construction			
SW3.1	**Landslide management** – Undertake detailed geotechnical investigations and landslide risk assessments at specific sites based on the recommendations in the Appendix G – Landslide Risk Assessment Report (1 of 2) and Appendix H – Geomorphology and geology assessment report. • A flowchart in Attachment 3 has been provided to help determine which mitigation measures have been recommended to each site. – Detailed rockfall/slide risk assessment to inform requirement of rockfall protection or stabilisation measures, including boreholes and rock mapping where rock outcrops exist. Specific sites requiring the assessment are listed in Section 7.1.3 of the Landslide Risk Assessment Report. – Adopt design recommendations provided in Section 7.1 of the Landslide Risk Assessment Report	Australian Geomechanics (2007) Jacobs. 2024. Appendix G – Landslide Risk Assessment Report (1 of 2) March 2025 NWTD-EP-DA-507 Rosengren, N. 2025. Appendix H – Geomorphology and geology assessment report March 2025 NWTD-EP-DA-508	Environmental Manager/Design Manager

Item	Specific control	Reference	Responsibility
	for the specific sites which have a risk of moderate or high. – Adopt the good design practices recommended in Section 7.2 of the Landslide Risk Assessment Report for sites which have a risk of low to very low. – For towers listed in Table D1 and access tracks listed in Table B-1, apply the general design principals recommended in Section 7.8 and Section 7.9 of the Geomorphology and geology assessment report. – It is recommended good hillside construction practices are adopted at all tower and pole locations, WDB pads and access as outlined in Australian Geoguide LR8. – Design tower foundations for local geotechnical conditions to avoid transferring loads to slopes. This will involve geotechnical investigations of the sites, including assessing thickness and composition of ground conditions and surface geology (particularly talus and colluvium) at proposed tower sites as a minimum.	CM013 CM026 CM068 CM069 CM070	
SW3.2	**Karst and springs investigation** Conduct pre-construction geotechnical investigations (including inspection by a suitably qualified karst expert) to identify limestone and subterranean karst features in karst areas crossed by the project including the Liffey karst area. This should involve at least one borehole at each proposed pile foundation, drilled without water where practicable, to assess presence of karst features, and use of geophysical assessment methods such as electrical resistivity surveys to understand the extent of the cavities if suspected and not evident. Discontinue drilling if cavities encountered in carbonate rocks (limestone and karst). Boreholes will be sealed by plugging the borehole above the cavity using a Van Ruth plug (or similar) and backfilling the borehole with a cement-bentonite grout. Grout boreholes that encounter limestone to the surface using a cement-bentonite grout upon completion to avoid water ingress and new dissolution pathways. Design and plan activities to avoid work in, over or adjacent to the cavities.	CM074	Environmental Manager/ Construction Manager
Construction			

Item	Specific control	Reference	Responsibility
SW3.3	**Landslide management** – Adopt the mitigation and management options during construction at specific sites provided in Appendix G – Landslide Risk Assessment Report and Appendix H – Geomorphology and geology assessment report. A flowchart in Attachment 3 has been provided to help determine which measures are applicable to a given site. – It is recommended good hillside construction practices are adopted at all tower and pole locations, WDB pads and access as outlined in Australian Geoguide LR8. – During construction, areas of mapped landslides close to transmission towers and poles and large slopes that may be impacted by construction works should be monitored. It is recommended a geotechnical Construction Monitoring Plan (CMP - typically prepared by the designer) is developed for sites that fit the criteria above. The minimum expectations are provided in Section 7.2.1 (Appendix G – Landslide Risk Assessment Report).	Australian Geomechanics (2007) Jacobs. 2024. Appendix G – Landslide Risk Assessment Report (1 of 2), March 2025, NWTD-EP-DA-507 Rosengren, N. 2025. Appendix H – Geomorphology and geology assessment report, March 2025, NWTD-EP-DA-508 CM013 CM069 CM070	Construction Manager
SW3.4	**Karst and springs management** Confirm the location of karst features and springs prior to ground disturbance, dewatering and piling activities. Manage karst features and springs in accordance with the Forest Practices Code 2020 (FPA 2020) and by implementing, as a minimum, the following where practicable: – Not operating machinery or constructing access tracks within a 20 m buffer of karst features including caves, sinkholes, collapsed sinkholes, karst depressions and stream sinks. – Not diverting or impeding drainage reporting to known cave systems and karst features. If tree removal is required within the buffer, felling trees away from karst feature to limit disturbance including structural damage to feature. – Implementing erosion and sediment controls to reduce sediment transport to karst features and springs.	CM075	Construction Manager

Item	Specific control	Reference	Responsibility
	– Casing bored piles prior to dewatering. – Ensure karst features are mapped on the GIS and displayed on the environmental control plans.		

7.4 Contaminated soils

Table 9 Summary of soil and water management controls – contaminated soils

Item	Specific control	Reference	Responsibility
Pre-construction			
SW4.1	Assessment of contamination risks – Known or potentially contaminated sites have been identified so far as reasonably practicable within the EIS for works subject to planning approval (this excludes the 22kV portion of works). Known or potentially contaminated sites can include ○ areas with oil filled assets such as transformers, ○ work near old town gas mains that may release cyanide or other gases, ○ areas of illegal dumping, ○ areas near existing or previous buildings that contain asbestos materials ○ areas with current or historical potentially contaminating activities such as fire stations, fuel stations,	TasNetworks Contaminated Land Standard (TasNetworks, 2023) CM086	Environmental Manager

Item	Specific control	Reference	Responsibility
	mechanical workshops, and other chemical and industrial facilities. – Where the potential for contamination has been identified (or is identified during construction activities), planning for additional controls that align with the requirements of the TasNetworks Contaminated Land Standard, ASC NEPM (2013) and PFAS NEMP 3.00 (HEPA, 2025) are required. **Additional contamination investigations** – Where construction works are within ○ Substations, ○ 25 m of known or potentially contaminated lands, ○ within 10 m of oil filled assets, ○ or where the land holder has information in relation to likely contamination, and have not been assessed as part of the EIS (e.g. 22kV augmentation) the following is required (if not already completed): – Gather existing reports and information from landowners and publicly available data – where indicated by the desktop assessment (desktop assessment to be completed by an SQP), a sampling and analytical program will be developed and implemented by a SQP to		

Item	Specific control	Reference	Responsibility
	assess risk posed by any contamination to site workers or ecological receptors and inform waste management and risk mitigation measures		
SW4.2	Prior to construction (as far as reasonably practicable) or prior to disturbance of soils a detailed site investigation (DSI) and sampling program will be designed by a SQP to meet (at a minimum) the recommendations of the PSI. The recommendations of the PSI are as follows: **PFAS testing** Two target sites near the TasFire premises - EBH03 and EBH04 (refer to Figure 8h, Appendix A of EIS Appendix Q). PFAS testing should be undertaken in accordance with the PFAS NEMP; results should be documented and used to inform waste soil handling and disposal requirements **TPH/TRH and PCB testing** Two target locations at the Burnie Substation (EBH03 and EB04) and Sheffield Substation (EBH14) (refer to Figure 8e and Figure 8h, Appendix A of EIS Appendix Q) For any planned disturbance at the site of the Sheffield Substation (EBH14), along with testing for TPH/TRH and PCBs prior to construction. **Heavy metals testing and other contaminants** – EBH24 – metals (15), TPH/TRH and BTEXN	CM086 EIS Appendix Q – Contaminated land and acid sulfate soils assessment report National Environment Protection (Assessment of Site Contamination) Measure 1999, amended 2013 Environmental Management and Pollution Control Act (EMPCA) PFAS NEMP V3	Environmental Manager

Item	Specific control	Reference	Responsibility
	Silica Risks associated with silica burial sites (i.e. EBH06) should be managed by avoidance (e.g. an exclusion zone should be established to prevent a tower, road, or other disturbance from occurring over these silica burial sites) Burial Site A and Site B from SMN 8113/16 (i.e. EBH06) are within or overlap the Project but are not within the footprint for towers SHBU T91 and SHBU T90 or associated access tracks; as such, including an exclusion zone for these two burial sites would not require micro-siting of tower SHBU T91 or SHBU T90 or associated tracks (refer to Figure 6d, Appendix A or EIS Appendix Q). It is noted that the DSI will likely identify additional testing required, upon receipt of the DSI recommendations this subplan will be updated to reflect any new requirements. Any soil disturbance within the boundary of a substation will require a risk assessment and sampling plan to be developed by a SQP in accordance with the TasNetworks OEMP (where one exists) and with the Contaminated Land Standard and Environmental Risk Management Standard. Project Managers and Site Supervisors are required to engage with the NWTD environmental team prior to substation works to		

Item	Specific control	Reference	Responsibility
	ensure risk assessment and sampling has been completed.		
SW4.3	**Site contamination management plans** Following the sampling and lab result analysis (where required), a plan for each contaminated site must be developed in accordance with regulatory requirements. Each plan will be developed by a Suitably Qualified Professional. The plan(s) will include, but not be limited to, the following measures: – Classification of materials and development of appropriate management measures. – Development of a management options assessment to inform any reuse, disposal or remediation approaches. – When considering options for remediation, a multi-criteria assessment needs to be undertaken, demonstrating that environmental, social and economic aspects have been considered, with a whole-of-life focus underpinning decision making. – Development of a remediation action plan (RAP) to direct any active remedial approach, including but not limited to: • Where onsite treatment is viable, outline baseline contamination levels, and post-treatment target levels of remediated material. • Design measures for clear separation of	Environmental Management and Pollution Control Act (EMPCA) Tasmanian EPA Information Bulletin No. 105 Classification and Management of Contaminated Soil for Disposal (v3, 2018) (IB105) (EPA, 2018). These guidelines are relevant to the sampling, analysis and classification of soils for offsite disposal IS Rating Design/As Built Technical Manual v2.1	Environmental Manager

Item	Specific control	Reference	Responsibility
	contaminated material based on classification including separation from clean material, ensuring clean material is not cross-contaminated or treated unnecessarily. • Design stockpile area such that no releases of stored soil occur through runoff or airborne pathways (see SW4.6). • Location of soil stockpiling and remediation area, including measures to prevent surface water entering the stockpile/treatment area, bunding, and sedimentation and dust controls. • Testing, monitoring, and validation requirements. • For materials that cannot be remediated or treated (e.g. soil contaminated with PFAS or asbestos), look at options for safe disposal at facilities licensed to receive these materials. • Document safety requirements for material handling and transport, including any PPE required.		
Construction			
SW4.4	**Importing soil and fill** – Imported soils are required to be of clean fill origin (including certified weed-free and disease-free sources) with records and documentation maintained in accordance with EPA requirements.	Approved Management Method for the disposal of Clean Fill Type 1 and Type 2 (EPA, 2025) CM023	Project Environmental Manager

Item	Specific control	Reference	Responsibility
	– Any fill material brought to site (including landscaping topsoil) must be classified as Level 1 Fill Material. If fill material is sourced from a licensed quarry, a letter from the quarry on a letterhead stating the material is from a virgin source and classified as Level 1 Fill Material must be provided for approval prior to any fill material being delivered to site. – Any soil or fill imported to the site from other sites that are not from a licensed quarry, including recycled fill materials, will be required to be tested by the supplier or the environmental consultant for contamination. Any imported fill material used on the site must be classified as clean fill type 1 or type 2 under Tas EPA IB105 and the AMM. – Where possible, the supplier of fill materials will provide clean fill certification prior to importation to the site.		
SW4.5	**Materials tracking** The movement and management of excavated and imported materials, particularly those impacted by contamination, require strict controls to ensure traceability, regulatory compliance, and environmental protection. A dedicated materials tracking register will be maintained throughout the construction phase.	CM088	Site Supervisor Environmental Manager TasNetworks (Audit of register)

Item	Specific control	Reference	Responsibility
	The register will include the following fields as a minimum: – Material type, quantity and source – Date and time of removal or delivery – Trucking company and truck registration – Initial and final location of material – Visual inspection notes – PFAS contamination status – Disposal or reuse destination The following supporting documentation shall be collected and organised in an easily accessible manner: – Daily site logs – Site diagrams or plans depicting materials movements – Disposal dockets or invoices from the receival facility – Invoices and proof of clean material status – Relevant Waste classification report – Disposal approvals (EPA) Temporary records will be established for all materials movements and updated as supporting evidence becomes available – waiting on dockets or invoices does not justify missing entries in the materials tracking register.		

Item	Specific control	Reference	Responsibility
SW4.6	**Stockpile management (contaminated materials)** Where stockpiles or bare areas have suspected or known contamination, including ASS, the following additional measures will be implemented. – Limit the longevity of stockpile storage onsite to as short as possible. – Establish an exclusion zone where personnel may only enter with permission and the correct PPE. – Establish an appropriate stockpile area that is designed to prevent or minimise potential releases of contamination. This may include lining the area with impermeable material (HDPE), bunding, covering with HDPE and dust suppression. – For asbestos containing materials (ACM), all materials handling will be conducted by a licensed asbestos removalist with appropriate health and safety controls in place. – Divert all sediment and water from bare areas and stockpiles with known or suspected contamination using cutoff drains which divert runoff to sediment ponds. – Sediment ponds that accept potentially contaminated water will be lined by a waterproof membrane to prevent contamination of the underlying soils and/or groundwater. This membrane will be installed	CM052	Construction Manager Environmental Manager

Item	Specific control	Reference	Responsibility
	and tested prior to use of the sediment pond. – Water and sediment collected in sediment ponds will be tested for waste classification purposes before appropriate offsite disposal. Membranes will be reinstalled after the collection of sediment due to the risk of puncturing by excavator equipment. At the end of the life of stockpiles and sediment pond, any liners will be disposed of appropriately based on the waste classification of the materials above. Sampling and testing of soils beneath the liner for the presence of contamination will be conducted prior to backfilling of sediment pond excavations.		
SW4.7	**Reuse, retention and treatment of contaminated material** – Where contaminated material is known to occur, or is at high risk of occurring, a Site Contamination Management Plan (SCMP) will be implemented. This will include an indicative program for reuse, retention or other treatment of contaminated material – Material will be classified in accordance with Tas EPA bulletin. – As per the waste management hierarchy, avoidance is the first priority. Where possible, avoid disturbance of contaminated soil. Avoidance measures will be informed by the Detailed Site Investigation undertaken for any	CM088 Tasmanian EPA Information Bulletin No. 105 Classification and Management of Contaminated Soil for Disposal (v3, 2018) (IB105) (EPA, 2018) These guidelines are relevant to the sampling, analysis and classification of soils for offsite disposal Environmental Management and Pollution Control Act 1994 (EMPCA)	Construction Manager Environmental Manager

Item	Specific control	Reference	Responsibility
	sites flagged as at risk of contamination (see Management measure SW1.9), and in accordance with EMPCA. – Minimising disturbance of contaminated soil, coupled with protocols for strict segregation and management of stockpiles to avoid cross-contamination, will reduce the amount of contaminated material. Separating contaminated material from the clean fraction is a critical component of the management measures. – Practicable options for treatment and reuse on site will be prioritised, depending on the type and extent of the contaminant and legislative requirements. Where possible, on-site treatment and reuse will be the preferred course of action, with landfilling the final option.		
SW4.8	**Soil disposal** Soil will be classified into 1 of 4 categories based on EPA bulletin No. 105 by a qualified contaminated land consultant. Level 1 - clean fill material: can be reused on site as long as the quantity does not exceed 100 Tonnes. Where reuse quantity is greater than 100T, EPA and/or Local Council approval may be required. Level 1 clean fill will be managed in accordance with the EPA Approved Management Measure for	CM088 Environmental Management and Pollution Control (Waste Management) Regulations 2010. EPA BuAlletin 105 EPA AMM for the disposal of clean fill type 1 and type 2 TasNetworks Waste Management Standard, June 2025	Environmental Manager Construction Manager

Item	Specific control	Reference	Responsibility
	the disposal of clean fill type 1 and type 2 Level 2 – low level contaminated material: EPA and Landfill operator approval must be sought prior to disposal. Reuse may be undertaken only where a risk assessment indicated an acceptable risk and EPA approval has been obtained (where required). Level 3 – Contaminated soil: EPA and Landfill operator approval must be sought prior to disposal. Level 4 - contaminated soil for remediation: treatment of the soil is required prior to transport to a receiving landfill. If more than 100 tonnes of any soil is to be disposed of offsite, EPA approval is required. For any soil that is being reused on a landowners property, the landowner will sign a customer indemnity form which will be provided back to TasNetworks as per the TasNetworks Waste Management Standard. Soil sampling for waste classification purposes will be conducted by qualified personnel in accordance with the relevant Australian Standards, which include: • AS 4482.1-2005 Guide to the investigation and sampling of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds (and any subsequent editions) • AS 4482.2-1999 Guide to the sampling and investigation of potentially contaminated soil.		

Item	Specific control	Reference	Responsibility
	Part 2: Volatile substances (and any subsequent editions) • In the case of potentially Acid Sulfate Soils, the Tasmanian Acid Sulfate Soil Management Guidelines published by Department of Primary Industries, Parks, Water and Environment should be consulted. – All transport of contaminated soils must be undertaken by a licensed waste transporter and delivered to a facility licensed to receive and/or treat waste soil. – Any asbestos containing materials to be disturbed must be removed from the site by an appropriately qualified and licensed waste transporter.		
SW4.9	**Quarry Materials** Where quarry material or imported fill from temporary construction activites (e.g. temporary access tracks or tower pads) is to be left onsite the customer/landowner is required to sign an indemnity form.	TasNetworks Clean fill Indemnity Biosecurity Management Subplan	Environmental Manager Project Manager

7.5 Water

Table 10 Summary of soil and water management controls - water

Item	Specific control	Reference	Responsibility
Pre-construction			
SW5.1	**Pre-construction hydrogeological assessment** – Conduct a pre-construction hydrogeological assessment at the proposed site to inform appropriate detailed design and construction methods. The hydrogeological assessment will include: • Installing additional groundwater monitoring wells. • Performing aquifer hydraulic testing. • Monitoring groundwater levels and quality to address identified data gaps and be sufficient to support development of further mitigation measures for MW GW02, GW04, and GW05. • Set groundwater exclusion zones within: - 200 m of actively flowing springs, - 66 m of GDEs including rivers, creeks, wetlands and swamps, - 200 m of burrowing crayfish habitat and, - 30 m of registered bores or spring fed dams For areas where proposed towers or distribution line cable trenches are to be within exclusion zones and dewatering may be required conduct	CM029 CM076	Environmental Manager

Item	Specific control	Reference	Responsibility
	site-specific hydrogeological investigations to ascertain dewatering risks. • Include a preliminary groundwater dewatering and drawdown assessment for areas where dewatering is anticipated, based on the engineering design and anticipated earthworks available at the time, using a revised hydrogeological conceptual model. The assessment should be completed by a suitably qualified hydrogeologist, and it should review whether the predicted impacts of the proposal on groundwater may be greater than those originally assessed. • Design site-specific pre-construction drainage plans for the switching station sites for 1 in 50 year rainfall events that allow sites to remain well-drained and free of ponding and run-off from adjacent land. The assessment results should be documented in a hydrogeological interpretive report that is made available prior to detailed design, and be suitable to support development of other management and mitigation measures. Relevant conclusions should be presented as part of the groundwater management plan, that will be prepared prior to, and implemented during construction.		
Construction			
SW5.2	**Reduce surface water flow in bare areas**	CM084	Construction Manager

Item	Specific control	Reference	Responsibility
	– Schedule key activities in the construction works such as bulk excavation and during periods of fine / dry weather where practical and postpone where heavy rain has been forecast. – Install cutoff drains upgradient of bare areas, excavations, and stockpile areas. – Keep cutoff and diversion drains clear of debris and operationally effective. – Utilise catch drains as necessary to redirect potentially sediment affected runoff in a non-erosive manner towards appropriate sediment controls. – Construct contour banks and drainage channels in large bare areas undergoing rehabilitation. – Site contour banks and drainage channels at an appropriate distance apart for the batter slope, as per the IECA (2008) guidelines. – Inspect waterways adjacent to towers for signs of channel erosion, migration, or avulsion. Inspect tower pads for scour and erosion, particularly in floodplains. Where detected, engage with relevant catchment management authority and landholder on appropriate controls or remediation. All inspections, engagement, and controls are to be documented.	CM085	Environmental Manager

Item	Specific control	Reference	Responsibility
SW5.3	**Groundwater management** Implement recommendations from the hydrogeological assessment. Minimise groundwater inflow into excavations, limit groundwater level drawdown, avoid mobilising contaminated or saline groundwater, and prevent groundwater acidification. Consider scheduling earthworks to reduce the duration of dewatering, so far as reasonably practicable, and assess the need for engineering controls such as sheet pile walls, aquifer injection, and decommissioning infrastructure, to ensure potential impacts to groundwater are avoided, and perform hydrogeological assessments to ensure the effectiveness of these controls. These measures must be informed by the site specific ASS management procedure and consider acidification risk in areas of predicted groundwater level drawdown. In the interim, dewatering in ASS areas will be managed in accordance with the Tasmanian Acid Sulfate Soil Management Guidelines (DPIPWE 2009) (refer SW7.1). These measures must be documented in a groundwater management plan that includes design specifications, monitoring requirements, and contingency plans. Provide alternative water supply to registered groundwater bore owners or other groundwater users (including spring fed dams) during construction where groundwater access is	CM032 CM077 CM078	Construction Manager Environmental Manager

Item	Specific control	Reference	Responsibility
	temporarily limited by project activities or where project-related impacts persist during operations.		
SW5.4	**Site specific groundwater management plan** (see SW5.8 for discharge controls) Develop and implement a groundwater management plan (informed by the hydrogeological assessment) to manage, monitor, reuse, treat, and dispose of groundwater during construction dewatering. The groundwater management plan will: – Prioritise groundwater reuse (such as for construction water supply, dust suppression, or reinjection for hydraulic control, where feasible). – Specify approved disposal options (e.g., discharge to surface water, sewer, or stormwater). – Where discharge occurs, no discharge is to be directly to watercourse, and site discharges to land to maximise infiltration. – Where erosion or sedimentation could occur, discharging water to a sediment settling and energy dissipation basin (for example, geotextile mat draped over straw bale enclosure). – Document agreed water quality discharge criteria and action trigger levels for each catchment area. These values will be determined with reference to the Tasmanian	EPA DGVs (2025) Tas SEP (1997) CM032 CM052 CM079	Environmental Manager

Item	Specific control	Reference	Responsibility
	EPA Default Guideline Values relevant to the ecosystems present at each site and in consultation with landowners and other stakeholders, including EPA Tasmania. Selection of default guideline values requires consideration of the community's expectations for how a water body should be used, as per Tas SEP (1997), and may require further ecological assessment, as per EPA DGVs (2025). – Outline suitable treatment technologies that will be implemented or reserved as contingency measures should unforeseen contamination be encountered.		
SW5.5	**Limit transport of contaminants and sediment into stormwater infrastructure** – Divert clean water from upslope of bare areas, excavations, and stockpiles to reduce the potential for erosion of loose or uncovered soil materials in these areas from entering stormwater infrastructure. – Apply sediment socks/coir logs or drain guards around stormwater drains and channels. – Line stormwater grates with a permeable geofabric to act as a filter of last resort. Ensure that the fabric is intact and has not been perforated.	CM032	Construction Manager Environmental Manager

Item	Specific control	Reference	Responsibility
	– For switching stations and substations, design and construct stormwater management systems to prevent runoff to adjacent land and capture and store potentially contaminated runoff in gross pollutant traps or triple interceptor pits. Design stormwater systems in accordance with the State Stormwater Strategy (DPIPWE 2010) and associated standards and guidelines.		
SW5.6	**Limit transport of sediments into natural waterways and the surrounding environment** – Install downgradient sediment fences for long excavations such as the easement area and access tracks and large bare areas where sheetwash is present. – Use a downgradient strip of vegetation as a sediment trap only in areas where contamination is not present. – Redirect water flowing around active work areas to reduce the risk of sedimentation, where possible. – Ensure that any temporary drains redirecting water around construction works have sufficient capacity for the most likely rainfall event, as per the below: • Drains to be used for less than 12 months should be designed for a 1 in 2 year event. • Drains to be used for between 12 -24 months	CM032	Environmental Manager

Item	Specific control	Reference	Responsibility
	should be designed for a 1 in 5 year event • Drains to be used for a period longer than 24 months should be designed for a 1 in 10 year event. Utilise catch drains as necessary to redirect potentially sediment affected runoff in a non-erosive capacity towards appropriate sediment controls.		
SW5.7	Obtain a licence issued under the *Water Management Act 1999* (Tas) if water is to be abstracted from a watercourse.	CM083	Environmental Manager
SW5.8	**Groundwater discharge** Groundwater that is required to be discharged as a result of construction activities i.e. piling, trenching, excavation will be managed in accordance with the below. **For uncontaminated groundwater (as Identified in the detailed hydrogeological assessment).** - No impacts to the chemistry/quality of the recieving water are to occur as a result of discharge - If hydrogeological assessment identifies the groundwater parameters as exceeding short term irrigation criteria then field parameters for pH and EC should occur prior to discharge and discharge should only occur if below the criteria.	CM079	Environmental Manager

Item	Specific control	Reference	Responsibility
	- If hydrogeological assessment identifies the groundwater parameters are below the short term irrigation criteria then groundwater discharge is allowed to flat grassy areas.TDS target will be <50 mg/L or Turbidity <50 NTU (whichever is lower, following testing) when discharged to sediment pond/tanks. - Water is to be pumped from the excavation and will be sent through either a sediment pond/tank or other filtration system to ensure suspended solids that resulted from the disturbance of soil are removed prior to discharge or discharged to a flat grassy area. - The flow rate of discharge must not cause erosion but allow water to permeate back into the soil. - The discharge must not be in the direction of a waterway, and discharge must not flow overland and directly enter any waterbody/waterway or drain. **For contaminated or potentially contaminated groundwater (as identified in the detailed hydrogeological assessment)** Where there is risk of interacting with contaminated groundwater the following will apply. - Pre-construction groundwater quality testing is likely required (This will be determined as		

Item	Specific control	Reference	Responsibility
	part of the detailed hydrogeological assessment) - Contaminated groundwater will need to be treated onsite through a treatment and clarification system and likely require discharge to sewer through trade waste agreement with TasWater and/or the local municipality. ***Please note that the controls for contaminated groundwater will be updated prior to construction upon receipt of the detailed hydrogeological assessment recommendations.*		

7.6 Hydrocarbon and hazardous substances

Table 11 Summary of soil and water management controls – hydrocarbon and hazardous substances

Item	Specific control	Reference	Responsibility
Construction			
SW6.1	**Hazardous materials management** Controls implemented in this section are intended to minimise the risk of contamination occurring on-site as a result of dangerous goods and hazardous materials brought on-site, by implementing the following: – Training personnel in the handling, storage and transport of dangerous goods and hazardous materials	CM063 CM064	Environmental Manager/ Site Supervisor

Item	Specific control	Reference	Responsibility
	– Communicating information on dangerous goods and hazardous materials to personnel handling, storing or transporting dangerous goods and hazardous materials. – All dangerous goods and hazardous materials will be clearly labelled, and storage locations will be clearly outlined in site plans. – Procuring, transporting, storing, handling, and disposing of dangerous goods and hazardous materials in accordance with legislation, guidelines and permit requirements. – Maintaining a register of all dangerous goods and hazardous materials used, handled or stored onsite. – Preferentially selecting and using low toxicity chemicals, where practicable. Selecting ‘fit for purpose’ products over generic or all-purpose products. – Employ best practice management to minimise potential for oil/diesel leaks from plant, equipment or vehicles (e.g. adequate servicing and inspections). A record of servicing and inspections should be kept on-site for all operational plant, equipment, and vehicles.		

Item	Specific control	Reference	Responsibility
	– An environmental incident register will be kept on-site that provides detail on any spills/leaks of hazardous materials (the register should include a record of the date of loss, the type of material lost, and the volume of loss). This procedure should be managed in accordance with the procedures outlined below in SW6.2. – Any spills or leaks are to be cleaned up and disposed of immediately in accordance with the Spill Management procedures outlined below in SW2.16. – Refuelling vehicles, plant and equipment in a designated refuelling area located at a suitable distance (to be stipulated by Environmental Manager) from watercourses, drainage lines, and any sensitive areas (including karst). – Providing and maintaining spill kits at all sites that are used to store hazardous materials, and in all designated refuelling sites. Where light vehicles are used to refuel mobile plant on-site, spill kits will be available in each vehicle used for refuelling activities. – Discovery of hazardous material will be managed in accordance with the Unexpected Finds Procedure.		

Item	Specific control	Reference	Responsibility
SW6.2	**Spill management** – All applicable staff will receive training in the prevention, response, and management of hazardous materials spills, delivered through Genus Group online inductions, site-specific induction sessions, and refresher courses conducted during toolbox or project commencement meetings. – Measures to prevent spills will be implemented, including proper storage and handling of hazardous materials, and regular maintenance of equipment. – Spill kits will be readily available at strategic locations around the construction site, containing absorbent materials, personal protective equipment (PPE), and tools for containing and cleaning up spills. – In the event of a spill, the area should be cleared of personnel and containment measures will be immediately implemented by trained staff to prevent the spread of the spilled material, using absorbent booms, sandbags, or other barriers. – Spilled materials and contaminated absorbents will be collected and	CM058 TasNetworks Oil and Fuel Spill Management IMS-WPI-00-91 Procedure (TasNetworks, 2024) Spill Response Standard, TasNetworks, 2023	Environmental Manager Personnel responsible for spill incident

Item	Specific control	Reference	Responsibility
	disposed of in accordance with local regulations, ensuring all waste is properly classified and disposed of at a licensed facility. – All spills must be promptly reported to the Environmental Manager, who will assess the incident and notify TasNetworks. – TasNetworks is responsible for coordinating external notifications, taking into account the nature and severity of the spill and its potential environmental impacts. Stakeholders to be notified may include, but are not limited to, landholders, regulatory authorities (e.g. EPA Tasmania, DCCEEW), emergency services, and relevant community groups. Notification will follow the procedures outlined in TasNetworks' Incident Management HSEQ Operational Procedure and comply with applicable legislative reporting requirements. – Should remedial measures be required, advice will be sought from an experienced contamination consultant. Any excavated materials with visible or olfactory signs of contamination are to be stockpiled on a sealed surface or a		

Item	Specific control	Reference	Responsibility
	designated stockpile area that has a waterproof cover such as tarpaulin or large plastic sheeting. This is to ensure that underlying soils are not impacted by contaminated materials. – Appropriate water and sediment management as per Section 5.1 is to be implemented to reduce the risk of contaminated soils or leachate impacting soils, groundwater, and surface water on and offsite.		
SW6.3	**Sulfur hexafluoride (SF6) management** Manage sulfur hexafluoride (SF6) in accordance with AS IEC 62271.4:2015 High-voltage switchgear and control gear, Part 4: Handling procedures for sulphur hexafluoride (SF6) and its mixtures, and the Industry Guideline for SF6 Management (ENA 2008). Minimise SF6 release using a closed cycle during installation, maintenance and decommissioning of equipment.	CM087	Environmental Manager/ Site Supervisor

7.7 Acid sulfate soils

Table 12 Summary of soil and water management controls - ASS

Item	Specific control	Reference	Responsibility
Pre-construction			

Item	Specific control	Reference	Responsibility
SW7.1	**Works below the water table in ASS** For any works extending below the water table within areas mapped or identified as having ASS risk (refer Appendix B and SW5.1 hydrogeological assessment), works will be undertaken in accordance with the Tasmanian Acid Sulfate Soil Management Guidelines (DPIPWE 2009) (Appendix E) as the interim management standard. Site-specific ASS management measures (including dewatering controls, treatment requirements and discharge criteria) will be developed from the outcomes of the ongoing hydrogeological investigations (SW5.1) and the ASS investigations triggered under SW7.2, and incorporated into the site-specific ASSMP (SW7.3) prior to construction.	Tasmanian Acid Sulfate Soil Management Guidelines (DPIPWE, 2009) SW5.1, SW5.3 CM071	Environmental Manager
SW7.2	**Additional ASS investigation** Where works involve greater than 100 m^3 of ASS disturbance determined by review of the ASS risk map on TheList (classed as low risk or higher) the following is required: Consult the attached ASS protocol (Attachment 2, herein) to determine the level of investigation and management required. Complete an ASS investigation and/or management as recommended in Attachment 2.	CM071 Tasmanian Acid Sulfate Soil Management Guidelines (DPIPWE, 2009)	Environmental Manager
SW7.3	**Site specific ASS plans** Where both initial risk assessment and additional investigation determine the need, prepare site-specific Acid Sulfate Soil Management Plans (ASSMPs) as per the Tasmanian Acid Sulfate Soil Management Guidelines (2009). The ASS protocol (Attachment 2) provides guidance on the level of management required and the management options available that can be tailored to the specific site.	CM071 Tasmanian Acid Sulfate Soil Management Guidelines (DPIPWE, 2009)	Environmental Manager
Construction			
SW7.4	**Implementation of site specific ASS plans** If applicable, implement the site-specific Acid Sulfate Soil Management Plan (ASSMPs) that was developed in the pre-construction phase.	CM071 Tasmanian Acid Sulfate Soil Management	Environmental Manager

Item	Specific control	Reference	Responsibility
		Guidelines (DPIPWE, 2009)	
SW7.5	**Materials tracking** Implement actions within contaminated soils section.	See contaminated soils Section 7.4	See contaminated soils Section 7.4

8. IS rating requirements

8.1 Description of Rso-2 credit – managing contaminated material

The Resource Efficiency (Rso) credits drive a more efficient and sustainable use of natural resources, with a focus on resource minimisation and recovery, waste avoidance, contamination remediation and management, smart design and materials selection. The Rso-2 credit specifically addresses the management of contaminated material. The driving intent of this credit is to eliminate or control risks to people and the environment from contaminated material and to maximise use of sustainable remediation options for the management of such material. Level 2 verification is being sought for this credit.

Table 13 maps the requirements from the IS Rating v2.1 Technical Manual, and the current status of meeting these requirements. As documented in Section 7, the management controls SW4.1, SW4.2 and SW4.3 detail the requirements for additional site investigations and the development of site specific Site Contamination Management Plans. Once the detailed site investigations have been completed, SMART targets will be developed that are appropriate to the level and type of contamination present.

Table 13 Rso-2 credit map

Credit	Must statements	Status
DL1.1	**A Site Contamination Management Plan (SCMP) has been developed for the management and treatment of contaminated material.** A Site Contamination Management Plan (SCMP) or equivalent must be developed by a suitably qualified professional to outline contamination management actions responding to identified risks and opportunities and performance targets (DL1.2). The SCMP must include a risk assessment which identifies potential contamination risk, assesses the likelihood of the risk occurring, estimates the expected consequence, and identifies potential mitigation measures (or recommendations) regarding potential contaminants. The assessment may be part of a broader sustainability or project risk assessment (as per Lea-2) or standalone. The SCMP must include the following factors, unless justification can be provided as to why elements are not applicable: – An Unexpected Finds Protocol for the identification, classification and treatment of any previously unknown contaminated material in the event that such material is encountered (only this measure is required for low materiality). – How contaminated material is to be characterised, classified, tracked, reused, treated and monitored throughout the project. – Project-specific performance targets (see DL1.2). – An indicative program for reuse, retention or other treatment of contaminated material and any legislation relevant to the project throughout the duration of the schedule of works. – How the volume of contaminated material will be minimised throughout the project by the contractor and their sub-contractors. – Specific mechanisms for adopting a 'reduce, reuse and recycle'	In this Subplan, requirements are outlined, but the site specific SCMPs will need to be developed to provide the level of detail required (see SW4.1, SW4.2 and SW4.3). This Subplan identifies risks and makes recommendations. Further investigation required (and SCMPs pre-construction). Finds protocol in this Subplan (see Adaptive Plan - Unexpected finds procedure for land contamination or hazardous materials). All of the remaining requirements are covered at high level in this Subplan, but will need further site-specific measures documented in SCMPs.

Credit	Must statements	Status
	approach for dealing with all contaminated material. The SCMP must be based on the completed risk assessment and any site investigations undertaken to verify and quantify contamination risk. Site investigations must be undertaken in accordance with Schedule A 'Recommended general process for assessment of site contamination' of National Environment Protection (Assessment of Site Contamination) Measure 1999 (amended 2013). Justification must be provided if no further site investigations are required.	
DL1.2	**Project performance targets for contaminated material risks and sustainable remediation have been developed.** SMART contamination remediation and management stretch targets must be developed (according to potential location, classification or type, and volume of contaminated material) and take into account previous site investigations and any other baseline contamination information. The Project targets must deliver no or low residual risk to people and the environment and maximise sustainable outcomes by: – Prioritising destruction of contaminated material where possible – Maximising separation of contaminated material and clean fraction – Reducing materials to landfill where options exist for practicable treatment to enable reuse of soil and/or groundwater – Maximising the sustainability of remediation options (see DL1.3) The project-specific targets and their justification against the requirements above must be prepared or reviewed by a suitably qualified contamination professional and the sustainability manager (or delegate).	SMART targets will be developed and documented in site specific SCMPs (guided by objectives in Section 2 and high level performance criteria in Section 6). Site SCMPs will be prepared by a suitably qualified professional
DL1.3	**A formal assessment has been completed to determine sustainable remediation options for identified contaminated material.** A multi-criteria options assessment that considers material environmental, social and economic aspects and whole of life costing must be undertaken to assess and identify sustainable remediation options for contaminated material in line with project targets (DL1.2). The assessment must be completed by a suitably qualified contamination professional and the sustainability manager (or delegate). See Additional Guidance regarding multi-criteria options assessment and relevant indicators. The assessment of sustainable remediation options must be started in the design phase and can be completed during construction if relevant.	This will be required as part of SCMPs pre construction
DL1.4	**The project design and construction methodology have responded to contamination risk and sustainable remediation options.** The project design and the construction methodology must reflect initiatives and management actions which reduce or eliminate contamination risk, implement sustainable remediation options identified and aim to achieve the project targets (DL1.2) across the design and construction phases.	Detailed design and construction methodology work in progress. Design Report will need to address this requirement
DL2.1	**Achievement of project specific targets has been demonstrated.**	To be completed as part of developing site specific SCMPs

Credit	Must statements	Status
	The project's methods for remediation and management of contaminated material must demonstrate that the project targets for Design & As Built are on track to be achieved.	
DL2.2	**The effectiveness and/or durability of the remedial solutions including maintenance and monitoring requirements have been outlined.** The effectiveness and/or durability of the remedial solutions identified for contaminated material, including ongoing maintenance and monitoring (see Additional Guidance for explanation), must be outlined over the lifetime of the project and incorporated into the SCMP. Where monitoring is necessary, there must also be contingency plans in case monitoring data demonstrates any fault or deterioration in the remedial solution.	Monitoring is covered at a high level in this Subplan (Section 9), will need further details at a site level during preparation of SCMPs
ABL1.1	Contamination risk assessment and the SCMP have been reviewed and updated.	This Subplan provides the high level framework for achieving these aspects during construction. Will need to be updated on the basis of additional requirements from the site specific SCMPs
ABL1.2	The formal assessment examining sustainable remediation options has been updated.	
ABL1.3	The SCMP including maintenance and monitoring requirements have been implemented	
ABL2.1	Project-specific targets have been achieved.	
ABL2.2	A summary statement has been prepared and the effectiveness and/or durability of remedial solutions has been assessed	

8.2 Description of Rso-3 credit – managing Acid Sulfate Soils

The Resource Efficiency (Rso) credits drive a more efficient and sustainable use of natural resources, with a focus on resource minimisation and recovery, waste avoidance, contamination remediation and management, smart design and materials selection. The Rso-3 credit specifically addresses the management of ASS with the intent to minimise adverse impacts on people and the environment when addressing the risks associated with ASS. Level 1 verification is being sought for this credit.

The Resource Efficiency (Rso) credits drive a more efficient and sustainable use of natural resources, with a focus on resource minimisation and recovery, waste avoidance, contamination remediation and management, smart design and materials selection. The Rso-3 credit specifically addresses the management of ASS with the intent to minimise adverse impacts on people and the environment when addressing the risks associated with ASS. Level 1 verification is being sought for this credit. Table 14 provides an overview of the Rso-3 requirements and the intersections with the CEMP and this Subplan maps the requirements from the IS Rating v2.1 Technical Manual, and the current status of meeting these requirements. As documented in Section 7, the management controls SW4.1, SW 4.2 and SW4.3 detail the requirements for additional site investigations and the development of site specific Site Contamination Management Plans. Once the detailed site investigations have been completed, SMART targets will be developed that are appropriate to the level and type of contamination present.

Table 14 Rso-3 credit map

Credit	Must statements	Status
DL1.1	**An Acid Sulfate Soil Management Plan (ASSMP) or equivalent has been developed outlining opportunities for avoidance of ASS or retention or reuse of any treated ASS material.** An ASSMP (or equivalent) must be developed by a suitably qualified professional to outline opportunities for avoidance or treatment and reuse onsite or offsite of any acid sulfate soil material, and include: – The outcomes of site investigations – An ASS risk assessment to identify potential ASS contamination risk – Design and construction methodologies to manage the ASS risk, following the avoid or treat and retain onsite, reuse offsite or dispose in suitable facility hierarchy – Recommendations and mitigation measures from the risk assessment (see factors listed below). Any site assessment investigations required to confirm and quantify ASS risk must be undertaken in accordance with relevant State/Territory or local jurisdiction ASS management guidelines. Outline and justification of ASS investigation methodology must be provided if no such guidelines exist. The desktop ASS risk assessment must identify the risk, assess the likelihood of the risk occurring, estimate the expected consequences, and identify mitigation measures (or recommendations) regarding ASSs. It may be part of a broader project risk assessment or a standalone environmental risk assessment (e.g. as per Lea-2). If there are changes to the risk assessment (nature or severity of risks) resulting from any further site investigations or changes to design or construction methodology prior to construction commencement, the ASSMP must be reviewed and updated by a suitably qualified professional. The following factors must be included when developing the mitigation measures, unless justification can be provided for omitting these factors: – How Unexpected Finds Protocol for the identification, classification and disposal of any previously unknown ASS material in the event that such material is encountered (only this measure is required for low materiality). – How ASS material is to be characterised, classified, tracked and monitored throughout the project. – Project-specific targets – default or other (see DL1.2). – The design of an indicative program for retention or reuse of ASS material, and how relevant legislation will be complied with for the duration of the project. – Specific documented mechanisms for adopting an 'avoid, reduce, retain, or reuse' approach for dealing with ASS material. – Mitigation actions identified from the risk assessment to be implemented during design and construction.	This Subplan provides high level guidance. Prior to construction Site specific ASSMPs will be developed to meet all of the ISC requirements (see SW7.2 and SW7.3). Must be developed by a suitably qualified professional. As described in SW7.2 and SW7.3. Desktop risk assessment completed during EIS. This Subplan provides the guidance for this, Site specific ASSMPs will be developed as required by a suitably qualified professional. Unexpected Finds Protocol in Attachments. This Subplan provides high level guidance on mitigation measures, to be further articulated in the site specific ASSMPs.

Credit	Must statements	Status
DL1.2	**Project-specific performance targets for ASS have been developed.** SMART performance targets for ASS must be developed in line with the 'avoid, reduce, retain, reuse' hierarchy and incorporated into the ASSMP according to potential location, classification or type, and volume, taking into account all previous site investigations and any other baseline ASS information. Default targets for treated acid sulfate soils are provided in Table En27.	Default targets from IS Rating v2.1 Technical Manual are used in Section 6 for ASS. To be reviewed after site specific ASSMPs are complete.
DL1.3	**The project design and construction methodology have responded to ASS risks.** The project design and the construction methodology must include initiatives or management actions to reduce ASS risk (DL1.1) across the asset lifecycle and aim to achieve the project targets for Design and As Built.	Detailed design and construction methodology work in progress. Design Report will need to address this requirement.
ABL1.1	**The ASSMP has been reviewed and updated.** The ASSMP (DL1.1) must be reviewed and updated during the construction phase at least annually by a suitably qualified professional, taking into account changes to the risk assessment that may result from further site investigations or changes to design or construction methodology.	This Subplan provides the high level framework for achieving these aspects during construction. Will need to be updated on the basis of additional requirements from the site specific ASSMPs
ABL1.2	**The ASSMP including maintenance and monitoring have been implemented.**	

9. Monitoring requirements

Monitoring requirements in relation to the implementation of the Soil and Water Management Subplan are presented in Table 15.

Table 15 Summary of Soil and Water Management Subplan monitoring program

Subject matter	Location	Monitoring requirement	Frequency	Record	Responsibility
Erosion and Sediment Control	Bare areas and stockpiles on construction site Up and downslope of excavations	Inspecting and maintaining temporary sediment controls weekly during dry weather periods and daily during wet weather periods, as well as before and after storm events, including cleaning out blocked drains and culverts, and reinstating damaged temporary sediment controls.	Weekly or when required based on weather events	Site inspection checklist, organised site photographs, stockpile register	Environmental Manager, Environmental Advisor and Site Supervisor
	Erosion and sediment control measures	Daily review of weather and rainfall forecasts	Daily	Plan for site inspections related to any anticipated rain event Record all inspections in the inspection log	Environmental Manager, Environmental Advisor and Site Supervisor
	All areas	Prior to an anticipated rain event, inspection of the drainage, erosion, and sediment control measures, to ensure that these are in appropriate condition.	Prior to an anticipated rain event	Site inspection checklist, organised site photographs	Environmental Manager, Environmental Advisor and Site Supervisor
	All areas	Following a rain event, inspection of drainage, erosion, and sediment control measures, including:	Within 24h of a rain event[2]	Site inspection checklist, organised site photographs	Environmental Manager,

[2] Defined as an event when rainfall may result in an offsite discharge and/or when onsite construction activities are ceased due to rain.

Subject matter	Location	Monitoring requirement	Frequency	Record	Responsibility
		– General check of all drainage, erosion, and sediment control measures – Maintenance of drainage, erosion, and sediment control measures – Inspection occurrences of excessive sediment deposition (weather on-site or off-site) – Inspection of construction materials, litter or sediment placed, deposited, washed, or blown from the site, including deposition by vehicular movements – Manage occurrences of excessive sediment deposition (whether on-site or offsite)			Environmental Advisor and Site Supervisor
	All areas	Weekly site inspections should include: – Inspection of all drainage, erosion, and sediment control measures in working areas – Inspection of any occurrences of excessive sediment deposition – Inspection of any occurrences of construction materials, litter or sediment placed, deposited, washed, or blown from the site, including deposition by vehicular movement – Inspection of any litter and waste receptors, and oil, fuel, and chemical storage facilities – Proposed response to any issues identified	Weekly	Site inspection checklist, organised site photographs	Environmental Manager, Environmental Advisor and Site Supervisor

Subject matter	Location	Monitoring requirement	Frequency	Record	Responsibility
Landslide	All areas	Regularly inspect and conduct timely maintenance as required to reduce the potential for site activities to trigger landslides, or structures and access tracks being damaged by landslides.	Weekly	Site inspection checklist and site photographs are required as a minimum for all sites. Additional forms, records, or information required by the landslide monitoring plans may include: – A slope condition assessment – Drainage and water flow observations – Ground movement indicators – Risk rating and mitigation recommendations – Follow up actions	Construction Manager and Site Supervisor
	Areas of mapped or unmapped landslides and 'significant slopes'* *As defined by Jacobs 2024	Identify areas of potential landslide risk during design and investigation stage. Develop site specific landslide monitoring plans in areas of potential landslide risk, in line with the recommendations in Section 7.2.1 of Appendix G – Landslide Risk Assessment Report.	At specific hold points, weekly and after heavy or prolonged rain		Site Supervisor
Contaminated soil Any soils related to hydrocarbon and hazardous substances spills	Imported materials	Visual inspection shall be undertaken throughout the course of works, to ensure that imported materials are free of indicators of contamination, such as staining, odours, and anthropogenic materials, the latter of which can include construction and demolition debris or other waste. Visual inspections shall be documented in site diary notes or environmental inspections and	Daily where materials are being imported	Records of the source and destination onsite of all imported materials will be maintained. Records of any laboratory analysis of imported fill will also be stored onsite. This will assist with testing and/or remedial efforts should contamination be suspected in imported materials.	Construction Manager and Environmental Manager

Subject matter	Location	Monitoring requirement	Frequency	Record	Responsibility
		photographic records of imported fill materials will be maintained. Should suspected contamination of imported materials be observed, importation of the material shall be immediately suspended and the following conducted: – Testing of the imported material both in stockpiles and locations where placed onsite may be required to confirm the presence of contamination. – The Environmental Manager or consultant may visit the source site to assess the risks of contamination being present in the imported materials prior to resumption of importation.		As per EPA requirements, records will contain the following: – The type of clean fill (clean fill type 1 or clean fill type 2) – The quantity of clean fill – The address of the source location of the clean fill – The identity of the person delivering the clean fill – The location where the clean fill has been received, stored, reused or disposed of on the land – Records must be kept for a minimum of 5 years and made available to the EPA on request Summary reports outlining the material type, source, destination on site and tonnage will be provided to Genus by the construction contractor on a weekly basis.	

Subject matter	Location	Monitoring requirement	Frequency	Record	Responsibility
Hydrocarbon and hazardous substances	Spill response	All site personnel will be made aware of their responsibility to report any spills of hazardous materials. Training and site inductions will include guidance on identifying signs of spillage such as staining, odours, or visible residue. A minimum weekly inspection will be conducted by the environmental manager to assess compliance with spill management protocols. The inspection will cover the following indicators: – No visible staining or signs of spills in work areas. – Spill kits are fully stocked; if kits are found empty without a corresponding incident report, an explanation must be documented. – Hazardous materials are stored correctly in accordance with site-specific construction protocols. – Unexpected finds protocols have been followed where applicable.	Weekly	Site inspection checklist, organised site photographs Incident reports where spills have occurred.	Personnel involved in the spill Environmental Manager
Hydrocarbon and hazardous substances	Storage	A minimum weekly inspection should be conducted by the Environmental Manager to assess compliance with hazardous materials use and storage protocols. The inspection will cover the following indicators: – Spill kits are fully stocked; if kits are found empty without a corresponding incident report, an explanation must be	Weekly	Site inspection checklist, organised site photographs Incident reports where spills have occurred.	Environmental Manager

Subject matter	Location	Monitoring requirement	Frequency	Record	Responsibility
		documented. – Hazardous materials are stored correctly in accordance with site-specific construction protocols.			
Water contaminated soil and ASS	Up and downslope of excavations	Inspecting watercourses adjacent to worksites for elevated turbidity. When elevated turbidity is detected, stopping work or augmenting erosion and sediment controls to reduce sediment transport.	Weekly	Site inspection checklist, organised site photographs	Environmental Manager
	Receiving waterways	Prior to commencement of construction a surface water monitoring plan will be developed in consultation with relevant authorities that confirms water quality parameters and analytes, sampling frequency and duration, and sampling locations. In areas where high sediment loads and erosion are expected, baseline monitoring up and downstream of cleared areas will be conducted prior to construction. Visual monitoring will be carried out for drainage infrastructure upstream and downstream of construction works weekly during dry weather periods and daily during wet weather periods and before and after storm events including: • cleaning out blocked drains and culverts, • and reinstating damaged temporary sediment controls. • Details of all inspections and maintenance events will be recorded.	Weekly and after a rain event	Site inspection checklist, organised site photographs Tables of analytical results for water samples collected compared to site specific criteria	Environmental Manager

Subject matter	Location	Monitoring requirement	Frequency	Record	Responsibility
		Daily visual monitoring will be carried out for active construction areas for visible water quality issues including high sediment loads or erosion. The following field water quality parameters will be collected weekly and during rainfall monitoring events using a calibrated water quality parameter probe: – Turbidity (NTU) – Electrical conductivity (µS/cm) – pH – Dissolved oxygen (mg/L) – Temperature (°C) – Litter, oil and grease (visual inspection) Chemical analysis of water quality samples will be required under the following circumstances: – Sensitive environmental receptors are present – Known or potential ASS or contamination is present – Spills of hazardous materials have occurred. – Site-specific lists of water quality analytes and corresponding assessment criteria will be developed for each location, informed by local land use, designated environmental			

Subject matter	Location	Monitoring requirement	Frequency	Record	Responsibility
		values, contamination status, and the sensitivity of the surrounding catchment. This will be developed in consultation with EPA Tasmania. – In areas of known or suspected contamination, contaminants of potential concern will be analysed in water quality samples as per the NEPM (2013) and PFAS NEMP (2025).			
Contaminated soil and ASS	Materials tracking	The materials tracking register will be updated daily by the Construction Supervisor. During periods of moving contaminated materials the materials tracking register will be reviewed daily (otherwise weekly) by the Environmental Manager to ensure completeness and accuracy. Spot checks will be conducted monthly to verify that material movements match register entries and that containment measures around bare areas, excavations, and stockpiled materials are in place on site. Any discrepancies or incidents involving uncontrolled movement of contaminated materials will be reported immediately to TasNetworks and the Tasmanian EPA. Where discrepancies are identified, the causation should be investigated and recorded in the materials tracking register. The effectiveness of rectification measures implemented	Daily to weekly	Materials tracking register Stockpile inventory/register listing the contamination status and source and destination of stockpiled materials. Site inspection checklists and mudmaps for onsite movements. Supporting documentation including receival receipts and invoices for imported and exported materials.	Construction Manager Environmental Manager

Subject matter	Location	Monitoring requirement	Frequency	Record	Responsibility
		is to be evaluated and reported to TasNetworks and the Tasmanian EPA to demonstrate compliance. The register and associated documentation will be retained for audit purposes and made available to regulators upon request.			
ASS	ASS verification testing	Where ASS is encountered verification testing will be conducted post treatment to confirm that sufficient neutralising agent has been thoroughly mixed with the soil to prevent any future acidification. Verification is required to occur on all treated material prior to reuse onsite. The criteria and frequency will be dependent on soil type, volume and acidity.	As needed based on volumes of treated material and acidity, determined in the site specific ASSMP	Calculations of Net Acidity, volume of soil to be treated and liming rates. Receipts showing quantities of neutralising agent purchased. Reconcile quantities of neutralising agent used on site e.g. per treatment pad, dates aglime was used on each treatment pad, aglime used in guard layers, reapplication of aglime in guard layers, dusting on drainage lines and bunds etc. Evidence of the composition, purity (including presence of metal contaminants) and particle size of the neutralising agent used. Photographic evidence of incorporation of neutralising agent e.g. thorough mixing on a treatment pad.	Environmental Manager

Subject matter	Location	Monitoring requirement	Frequency	Record	Responsibility
Various	Rehabilitation	Monitoring and Maintenance: Inspect rehabilitated areas for weeds, erosion, sedimentation, and revegetation success: – Remediate any areas where rehabilitation is unsuccessful.	Quarterly for the first year Every six months for the following two years After significant storm events during these periods	Documentation and Reporting: Record all inspection, monitoring, testing, and remediation activities. Include photographic evidence of rehabilitation progress and outcomes.	Environmental Manager

10. Adaptive management measures

Adaptive management measures in relation to the implementation of the Soil and Water Management Subplan are presented in Table 16.

Table 16 Soil and Water Management Subplan triggers and contingencies

Trigger	Adaptive management measure
Unexpected finds - Overarching	If earthworks encounter an unanticipated discovery while breaking ground and/or excavating material, the general unexpected finds procedure below has been developed to manage such situations. In general, unexpected finds should be managed as follows: – All activity in the immediate area of the discovery must cease, a buffer zone established, and Aboriginal Heritage Tasmania notified within 48 hours. Works must not recommence until advice is received from Aboriginal Heritage Tasmania and any required approvals under the Aboriginal Heritage Act 1975 are obtained. – Follow any site emergency management procedures and the TasNetworks Incident Management HSEQ Operation procedure if the unexpected find presents a potential safety risk (i.e. live utilities). – If the find is of potential cultural heritage and/or Aboriginal significance, the Unanticipated Discovery Plan should be consulted.
Unexpected finds - Previously unknown services or assets	– Do not approach if live electricity is suspected. Check for indications that the service is in use and contact local authority management and/or utility owner/service provider. Attempt to switch off or isolate the utility if safe to do so. – If the service appears redundant, check available DBYD information to determine its provenance. Redundant services may be removed if practical.
Unexpected finds - Karst and Sinkholes	– Stop work, make the work area safe, use physical barriers to prevent access to the suspected Karst and Sinkholes within a 20m radius of the feature. – Notify Genus. Photograph and document all findings and outcomes. – Genus to engage a suitably qualified Karst specialist to assess the feature. – Continue works if the find has been appropriately assessed and managed, is safe to do so, and Genus has given permission to continue works.
Unexpected finds - Landslides:	If a previously unmapped landslide has occurred at the site, it should be managed by: – Stop work, make the work area safe (turn off and/or de-energise all plant and equipment), if safe to do so. Follow site emergency management procedures if the landslide hazard presents a potential safety risk. – Engage a specialist geotechnical practitioner to undertake an assessment of the risk and provide risk management recommendations.
Unexpected finds - Gross contamination and/or, hydrocarbons or hazardous materials	– Evacuate the area if hazardous levels of vapours and/or hazardous materials present a risk to personnel. – Apply PPE (e.g. P2 dust mask or respirator) and clear the excavation/work area with gas detectors prior to approaching suspect material. – Wet down the area if asbestos is suspected. Engage a suitably qualified occupational

Trigger	Adaptive management measure
	hygienist to assess. Do not disturb or agitate suspected asbestos-containing material. – The protocol is provided in Appendix A.
Spill Response - Gross contamination and/or, hydrocarbons or hazardous materials	When hazardous materials required for operations onsite, for example fuel, are spilled. – The protocol is provided in Appendix A. Personnel onsite will be aware of this protocol and receive the appropriate level of training to manage hazardous material spills suitable to the role they are undertaking. – The protocol has been developed to align with the TasNetworks Oil and Fuel Spill Management Procedure (IMS-WPI-00-91).
Unexpected finds - ASS	Material suspected of containing ASS is disturbed in an area where the initial risk assessment determined low risk and subsequently no ASSMP is in place, or where visual or olfactory indications of ASS are observed: – An adaptive management plan for unexpected ASS will be implemented in response to suspected ASS unexpectedly encountered during site activities. – This protocol does not apply to ASS already identified during the risk assessment and subsequent ASS investigations done in the PSI and DSI. – The protocol is provided in Attachment 1. Personnel onsite will be aware of this protocol and receive the appropriate level of training to identify signs of ASS suitable to the role they are undertaking.

11. Reporting and documentation requirements

Reporting and documentation requirements in relation to the implementation of the Soil and Water Management Subplan are presented in Table 17.

Table 17 Reporting and documentation requirements

Reporting requirement	Type	Frequency	By who	To who
Pre-construction				
Site specific DSI	Reports (landslide, contaminated soil and ASS)	Once off	Subcontractor	Environmental Manager
Site specific management plan	Report (landslide, contaminated soil and ASS)	Once off	Subcontractor	Environmental Manager
Construction				
Inspection records	Inspection	Daily (may vary based on activities and environmental risks)	Site Supervisor /Environmental Manager	Recorded and available for Environmental Manager inspection and summarised in environmental compliance updates

Reporting requirement	Type	Frequency	By who	To who
				to Executive Steering Committee
Water quality monitoring records	Monitoring data	As required	Environmental Manager	Recorded and available for environmental compliance reporting

12. Reviews and updates

If monitoring determines that the controls outlined in this Subplan are not effective, the process generating the adverse outcome will be paused. Alternative management controls will be determined in accordance with the CEMP and the above management measures. Once determined, works may resume.

This document is not static and will be updated to reflect new information and changes to management measures, in accordance with the CEMP.

13. Document history

13.1 Current document authoriser

Title	Name
General Manager – Major Projects Transmission	Craig Gosney

13.2 Revision history

Rev	Date	Author	Authoriser	Details of Amendment
A	27/10/2025	GHD	Craig Gosney	Initial document – 70% Design Gate Draft
B	30/01/2026	GHD Genus	Craig Gosney	90% design gate submission addressing TasNetworks' comments from 70% design gate submission
C	27/03/2026	GHD Genus	Craig Gosney	90% TasNetworks' comments addressed, MIDA Act Permit Conditions Addressed, IFC Submission
D	27/04/2026	GHD Genus	Craig Gosney	100% design gate TasNetworks' comments addressed, EPBC provisional permit conditions addressed
E	15/06/2026	GHD Genus	Criag Gosney	Addressing TPC and DCCEEW comments
F	09/07/2026	GHD Genus	Craig Gosney	Addressing further TPC comments

14. Glossary

Term	Definition
Acid Sulfate Soils (ASS)	Soils or sediments containing sulfides which, when exposed to oxygen through disturbance or drainage, can generate sulfuric acid and mobilise metals, potentially causing harm to the environment, infrastructure, and human health.
Actual Acid Sulfate Soils (AASS)	Acid sulfate soils that have already oxidised and are acidic, capable of generating acidic leachate without further disturbance.
Adaptive Management	A structured and iterative process for decision-making that allows management measures to be reviewed, refined, and amended in response to monitoring results, incidents, or changing site conditions.
ASS Management Plan (ASSMP)	A site-specific plan prepared by a suitably qualified professional outlining investigation, treatment, reuse, or disposal measures for acid sulfate soils to avoid environmental harm.
Catchment	The land area from which surface water runoff drains to a particular waterway, drainage line, or waterbody.

Clean Fill (Type 1 / Type 2)	Soil, rock, sand, or other inert material classified in accordance with EPA Tasmania requirements as suitable for reuse or disposal without adverse environmental risk.
Construction Environmental Management Plan (CEMP)	The overarching environmental management document that sets out the framework for managing environmental risks and impacts during construction, under which this Subplan has been prepared.
Contaminated Material	Soil, water, or other material containing contaminants at concentrations that pose, or have the potential to pose, a risk to human health or the environment.
Detailed Site Investigation (DSI)	An intrusive investigation undertaken by a suitably qualified professional to assess the nature, extent, and risks associated with contamination or acid sulfate soils.
Erosion	The detachment and transport of soil or sediment by water, wind, or mechanical means.
Erosion and Sediment Control Plan (ESCP)	A site-specific plan detailing erosion and sediment control measures implemented to prevent sediment loss from disturbed areas.
Groundwater	Water that occurs beneath the ground surface in soil pores and rock fractures.
Hydrogeological Assessment	An assessment of groundwater conditions, including aquifer characteristics, groundwater quality, flow direction, and potential impacts from construction activities such as dewatering.
Infrastructure Sustainability (IS) Rating	A rating scheme administered by the Infrastructure Sustainability Council assessing sustainability performance across infrastructure projects.
Karst	A landscape formed by the dissolution of soluble rocks such as limestone, characterised by sinkholes, caves, voids, and underground drainage systems.
Landslide	The movement of soil, rock, or debris down a slope due to gravity, often influenced by geology, groundwater conditions, slope, and disturbance.
Monitoring	The systematic collection of information (e.g. visual inspections, sampling, testing) to assess the effectiveness of management controls and identify environmental issues.
National Environment Protection Measure (Assessment of Site Contamination) 1999 (ASC NEPM)	A national framework providing guidance on the assessment and management of contaminated land.
Per- and Poly-fluoroalkyl Substances (PFAS)	A group of persistent synthetic chemicals that may pose risks to human health and the environment when present in soil or water.
PFAS National Environmental Management Plan (PFAS NEMP)	National guidance outlining best-practice management of PFAS-contaminated materials.

Potential Acid Sulfate Soils (PASS)	Soils or sediments containing sulfides that may generate sulfuric acid if disturbed and exposed to oxygen.
Receiving Environment	The environment that receives discharges or may be affected by construction activities, including waterways, groundwater, soils, ecosystems, and adjacent land.
Sediment	Soil or other particulate matter that is transported by water or wind and may be deposited in waterways or on land.
Sediment Control	Measures implemented to trap, contain, or reduce the transport of sediment generated by erosion.
Site Contamination Management Plan (SCMP)	A site-specific plan prepared by a suitably qualified professional describing how contaminated material will be managed, treated, reused, or disposed of.
Suitably Qualified Professional (SQP)	A person with appropriate qualifications, experience, and professional standing recognised by relevant regulators to assess and manage contamination or acid sulfate soils.
Watercourse	A natural or artificial channel through which water flows, including rivers, creeks, streams, and drainage lines.
Water Quality	The chemical, physical, and biological characteristics of water relevant to its ecological condition and suitability for use.

Appendices

Appendix A

Adaptive plans

Adaptive plan – Unexpected ASS

Purpose

This plan is to be implemented in the event that, during construction activities, indicators of ASS are observed in areas where no ASSMP was initially required. This protocol does not apply to ASS already identified and managed under an ASSMP.

Suspected ASS

Indicators of ASS include (but not limited to):

A rotten egg smell (H_2S),
Yellow or orange mottling (iron oxides or jarosite),
An oily sheen on water surfaces,
Soil that is water-saturated with a sticky texture and steely blue grey to black colour (monosulfidic black oozes).

Visual examples provided below.

Action

In the event that, any unusual soil or water conditions are encountered, the following steps should be implemented:

1. **Stop work**

If material suspected of containing ASS in encountered during earthworks, a stop work should be implemented, and the site environment supervisor should be consulted.

2. **Additional investigation**

The site environmental supervisor will arrange for the nominated subject matter expert (SME) to inspect the find and determine the appropriate course of action.

3. **Sampling and analysis**

The SME may determine sampling and laboratory analysis is required. Samples of the suspected material will be collected following the procedure outlined in the Tasmanian ASS guidelines and sent for laboratory analysis.

If the SME suspects ASS, a Field pH and pH_{FOX} test can be completed to provide a rapid preliminary risk assessment. This is preferred, as it allows for prompt action (e.g., reburial or treatment) to be taken in the event the material is PASS which can prevent uncontrolled mobilisation of acidity and metals into the receiving environment while awaiting laboratory results.

4. **Classification**

Table A1- can be used for interpreting the results of the preliminary risk assessment, the Tasmanian ASS guidelines can be consulted for more information.

Table A1-1 Preliminary risk assessment interpretation

Test results	Resulting risk
pH_{FOX} causes a reaction (strong bubbling /effervescing, note organic matter can also cause this)	A strong reaction can indicate a risk of ASS
A lower pH_{FOX} result compared to field pH result	A difference of one unit or greater indicates a risk of ASS
pH_{FOX} <3 (and the above indicators are met)	Strongly indicates a PASS material
pH_{FOX} 3-4	Moderate risk, lab analysis required to confirm
pH_{FOX} 4-5	Low risk, lab analysis required to confirm
pH_{FOX} >5 and little to no drop in pH from field value	Extremely low risk of ASS, no further action required, but field investigation should be documented

If the preliminary risk assessment classifies the material as anything equal to or higher than low risk, any adjacent material should not undergo further disturbance until laboratory testing has been completed and the risk and extent of ASS fully understood. The material that has been disturbed should be contained on a suitably designed treatment stockpile or equivalent that prevents contamination of the receiving environment while awaiting laboratory results.

5. **Management**

If the laboratory testing classifies the material as ASS (including PASS and AASS), the area will need to complete an ASS investigation and have a site specific ASSMP developed before work can recommence, the ASSMP should follow the general guidance for ASS management, outlined in Section 7.

Adaptive plan – Spill response procedure

Table A1-2 Spill response procedure

Stage	Action
Assess and prepare	Stop the activity and assess the safety of the site, ensure all personnel are not at risk from any potential hazards and if safe to do so assist anyone in immediate danger. Isolate other site workers, and the public where necessary, from the spill area and implement traffic control if required. Where oil/fuel is potentially lost during transportation: – Assess the volume lost and nature of the route to determine if the oil or fuel may be posing a traffic hazard. – If a traffic hazard may be present, drive the route to identify areas that may require clean up. All spills should be considered hazardous unless the nature of the spill is clear and obvious, or until a spill is proven otherwise. This is particularly the case for known or suspected oil leaks from transformers, which may contain PCBs. The following PPE is required as minimum when attempting to control or clean a spill: – Chemical resistant clothing and gloves.

Stage	Action
	– Chemical resistant safety glasses and/or face shield. – Half or full-face respirators with organic vapour cartridge where there is a risk of volatilisation.
Control	Control the spill by stopping the source of the spill (where possible): – If the spill is in relation to transformer fluids, the asset may need to be stood upright or plugged using putty. – If the spill is from hydraulic hoses, the hose may need to be crimped, if safe to do so. – If the spill is in relation to fluids that are being pumped or operating vehicles these should be switched-off, stopped or isolated to prevent further spillage. – If the spill involves flammable or combustible liquids, eliminate any sources of ignition in the immediate area.
Contain	Where safe and able to do so, action should be taken as soon as possible to contain the spill to stop the material entering stormwater drains or contaminating soil. Spills will be contained and spread prevented using the following methods as necessary: – Booms, socks, and absorbent pads in onsite spill response kits. – A soil bund can be created with a shovel or machinery. – Prioritise resources to prevent the spill from entering the stormwater system or natural waterways. – Dispersants and in-situ burning will NOT be utilised as a containment measure to a spill of hydrocarbons. For larger spills, consideration will be given to potential impacts to neighbouring sites.
Contact	As soon as practicable, raise the alarm with the immediate Manager or Supervisor, and the Environmental Officer. Provide details of location, substance spilt, response initiated and/or emergency support needed and an estimate of quantity. These parties will then support further communications and coordination as needed. All spill incidents are required to be reported to the Construction Manager within 24 hours of the incident occurring. An incident report must be provided for medium (moving spill that can be contained prior to entering drains or impacting the surrounding land) and large (fast moving spill that cannot be contained prior to entering drains or impacting the surrounding land) within 24 hours of the incident occurring.
Clean	Where safe and able to do so, clean-up of the spill will take place in accordance with the SDS for the substance and with personnel wearing the Personal Protective Equipment (PPE) outlined on the SDS. In general, the following clean up techniques will be employed: – Spills on unsealed ground (e.g. soil): Apply absorbent materials such as pads, peat moss, or equivalent to soak up pooled oil or fuel. Where contamination has occurred on soil, excavate the affected area along with a buffer of surrounding soil to ensure complete removal. Place excavated material into appropriately labelled bags, including the relevant asset number. – Spills on sealed surfaces (e.g. bitumen): Use absorbent pads and/or peat moss to capture the spilled liquid. Once absorbed,

Stage	Action
	agitate the peat moss with a stiff broom and sweep up for disposal in accordance with waste management protocols. – Spills affecting vegetation: Clean oil from affected vegetation where feasible. If removal of significant vegetation (excluding grass) is required, notify the Environmental & Sustainability (E&S) Team prior to undertaking any clearing. The disposal of any waste material must be carried out in accordance with the Waste Management Subplan.

Adaptive plan - Unexpected finds procedure for land contamination or hazardous materials

In general, unexpected finds should be managed as follows:

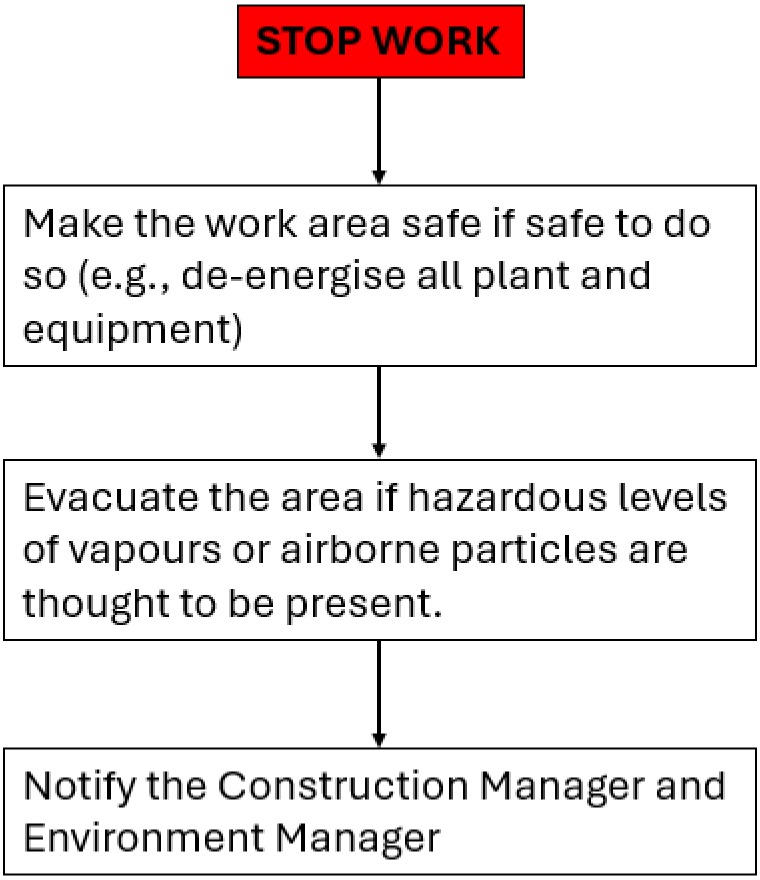


Figure A1-1

Stop work, make the work area safe (turn off and/or de-energise all plant and equipment), if safe to do so. Follow any site emergency management procedures if the unexpected find presents a potential safety risk (i.e. live utilities).

Inspect the unexpected find, determine what it is likely to be, and take the following actions:

Gross contamination and/or hazardous materials:

Evacuate the area if hazardous levels of vapours and/or hazardous materials present a risk to personnel.
Apply PPE (e.g. P2 dust mask or respirator) and clear the excavation/work area with gas detectors prior to approaching suspect material.
Wet down the area if asbestos is suspected. Engage a suitably qualified occupational hygienist to assess. Do not disturb or agitate suspected asbestos-containing material.
Notify the Construction Manager and Environmental Manager. Photograph and document all findings and outcomes.
Only continue works if the find has been appropriately managed, and it is safe to do so, and the Construction Manager has given permission to recommence.

In the event of an unexpected discovery of contamination, contact the Environmental Manager (who will seek advice from a suitably qualified contaminated land consultant if required). They will confirm the nature of the contamination identified, and develop an appropriate response prior to recommencing work. Following investigation, if required a SCMP will be developed, outlining the steps in managing the contaminated material, including options for remediation and reuse, or safe disposal.

Appendix B

ASS risk assessment and investigation

Step 1 – ASS initial risk assessment

The following decision tree will determine the initial risk of encountering ASS.

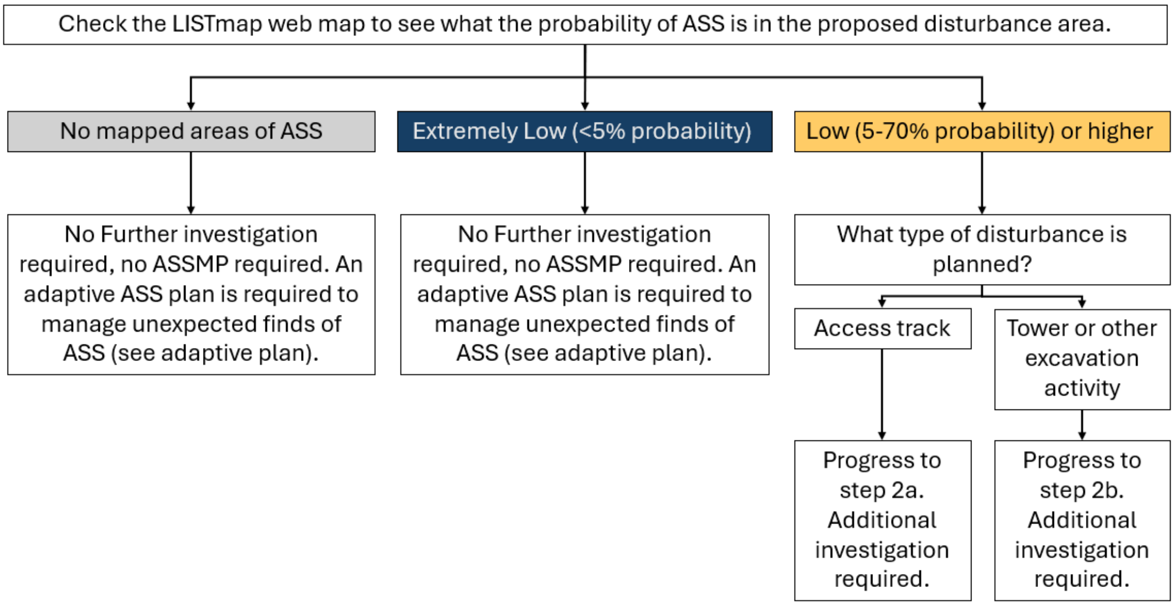


Figure A2-1 Step 1 – Initial risk assessment decision tree

Table A2-1 summarises the indicative ASS risk by transmission line segment site based on the above decision process. Table A2-1 summarises the indicative ASS risk by transmission line segment site based on the above decision process. It indicated that 85% of sites do not require any additional investigation or management plan and only need to incorporate the overarching adaptive management plan for unexpected finds of ASS. A total of 45 sites classify as low risk of ASS and three sites classify as high risk of ASS, these sites represent 15% of the total sites, they will require additional investigation and potentially management plans. NOTE – the assessment of risk described here and detailed in the accompanying tables is indicative only, and it is up to the contractor to make their own assessment of the risks of ASS an apply that assessment accordingly.

When divided into transmission line segments, the Sheffield to Burnie (SHBU) segment has no sites that require additional investigation or management (other than an adaptive management plan), none of the towers in the Heybridge segment require additional works (the gantry site is an exception). The Palmerston to Sheffield (PMSH) hosts nearly all of the sites that have an ASS risk (47 out of 48). Table A2-2 outlines which specific locations require additional investigation and management, it also summarises the findings of the previous investigation classification by Pitt and Sherry (2025) where applicable.

Table A2-1 Summary of indicative ASS LISTmap risk by transmission line segment

Transmission line segment	No mapped areas of ASS	Extremely low	Low	High
Sheffield to Burnie (SHBU)	125	-	-	-
Sheffield Gantry	1	-	-	-
Palmerston to Sheffield (PMSH)	132	1	44	3
Heybridge (HB)	18	-	-	-
Heybridge Gantry	-	-	1	-
Total	276	1	45	3

Table A2-2 ASS LISTmap risk and additional investigation and management requirements.

Transmission line segment	Tower ID	ASS risk level	Additional work required
Sheffield to Burnie	SHBU T1	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T2	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T3	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T4	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T5	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T6	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T7	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T8	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T9	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T11	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T12	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T13	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T14	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T15	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T16	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T17	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T18	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T18A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T19	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T20	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T21	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T22	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T23	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T24	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T25	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T26	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T27	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T28	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T29	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T30	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T31	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T32	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T33	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T34	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T35	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T36	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T37	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T38	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T39	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T40	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T41	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T42	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T43	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T44	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T45	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T46	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T47	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T48	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.

Transmission line segment	Tower ID	ASS risk level	Additional work required
Sheffield to Burnie	SHBU T49	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T50	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T51	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T52	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T53	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T54	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T54A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T55	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T56	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T57	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T57A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T58	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T59	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T59A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T60	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T60A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T61	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T62A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T63A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T64	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T65	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T65A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T66	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T67	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T68	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T69	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T70	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T71	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T72	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T73	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T74	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T75	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T75A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T76	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T77	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T78	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T79	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T80	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T81	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T82	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T83	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T83A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T84	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T85	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T86	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T87	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T88	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T89	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T90	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.

Transmission line segment	Tower ID	ASS risk level	Additional work required
Sheffield to Burnie	SHBU T91	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T91	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T92	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T92	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T93	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T93	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T94	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T94	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T95	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T96	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T97	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T98	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T99	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T100	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T113	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T114	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T115	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T116	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T117	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T118	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T119	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T120	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T121	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T122	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T123	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T124	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T126	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield to Burnie	SHBU T127	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Sheffield	SH Gantry	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T1	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T2	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T3	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T4	LOW	Based on the 2 results in Pitt and Sherry, 2025 (sampled as ASS118), no ASS risk identified. Based on desktop risk rating, insufficient sample density for CEMP 90% stage, additional investigation required (step 3).
Palmerston to Sheffield	PMSH T5	LOW	Based on the 2 results in Pitt and Sherry, 2025 (sampled at ASS116 between PMSH T5 and T7 and ASS117 at PMSH T5), ASS risk identified. Based on desktop risk rating, insufficient sample density for CEMP 90% stage, additional investigation required (step 3).
Palmerston to Sheffield	PMSH T7	LOW	
Palmerston to Sheffield	PMSH T8	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T9	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T10	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T11	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T12	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T13	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.

Transmission line segment	Tower ID	ASS risk level	Additional work required
Palmerston to Sheffield	PMSH T14	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T15	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T16	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T17	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T18	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T19	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T20	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required. Sampled as ASS110 (Pitt and Sherry, 2025).
Palmerston to Sheffield	PMSH T21	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required. Sampled as ASS109 (Pitt and Sherry, 2025).
Palmerston to Sheffield	PMSH T22	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T23	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T24	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T25	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T26	NA	Based on the 2 results in Pitt and Sherry, 2025 (sampled as ASS107), there is an ASS risk. Based on desktop risk rating, insufficient sample density for CEMP 90% stage, additional investigation required (step 3).
Palmerston to Sheffield	PMSH T27	LOW	Based on the 2 results in Pitt and Sherry, 2025 (sampled as ASS106 between PMSH T27 and T28), no ASS risk identified. Based on desktop risk rating, insufficient sample density for CEMP 90% stage, additional investigation required (step 3).
Palmerston to Sheffield	PMSH T28	LOW	
Palmerston to Sheffield	PMSH T29	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T30	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T31	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T32	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T33	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T34	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T35	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T36	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T37	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T38	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T39	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T40	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T41	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T42	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.

Transmission line segment	Tower ID	ASS risk level	Additional work required
Palmerston to Sheffield	PMSH T43	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T44	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T45	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T46	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T47	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T48	NA	Based on the 2 results in Pitt and Sherry, 2025 (sampled as ASS097), no ASS risk identified. Based on desktop risk rating, insufficient sample density for CEMP 90% stage, additional investigation required (step 3).
Palmerston to Sheffield	PMSH T49	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T50	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T51	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T52	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T53	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T54	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T55	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T56	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T57	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T58	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T59	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T60	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T61	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T62	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T63	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T64	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T65	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T66	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T67	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T68	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T69	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T70	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T71	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).

Transmission line segment	Tower ID	ASS risk level	Additional work required
Palmerston to Sheffield	PMSH T72	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T73	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T74	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T75	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T76	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T77	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T78	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T79	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T80	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T81	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T82	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T83	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T84	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T85	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T86	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T87	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T88	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T89	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T90	EXTREMELY LOW	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T91	LOW	Based on the 2 results in Pitt and Sherry, 2025 (sampled as ASS084), there is an ASS risk. Based on desktop risk rating, insufficient sample density for CEMP 90% stage, additional investigation required (step 3).
Palmerston to Sheffield	PMSH T92	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T93	HIGH	Further ASS investigation required incorporate as part of a DSI. An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T94	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T95	HIGH	Based on the 2 results in Pitt and Sherry, 2025 (sampled as ASS080), no ASS risk identified. Based on desktop risk rating, insufficient sample density for CEMP 90% stage, additional investigation required (step 3).
Palmerston to Sheffield	PMSH T96	HIGH	Further ASS investigation required incorporate as part of a DSI. An ASSMP may be required depending on the results (Step 3).
Palmerston to Sheffield	PMSH T97	LOW	Sampled as ASS079 (Pitt and Sherry, 2025). Based on desktop risk rating, insufficient sample density for CEMP 90% stage, additional investigation required (step 3).
Palmerston to Sheffield	PMSH T98	LOW	Based on the 2 results in Pitt and Sherry, 2025 (sampled as ASS078), no ASS risk identified for disturbance that is <1000 tonnes. Based on desktop risk rating, insufficient sample density for CEMP 90% stage, additional investigation required (step 3).
Palmerston to Sheffield	PMSH T99	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required. Sampled as ASS077 (Pitt and Sherry, 2025).
Palmerston to Sheffield	PMSH T100	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.

Transmission line segment	Tower ID	ASS risk level	Additional work required
Palmerston to Sheffield	PMSH T101	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T102	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T103	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T104	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T105	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T106	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T107	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required. Sampled as ASS074 at T108 (Pitt and Sherry, 2025).
Palmerston to Sheffield	PMSH T109	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T110	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T111	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T112	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T114	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T115	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T116	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T117	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T118	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T119	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T120	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required. Sampled as ASS071 (Pitt and Sherry, 2025).
Palmerston to Sheffield	PMSH T121	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T122	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T123	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T124	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T125	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required. Sampled as ASS070 (Pitt and Sherry, 2025).
Palmerston to Sheffield	PMSH T126	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T127	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T128	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T129	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T130	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T131	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.

Transmission line segment	Tower ID	ASS risk level	Additional work required
Palmerston to Sheffield	PMSH T132	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T133	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T134	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T135	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T136	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T137	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T138	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T139	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T140	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T141	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T142	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T142A	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T143	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T144	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T145	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T146	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T147	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T148	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T149	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T150	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T151	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T152	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T153	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T154	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T155	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T156	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T157	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T158	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T159	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.

Transmission line segment	Tower ID	ASS risk level	Additional work required
Palmerston to Sheffield	PMSH T160	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T161	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T162	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T163	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T164	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T165	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T166	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T168	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T169	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T170	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T171	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T172	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T173	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T174	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T175	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T176	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T177	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T178	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T179	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T180	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSHT181	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T182	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Palmerston to Sheffield	PMSH T183	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur East T1	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur West T1	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur East T2	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur West T2	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur East T3	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur West T3	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur East T4	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur West T4	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur East T5	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur West T5	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur East T6	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.

Transmission line segment	Tower ID	ASS risk level	Additional work required
Heybridge	HB Spur West T6	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur East T7	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur West T7	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur East T8	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur West T8	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur East T9	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge	HB Spur West T9	NA	No further investigation/ASSMP required, an adaptive management plan for unexpected ASS is required.
Heybridge Gantry	HB Gantry	LOW	Further ASS investigation may be required incorporated as part of a DSI (see step 2b). An ASSMP may be required depending on the results (Step 3).

Step 2a – Additional investigation track clearing

The following decision tree will determine the need for additional ASS investigation based on the risk of encountering ASS.

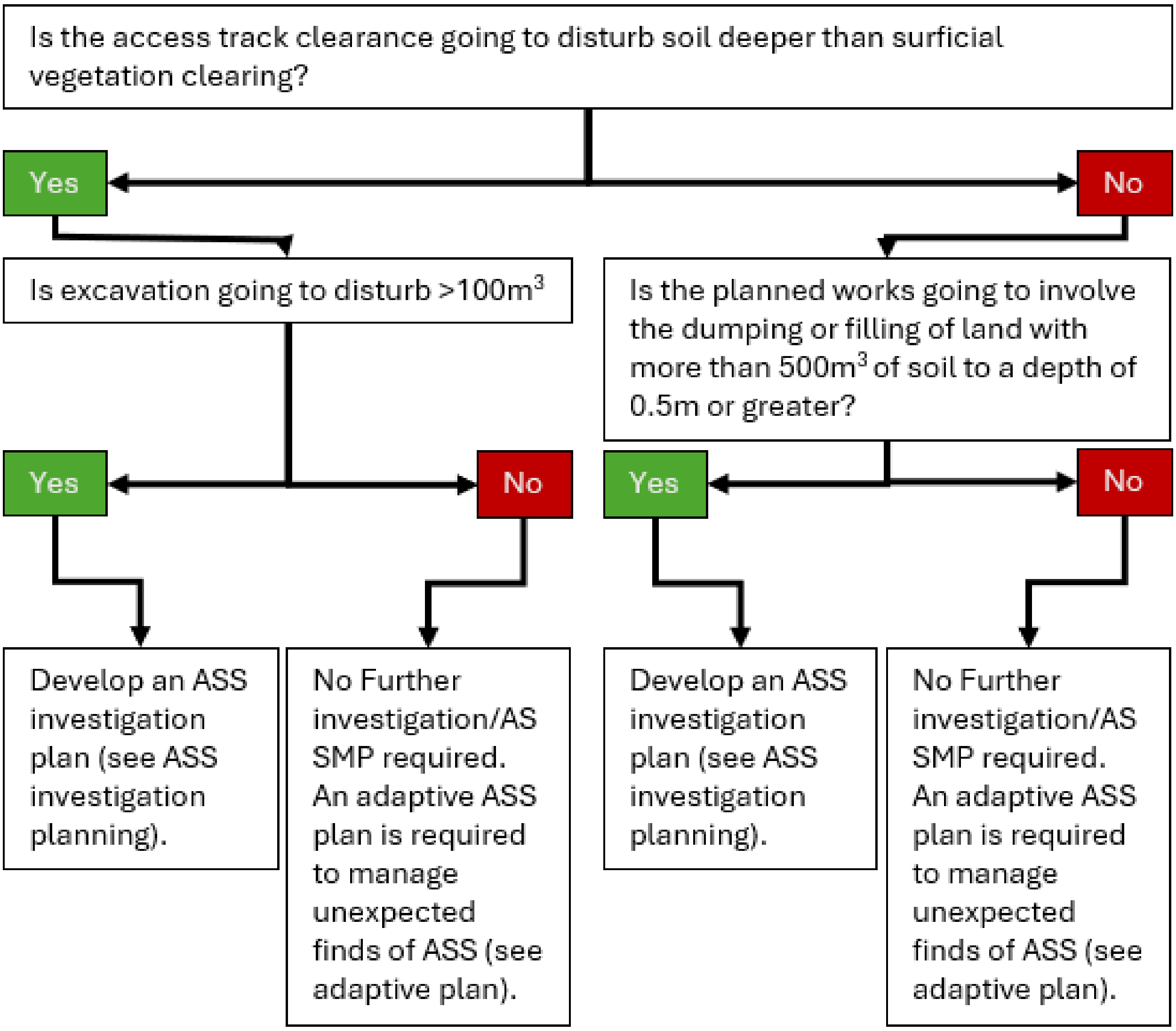


Figure A2-2 Step 2a – Additional investigation decision tree

Step 2b – Additional investigation other ground disturbance

In the event that sites are moved, additional sites are created, or other changes are made to the design that are not covered in table 16, the decision tree in step 1 and the decision tree below can also be applied to determine if additional ASS investigation is required.

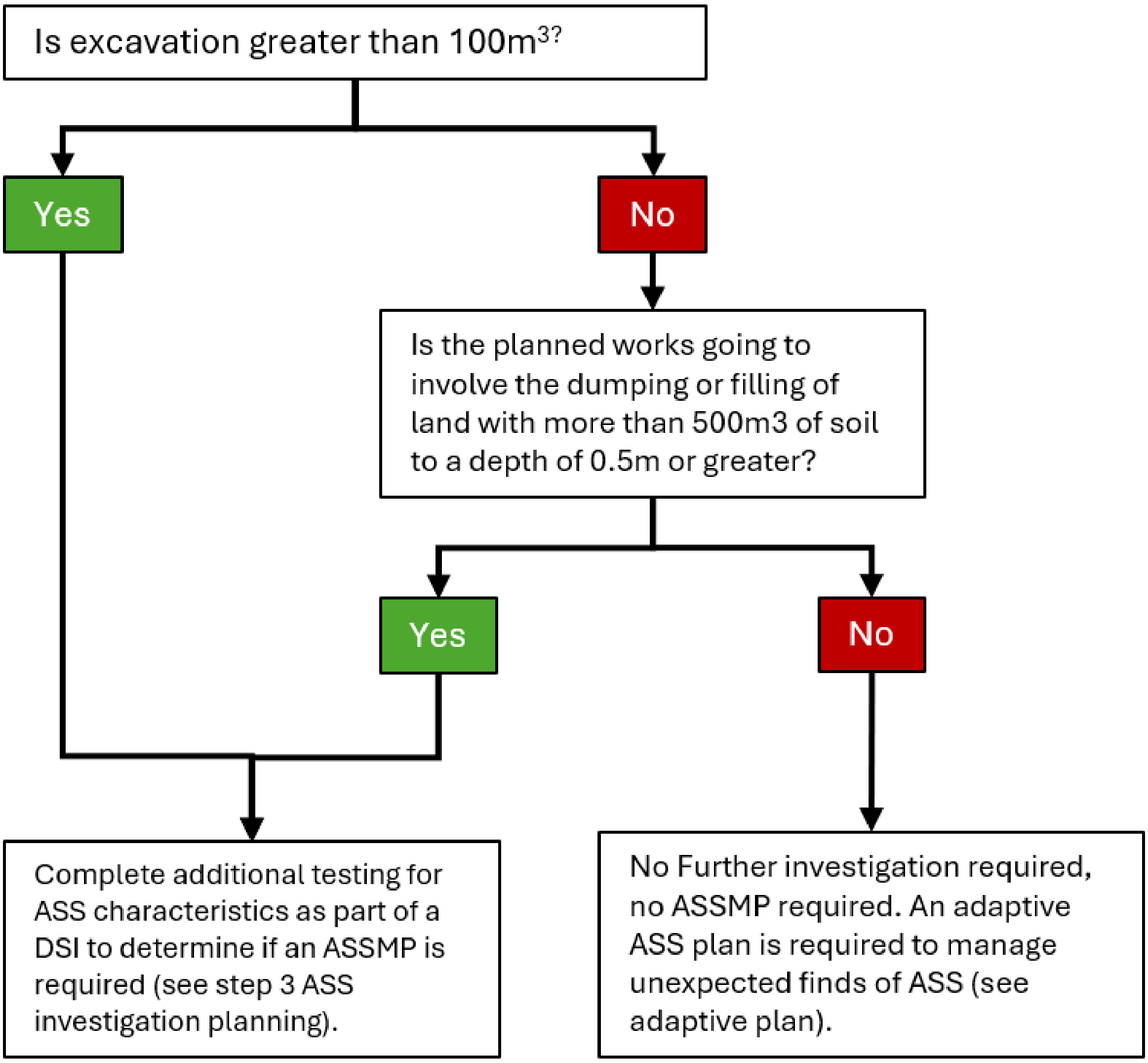


Figure A2-3 Step 2b – additional investigation decision tree

Step 3 – ASS investigation planning

A field investigation program should be tailored to suit the scope and limitations of each project. The design and sampling practices described below are tools taken from the Australian National ASS sampling and identification methods manual to assist with the investigation design considerations and cost estimates. The appropriate number of sampling locations and samples is specific to the project and should be informed by the judgment of an appropriately qualified and experienced practitioner. The rationale for the sampling intensity should be provided in a "Sampling and Analysis Plan" (SAP) to guide the field work which should be appended to the site assessment report (or as a section of a DSI). An investigation plan should consider the planned extent and depth of ground disturbance to inform sampling plans.

Sampling density – Tower footprint

Soil sample intensity is dependent on the nature, depth and size of the disturbance proposed and the sensitivity of the surrounding environment.

The Australian National ASS sampling and identification methods manual provides the table below as a typical intensity for test pits or boreholes required based on expected ground disturbance. Due to the distance between each transmission tower (minimum of 400 m) each tower should be considered a separate area.

Table A2-3 ASS Sampling density numbers

Area of site	Typical number of sampling locations
Up to 1 ha	4 locations
1-2 ha	6 locations
2-3 ha	8 locations
3-4 ha	10 locations

Sampling density - tracks

For access tracks, complete transect sampling at 50 m intervals along the track line.

Sample depths

Borehole or test pit depth should be 1 m below the planned disturbance depth of the civil works or at least 2 m from the surface, whichever is the greater.

Sampling intervals

At each sampling location, the sampling of the vertical soil profile should be conducted at 0.25 m intervals. If distinct soil horizons occur, all discrete samples should be confined to a singular horizon. If there are multiple soil horizons in a 0.25 m interval, all soil horizons should be sampled (ensuring that each sample represents a distinct horizon).

Once detailed design has confirmed planned disturbance depths, volumes and extents, the above information can be used to estimate the scale and complexity of the investigation per site.

Step 4 – ASS management planning

Site specific management plans will need to be developed for sites where the initial desktop risk and the subsequent investigation determine ASS is likely to be impacted by the planned works. The following information outlines the guidelines preferred hierarchy for management and the available options for management and treatment. These should be incorporated into the site specific management plans with consideration to specific site constraints.

A staged approach should be taken to risk management. The following hierarchy of management options is recommended to reduce the costs of assessment, remedial actions and the possibility of residual ASS impacts:

1. **Avoidance –** The most effective and environmentally safe strategy is always to avoid disturbing ASS. This approach minimizes risk, as PASS remain stable when confined to anaerobic (oxygen-free) conditions. Moreover, avoiding disturbance is typically the most cost-effective option since the potential harm to public health, ecosystems, infrastructure, and the associated remediation or regulatory expenses often outweigh any perceived benefits.

   A site-specific ASS Management Plan should be prepared to demonstrate the proactive steps taken to avoid disturbance, where practicable. If disturbance is unavoidable, the plan should present a well-reasoned justification based on site-specific considerations.

   It is critical to recognize that ASS can exist not only in disturbed or undisturbed natural soils and sediments, but also within fill material. In areas with both a high likelihood of ASS and past land disturbance, historical earthworks may have occurred without proper documentation or assessment. These sites pose additional risks, as reburied ASS material may have already oxidized into AASS without adequate treatment or mitigation.

2. **Minimisation –** When it is not feasible to avoid disturbing ASS, the next best approach is to minimise the extent and impact of any disturbance.

   Effective minimisation begins with a comprehensive ASS investigation that accurately maps both the distribution of actual and potential acidity across the site, as well as the local groundwater dynamics and interaction with surface water. This thorough understanding of site conditions should inform a conceptual site model and an assessment of relevant risks. These steps allow for the development of tailored minimisation strategies that are both site-specific and informed by a robust risk assessment process.

   Minimisation techniques may include, but are not limited to, adjusting the scope and location of earthworks, choosing methods that reduce soil or groundwater disturbance, and carefully timing interventions to limit exposure to adverse conditions.

   By proactively identifying areas of higher risk and planning works accordingly, projects can substantially reduce the environmental, civil and health risks associated

3. **Management and treatment –** When the ASS cannot be avoided or minimised and management or treatment is required, there are several options available. A combination of the net acidity results collected during the ASS investigation and the estimated tonnages of disturbed ASS should be used to determine the level of management required. These are broken down into five treatment levels shown in Figure A2-4.

Disturbed ASS (t)[2]	Net Acidity, expressed in %S and mol H⁺/t units[1]													
	0.03 *18*	**0.06** *36*	**0.1** *62*	**0.2** *125*	**0.4** *250*	**0.6** *375*	**0.8** *500*	**1** *625*	**1.5** *940*	**2** *1250*	**2.5** *1560*	**3** *1870*	**4** *2500*	**5** *3120*
1	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.2	0.2
10	0	0	0	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.2	1.4	1.9	2.3
50	0.1	0.1	0.2	0.5	0.9	1.4	1.9	2.3	3.5	4.7	5.9	7.0	9.4	12
100	0.1	0.3	0.5	0.9	1.9	2.8	3.7	4.7	7.0	9.4	12	14	19	23
250	0.4	0.7	1.2	2.3	4.7	7.0	9.4	12	18	23	29	35	47	59
500	0.7	1.4	2.3	4.7	9.4	14	19	23	35	47	59	70	94	117
1000	1.4	2.8	4.7	9.4	19	28	37	47	70	94	117	140	187	234
2000	2.8	5.6	9.4	19	37	56	75	94	140	187	234	281	374	468
5000	7.0	14	23	47	94	140	187	234	351	468	585	702	936	1170
10 000	14	28	47	94	187	281	374	468	702	936	1170	1404	1872	2340
50 000	70	140	234	468	936	1404	1872	2340	3510	4680	5850	7020	9361	11701
100 000	140	281	468	936	1872	2808	3744	4680	7020	9361	11701	14041	18721	23401

L	Low treatment (<0.1 t $CaCO_3$)[3]
M	Medium treatment (0.1 to 1 t $CaCO_3$)
H	High treatment (1 to 5 t $CaCO_3$)
VH	Very High treatment (5 to 25 t $CaCO_3$)
XH	Extra High Treatment (>25 t $CaCO_3$)

TABLE NOTES

1. Net Acidity is the sum of the Potential Acidity plus Actual Acidity plus Retained Acidity. Potential Acidity is measured using Chromium Reducible Sulfur (S_{CR}) or Peroxide Oxidisable Sulfur (S_{POS}). For samples with pH <6.5, the Actual Acidity must also be measured using Titratable Actual Acidity (TAA). The Retained Acidity of soils with pH<4.5 and/or if jarosite or other insoluble sulfate minerals must be estimated using calculations based on Net Acid Soluble Sulfur (S_{NAS}) or Residual Acid Soluble Sulfur (S_{RAS}). If the ANC of the soil is corroborated by appropriate testing (e.g. via slab incubation tests), the ANC can be used in Net Acidity calculations.
2. An approximate soil weight (tonnes) can be obtained by multiplying the volume of soil (in cubic metres, m^3) by bulk density (BD, t/m^3). Dense fine sandy soils may have a BD up to 1.8, and hence 100 m^3 of such soil may weigh up to 180 t. If soil BD is unknown, use 1.7 t/m^3 or refer to Table 5.1 in Sullivan *et al.* (2018b). In these calculations, figures should be converted to dry soil mass, since laboratory results are reported on a dry weight basis.
3. Application amounts are for pure fine $CaCO_3$, assuming a neutralising value (NV) of 100% and using a safety factor of 1.5. A factor that accounts for Effective Neutralising Value must be used for commercial grade aglime. See ASS Tip 18.

Figure A2-4 Treatment levels for an ASSMP based on planned disturbance tonnages and %S.

Understanding the treatment level for the project is valuable, not only does it determine the required liming rate (which can be included in cost estimates for the works) but the treatment requirements also. These treatment requirements become more stringent the higher the treatment category and will have impacts on the cost estimates. The full treatment category impacts are found in the QLD ASS technical manual – soil management guidelines (2024), which are referenced by both the national and Tasmanian guidelines, the below table is a summary of the key differences in treatment requirements:

Table A2-4 Summary of management measures based on treatment category

Category	Management measures
Low level of treatment – Category L	Soils are treated with an amount of neutralising agent that will counter their Net Acidity (up to the equivalent of 0.1 t of fine $CaCO_3$). Thorough mixing of the aglime is not required, verification testing is not required. Site run-on, runoff and infiltration of water and leachate that is percolating through the soil is managed (any bunding must be made from non-ASS materials). Document the ASS management strategies that were implemented on site and include photographic records. These may need to be provided to the regulatory decision maker upon request.
Medium level of treatment – Category M	Soils are treated with an amount of neutralising agent that will counter Net Acidity (up to the equivalent of 1 t of fine $CaCO_3$). The neutralising agent is thoroughly mixed with the soil, but verification testing is not required. Remaining measures as above.
High level of treatment – Category H	More detailed plans of disturbance and detailed ASS investigation reports are provided to the regulatory decision makers. Soils are treated with an amount of neutralising agent that will counter their Net Acidity (up to the equivalent of 5 t of fine $CaCO_3$).

Category	Management measures
	The neutralising agent is thoroughly mixed with the soil and verification testing is completed. pH of any pools of water collected within a bund or sump (particularly after rain) is monitored and treated appropriately before release or reuse to keep pH in the range 6.5 to 8.5 (or as per site-specific conditions). A guard layer of neutralising material is applied to treatment pad surfaces to help intercept and neutralise leachate from ASS. All leachate from treatment pads and/or discharge water from excavations should be contained in a sump, and must meet acceptable standards of pH, oxygen, metal content (particularly iron and aluminium), and turbidity prior to release. Remaining measures as above.
Very high level of treatment – Category VH	More detailed plans of disturbance and detailed ASS investigation reports are provided to the regulatory decision makers. Treating soils according to their Net Acidity with the appropriate amount of neutralising agent (up to the equivalent of 25 t of fine $CaCO_3$). The neutralising agent is thoroughly mixed with the soil and verification testing is completed. Substantial bunding of the site using non-ASS material to divert site run-on and collect all site runoff during earthworks. Monitoring the pH of any pools of water collected within the bund (particularly after rain). Water must be treated to keep pH in the range 6.5 to 8.5 (or as per site-specific conditions). Treatment pads are designed as per section 7.4 in the QLD ASS technical manual – soil management guidelines (2024). Preventing infiltration of water and/or leachate from passing through ASS to groundwater using impermeable materials. Otherwise, apply extra layer of neutralising material to intercept and neutralise leachate from ASS. All leachate from treatment pads and/or discharge water from excavations should be contained in a sump, and must meet acceptable standards of pH, oxygen, metal content (particularly iron and aluminium), and turbidity prior to release. On completion of works, provide documentation of ASS management strategies to the regulatory decision makers in the form of a simple closure report, including information on the final placement/use of disturbed soil.
Extra high level of treatment – Category XH	For ASS disturbances requiring treatment with more than 25 t of $CaCO_3$, a comprehensive EMP must be formulated, and a risk assessment undertaken. The EM plan must consider groundwater dewatering if the seasonally lowest watertable level will be altered. Detailed closure reporting will be required as part of this process. All EM plans must be completed by a suitably skilled and experienced person in ASS science.

Appendix C

Landslide management

Landslide management measures to be implemented

Two previous assessment reports have been undertaken which recommend management/mitigation measures that should be implemented at specific sites to reduce:

1. The risk of landslide hazards to both infrastructure and people (Appendix G – Landslide Risk Assessment Report (1 of 2) March 2025 NWTD-EP-DA-507).
2. Reduce the magnitude of impact from project activities (Appendix H – Geomorphology and geology assessment report March 2025 NWTD-EP-DA-508).

The decision tree/flow charts provided in Figure A3-1 and Figure A3-2 will help navigate the two reports respectively, and assist in determining if a specific site requires management/mitigation measures to reduce risk/impact associated with landslides and which specific measures are recommended.

Figure A3-1 Flow chart/decision tree to lookup site specific mitigation measures recommended in the Landslide Risk Assessment Report (Jacobs 2024)

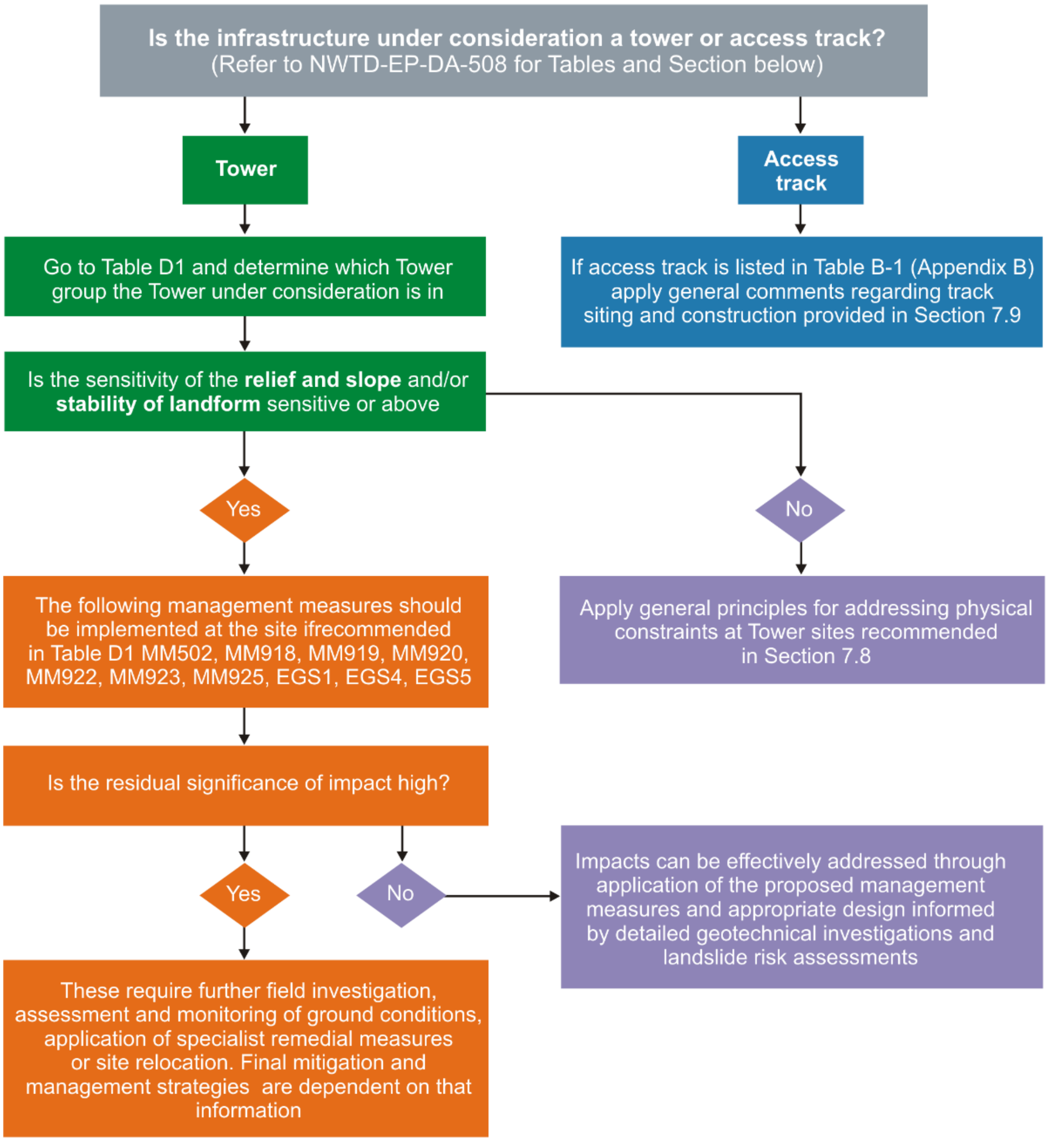


Figure A3-2 Flow chart/decision tree to lookup site specific mitigation measures recommended in the Appendix H – Geomorphology and geology assessment report (Environmental GeoSurveys P/L 2025)

Table A3-1 provides a summary of the number of infrastructure locations which these assessments recommend require specific mitigation/management measures.

Table A3-1 Summary from assessment reports

Item	Appendix G – Landslide Risk Assessment Report (1 of 2)	Appendix H – Geomorphology and geology assessment report
No. of towers and poles assessed as having a moderate to high risk without implementation of mitigation measures	55	n/a
No. of access tracks assessed as having a moderate to high risk without implementation of mitigation measures	131	n/a

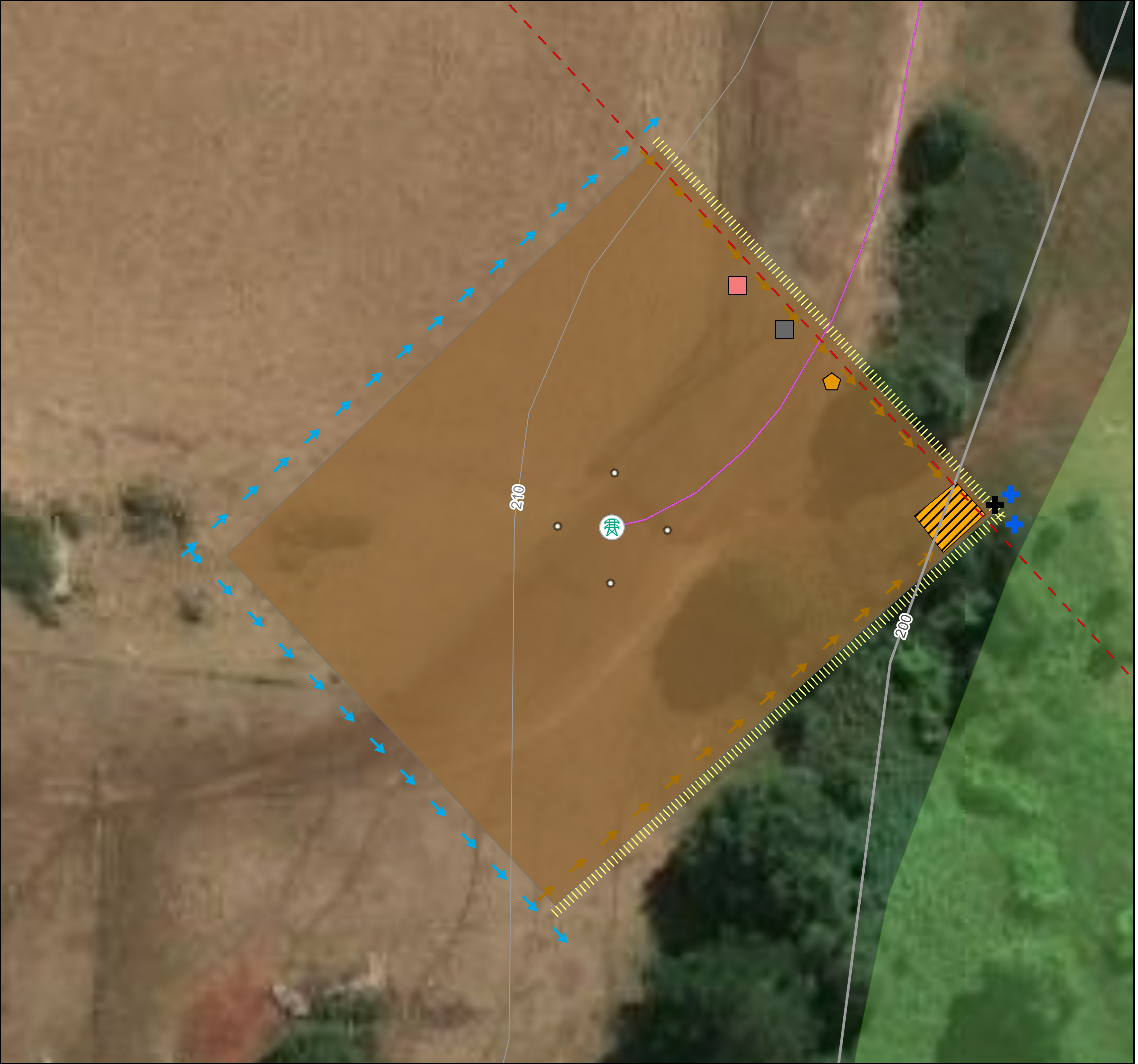
Item	Appendix G – Landslide Risk Assessment Report (1 of 2)	Appendix H – Geomorphology and geology assessment report
No. of towers assigned a sensitivity of ‘sensitive’ or higher for the attributes ‘Relief & slope’ and ‘Stability of landform’	n/a	142
No. of towers which have a residual significance of impact of **high**	n/a	2

Appendix D

Example Erosion and Sediment Control Plan

Appendix D

Example Erosion and Sediment Control Plan



NWTD: Environmental Control Plan Tower 28

- Notified Corridor
- Waterway Protection Areas Buffer area
- WS - Waste Bin/Skip
- WS - Concrete Washout
- SP - General Purpose Spill Kit
- SD - Spill Through Weir
- SD - Coir Logs
- SD - Sediment Fence
- SD - Clean Water Diversion
- SD - Construction Water Diversion
- SD - Excavated Sediment Trap
- New Access Track

EXAMPLE ONLY - NOT FOR SITE USE

0 5 10 20 Meters

N

Appendix E

Tasmanian Acid Sulfate Soils Management Guidelines

Tasmanian

Acid Sulfate Soil

Management Guidelines

CARING FOR OUR COUNTRY

Cradle Coast NRM

NRM North
Natural Resource Management in Northern Tasmania

nrm SOUTH
NATURAL RESOURCE MANAGEMENT

Sustainable Land Use
Department of Primary Industries, Parks, Water and the Environment

Tasmania
Explore the possibilities

ACKNOWLEDGEMENTS

The Tasmanian Acid Sulfate Soils Information Project (TASSI) was undertaken with funding from the Australian Government through its Caring for our Country (formerly Natural Heritage Trust) program.

The *Tasmanian Acid Sulfate Soil Management Guidelines* are a principal output of the TASSI project and draw heavily from and build upon the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines* and the *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland*. Additional material has been drawn from the NSW Acid Sulfate Soil Manual. Permission to use material from these publications is gratefully acknowledged.

The development of these Guidelines was supported by a Steering Committee comprising:

Sue Botting – Cradle Coast NRM
Ian Ferris – Environmental Service and Design Pty Ltd
Christine Materia – Local Government Association of Tasmania
Belinda Colson – Cradle Coast NRM
Don Thompson – Sustainable Farm Practices Facilitator, Australian Government, Land and Coasts
Nicole Middleton – Australian Government, Land and Coasts
Declan McDonald – Department of Primary Industries, Parks, Water and Environment

Technical input was provided by the Sustainable Land Use Section of the Land Conservation Branch of DPIPWE, particularly Rob Moreton and Chris Grose. Additional technical input was provided by Robert Virtue. Initial research was compiled by Amy Jansen.

Predictive modelling for ASS occurrence was completed by Mat Webb and Rob Moreton of the Land Conservation Branch of DPIPWE.

The Project was coordinated by Declan McDonald, Sustainable Land Use Section, Land Conservation Branch, DPIPWE.

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DISCLAIMER

PURPOSE OF THE GUIDELINES

The purpose of these guidelines is to provide technical and procedural advice to avoid environmental harm from acid sulfate soils (ASS) and to assist in achieving ***best practice environmental management*** through the use of six management principles. The guidelines have also been designed to assist decision-making and provide greater certainty to the construction and agricultural industries, state and local governments and the community in carrying out planning for activities that may disturb ASS. It is anticipated that the guidelines will be used by consultants, earthmoving contractors, developers, agricultural and aquaculture producers, sand and gravel extraction operators, community groups and administering authorities from state and local government. While the guidelines focus on developments below 20m AHD the requirement for a management plan should apply wherever significant disturbance of ASS occurs in the State.

SECTION 1 provides an introduction to ASS and why we should be concerned about them, where they occur in Tasmania and the Tasmanian legislation that is relevant to them.

SECTION 2 steps through the process of assessing projects which may involve disturbance to ASS, with the aim of determining whether a management plan is necessary for the project.

SECTION 3 outlines the management principles used to guide the development of a management plan.

SECTION 4 gives details of management strategies, including avoidance, minimisation and neutralisation.

Within the various appendices the Guidelines go on to provide further detail regarding the legislation likely to impact on ASS management, soil sampling procedures, analytical methods for identifying ASS and potential acid generation and treatment options, liming rates and considerations for treatment pad design.

While management options are available for minimising environmental damage from ASS the first option should always be to avoid disturbing these sediments. Only if this option is unavailable should other options be considered.

1. INTRODUCTION

1.1 WHAT ARE ACID SULFATE SOILS?

Acid Sulfate Soils underlie large areas of Australia's coastline. They are natural soils that contain sulfides (mostly iron sulfides), usually in microscopic form. Most of these sulfides were formed by bacterial activity underwater long ago. Sea water provides a ready source of sulfur for conversion to sulphides and thus the higher risk areas tend to be low-lying coastal margins that were once covered by sea water. As the seas receded, the sulfur-rich sediments remained and today can be found in areas such as coastal plains, wetlands and estuaries.

In an undisturbed and waterlogged state these soils are harmless, but when disturbed and exposed to oxygen through drainage or excavation, a process of oxidation can produce sulfuric acid in large quantities. In the undisturbed state the soils are called Potential Acid Sulfate Soils (PASS). Once they are disturbed and start oxidising, they are called Actual Acid Sulfate Soils (AASS). They are collectively referred to as Acid Sulfate Soils (ASS).

After rain and particularly following prolonged dry periods, the sulfuric acid in these soils is released into the surrounding environment. As the acid moves through the soil profile it may cause the release of heavy metals and other toxins, which eventually flow into surrounding waterways. Toxic "slugs" of concentrated acid runoff can move downstream and flow into estuaries, reducing oxygen levels in the water, significantly decreasing water quality, killing fish and damaging sensitive ecosystems. For example, this process caused extensive environmental damage in NSW 1987 when flooding mobilised aluminium and acid from disturbed ASS into the Tweed River.

ASS runoff has significant environmental, economic and social impacts on coastal communities. Besides the obvious impacts on the environment such as fish kills, death of other aquatic organisms and decline of riparian and aquatic vegetation, acid runoff has been attributed to the decline or failure of agriculture, fishery and aquaculture industries. The ecological damage can also affect valuable tourist resources including fishing grounds, swimming areas and other water sports areas. Acid discharges can damage infrastructure services and structures such as pipes, foundations, drains, bridges and flood controls. High levels of iron and manganese may precipitate in receiving waters, causing aesthetic issues, staining infrastructure, coating aquatic vegetation and preventing photosynthesis or blocking the gills of aquatic fauna. High levels of some elements such as aluminium and arsenic may also have human health implications.

Acid sulfate soils may also underlie inland areas such as peat bogs, salt lakes and wetlands. If acid sulfate conditions underlie such natural features, disturbance will have a similar effect on the surrounding area as in coastal regions with release of sulfuric acid and reduced oxygen levels in the water. Risks are increased where inland water bodies receive irrigation return water, groundwater or recycled water, as they typically contain elevated sulfate concentrations.

1.2 TASMANIAN CONTEXT

ASS have been identified in Tasmania. Some predictive modelling and mapping, based on geological history and height above sea-level, was undertaken by Mineral Resources Tasmania in 1995. This modelling was refined and extrapolated by the Australian Soil Resources Information System (ASRIS) which included other parameters (such as coastal vegetation and estuaries data) in their model to predict where ASS are likely to occur. In 2008-09, the Land Conservation Branch of DPIPWE undertook extensive investigation of ASS in Tasmania and the results are shown in Figure 1.

It can be seen from this map that most of the non-tidal (coastal) ASS occur along the north coast of Tasmania. In Southern Tasmania, extensive areas of ASS occur only in estuaries. There are an estimated 214,500 ha of coastal land in Tasmania that may contain some soils affected by ASS, with a further 51,239 ha of tidal and sub-tidal sediments. In addition, there are 369,538 ha of inland areas with some probability of ASS occurring.

Any activity which may disturb soils in areas which have ASS may result in the production of sulfuric acid and toxic / nuisance metal and nutrient concentrations. Thus agricultural activities involving deep drainage, infrastructure developments such as the construction of roads and / or installation of pipes, and coastal developments of any scale (private dwellings to resorts), may all result in disturbance of ASS. Further, if spoil from dredging materials contain ASS, release of sulfuric acid and heavy metals may result if not stored or disposed of with care.

Due to the nature of ASS, a large number of authorities, organisations, industries and individuals can cause disturbance of ASS and/or can be impacted by the results of this disturbance. Despite the extent of occurrence of ASS in Tasmania, the level of development in most of these areas has been relatively low, so there have been relatively few documented problems caused as a result of disturbance of ASS. However, with rapidly increasing pressure on some coastal areas of Tasmania, as well as intensification of agriculture in some northern regions, the potential for problems to arise is increasing.

1.3 LEGISLATION

TASMANIAN

There is no legislation directly relevant to ASS in Tasmania. However, ASS impacts may come under the "general environmental duty" section of the Environmental Management and Pollution Control Act 1994, such that: "A person must take such steps as are practicable or reasonable to prevent or minimise environmental harm or environmental nuisance caused, or likely to be caused, by an activity conducted by that person."

The recently released State Coastal Policy 2006 also may cover ASS. It aims to facilitate:

- » The conservation of intrinsic assets, values and processes of the coastal area; and
- » The sustainable use or development of the coastal area.

There is no explicit mention of ASS in the policy, but it does appear in supporting documents:

1) State Coastal Policy 2006 – Implementation Guidelines. This document lists ASS as one of the hazards that should be considered in planning schemes.
2) State Coastal Policy 2006 – Model Standards. This document mentions ASS in the model standards for water quality and coastal management

COMMONWEALTH

(1) The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the centrepiece of the Commonwealth's environmental regulatory regime. The following objectives of the EPBC Act are relevant to ASS:

- » to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance;
- » to promote: ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; the conservation of biodiversity; and a co-operative approach to the protection and management of the environment involving governments, the community, landholders and indigenous peoples; and
- » to assist in the co-operative implementation of Australia's international environmental responsibilities.

(2) The *Environment Protection (Sea Dumping Act) 1981* regulates the deliberate loading and dumping of wastes and other matter at sea. This Act potentially relates to the dumping of ASS material including dredge spoil into the sea.

More details of these Acts and Policies can be found in Appendix A.

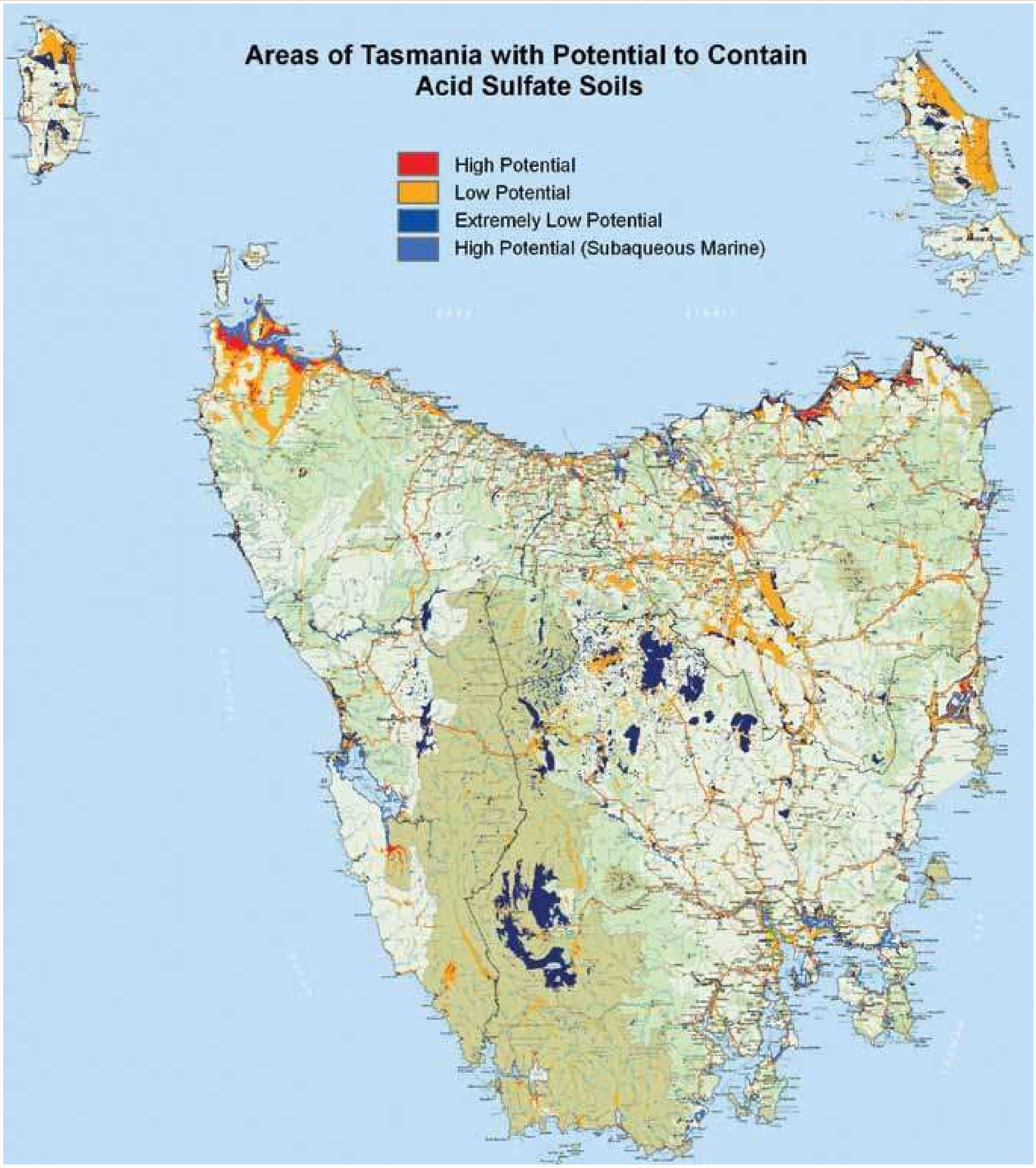

Figure 1. Predicted distribution of Acid Sulfate Soils in Tasmania

2. ASSESSMENT OF PROJECTS WHICH MAY AFFECT ASS

Any project in a coastal area which may affect soils or sediments below 20 metres Australian Height Data (AHD)[1], including direct disturbance of these soils and any disturbances to nearby groundwater hydrology and drainage which might influence these soils, should consider the likelihood of encountering ASS. This section details the steps necessary in assessing such a project, and includes a flowchart summary at the end (Figure 3).

STEP 1.

If the proposed project is in the coastal zone and is at or below 20 metres AHD, or will disturb soil or nearby groundwater hydrology at or below 20m AHD, proceed to Step 2 (if not, no further consideration of ASS is required). If the proposal is in an inland area but within or adjacent to a deflation basin (topographic depression scoured by wind), wetland area or an area of known acid mine discharge, or if indicators of acid conditions are identified, proceed to Step 2.

STEP 2.

If the project will excavate 100m^3 of soil or sediment, or will involve the dumping or filling of land with more than 500m^3 of soil to a depth of greater than 0.5m then proceed to step 3, otherwise no further consideration of ASS is required.

1. In 1971 the mean sea level for 1966-1968 was assigned the value of zero on the Australian Height Datum at thirty tide gauges around the coast of the Australian continent. The resulting datum surface, with minor modifications in two metropolitan areas, has been termed the Australian Height Datum (AHD) and was adopted by the National Mapping Council as the datum to which all vertical control for mapping is to be referred. (http://www.bom.gov.au/lam/glossary/apagegl.shtml)

STEP 3.

Existing mapping information should be checked. Maps identifying the predicted distribution of coastal areas affected by ASS are available at www.thelist.tas.gov.au. and on the ASRIS website (http://www.asris.csiro.au/index_ie.html). If the project falls within an area identified as being at risk proceed to step 4, if not no further action is required.

Although the map is based on best available information, it is important to be aware of possible limitations of this dataset. The local scale variation in Tasmanian landscapes can result in small pockets of ASS outside the zones indicated on the map. Similarly, within the zones indicated, ASS may not be uniformly distributed. It is intended that proper application of these Guidelines will improve the capacity of soil scientists, environmental scientists, planners, engineers and landholders to carry out an initial risk assessment for ASS if suggested by indicators or local topography and determine the need for further testing.

STEP 4.

Conduct a desktop risk assessment. All disturbances to the groundwater hydrology or surface drainage patterns in coastal areas below 20 metres AHD should be investigated, designed and managed to avoid potential adverse effects on the natural and built environment (including infrastructure) and human health from ASS. This recommendation also applies to the investigation of subsoil or sediments below 20 metres AHD where the natural ground level of the land exceeds 20 metres AHD (figure 2). In some situations, ASS may also occur at elevations greater than 20 metres AHD (i.e. inland areas), and these guidelines also apply to the management of those soils where they are identified.

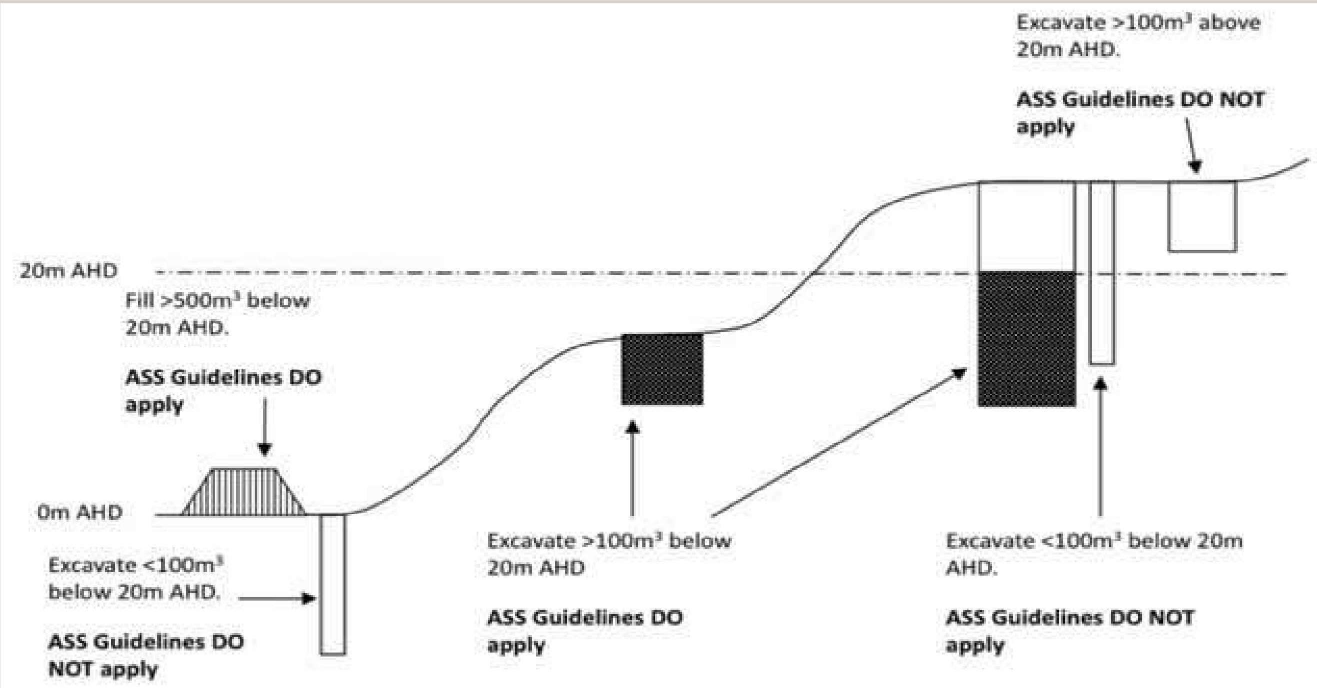

Figure 2. Areas and developments which may require an ASS investigation and management plan.

STEP 5.

Develop a soil profile. If it is determined, from mapping or site assessment, that the probability of ASS occurrence is likely, on site investigations will be required to determine where, and at what depth and concentration, the ASS may occur. The first step in this process is to develop a soil profile of the site, with detailed information on elevations, soil types and depths. Only some soil types are likely to contain ASS, and it will only be necessary to conduct further sampling if the proposed project is likely to disturb significant amounts of ASS (as per step 2). If disturbance is likely consideration should be given to redesigning the project so that the ASS materials can be avoided. If this is not possible, a management plan should be developed to minimise environmental harm from the project and justification provided as to why the ASS cannot be avoided. If disturbance is unavoidable proceed to step 6.

STEP 6.

Conduct field tests and laboratory analyses. Sampling and testing of the soil types likely to contain ASS should be done by a qualified and experienced soils professional in accordance with the Guidelines (see Appendix B). Once the location, depth and concentration of any ASS present on the site have been determined, options to manage the risk can be considered (step 7).

STEP 7.

Develop an ASS Management Plan. The remainder of these Guidelines outlines the principles and management strategies to be used in developing a management plan to minimise and/or neutralise any impacts from the disturbance of ASS.

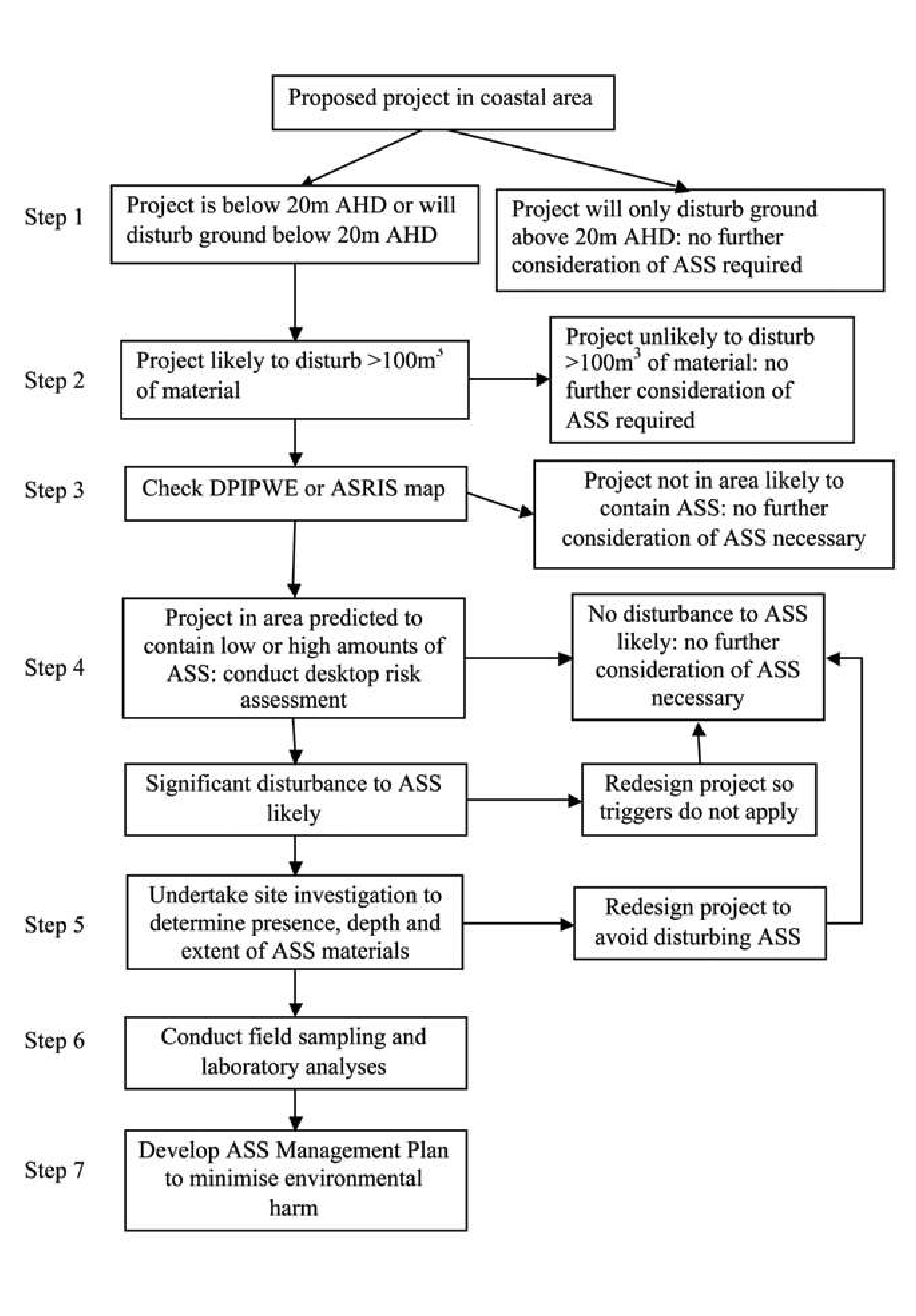

Figure 3 Summary of steps in the assessment of a project in a coastal area

3. MANAGEMENT PRINCIPLES

The Tasmanian Acid Sulfate Soil Management Guidelines should be applied in accordance with the following management principles.

1) The disturbance of ASS should be avoided wherever possible. This is by far the best option, both economically and environmentally.

2) Where disturbance of ASS is unavoidable, preferred management strategies are:

   - minimisation of disturbance;
   - neutralisation;
   - strategic reburial.

   Other management measures may be considered. All strategies must be subject to detailed technical assessment and must not pose unacceptably high risks to human health, the environment or infrastructure.

3) Where disturbance of acid sulfate soils is likely, a management plan is required for any works which may disturb the soil or groundwater. This plan should detail the technical feasibility of measures proposed to manage risks (ref. Principle 2.)

4) Receiving waters (marine, estuarine, or fresh) shall not be used as a primary means of diluting and/or neutralising ASS or associated contaminated waters.

5) Stockpiling of untreated ASS with or without containment is not an acceptable long-term management strategy. Soils that are to be stockpiled, placed as temporary or permanent cover on land or in waterways, sold or exported off the treatment site or used in earth bunds must be treated / managed to eliminate the short- and long-term risks of pollution.

6) The following issues should be considered when formulating ASS environmental management strategies:

   - the sensitivity and environmental values of the receiving environment. This includes the conservation, protected or other relevant status of the receiving environment;
   - whether groundwaters and/or surface waters are likely to be directly or indirectly affected through overland flow or infiltration;
   - the heterogeneity, geochemical and textural properties of soils on-site; and
   - the management and planning strategies of Local and/or State Government, including Catchment Management Plans/Strategies and Coastal Management Plans.

4. MANAGEMENT STRATEGIES

As outlined in the Management Principles above, the preferred strategy to deal with ASS is avoidance (see section 4.1). Avoiding the disturbance of ASS should be the primary consideration. This may require a review of the construction design or layout. There will be situations where disturbance is unavoidable. For these situations, the following risk-based management strategies are preferred:

» minimisation of disturbance (section 4.2);

» neutralisation of acid sulfate soils (section 4.3);

» strategic reburial of potential acid sulfate soils (section 4.4).

Within the preferred management strategies, avoidance and minimisation of disturbance are the most preferred. It should be noted that even though neutralisation and strategic reburial are options, there are still environmental risks associated with these techniques. In addition, the strategy may not be suitable for every site. All projects should be subject to a risk assessment to determine the degree to which risks can be managed without environmental harm.

Management strategies other than those listed as preferred may be considered but will need to be supported by technically sound assessments that demonstrate the feasibility of the strategy to avoid environmental harm. Higher risk management strategies include stockpiling ASS, strategic reburial of soils with existing acidity (AASS), large-scale dewatering or drainage, and vertical mixing. Strategies regarded as generally unacceptable include above-ground capping, hastened oxidation, seawater neutralisation and offshore disposal of ASS.

A variety of management strategies may be utilised to ensure the most appropriate management for the specific soil type or situation. For example, larger developments (e.g. >5000 tonnes of soil disturbance) should be staged to ensure that the disturbance is manageable; hydraulic separation may be appropriate for light soils; neutralisation may be appropriate for fine textured soils with low levels of sulfides; and hard-to-treat clays could be strategically reburied. Other strategies will also need to be developed to manage the impacts from smaller disturbances (such as infrastructure trenching).

In managing risk and selecting preferred management strategies it is the responsibility of the developer/operator to ensure that the work can be conducted in a way that will not result in environmental harm.

4.1 AVOIDANCE

Avoiding the disturbance of ASS is always the preferred option; it carries the least environmental risk as PASS remain inert as long as they are kept in an anaerobic (reducing) environment. It is also usually the cheapest option, as the risks from disturbance of ASS to human health, the natural environment, the built environment (e.g. infrastructure) and associated remediation / regulatory costs, may outweigh the benefits.

The ASS Management Plan should provide evidence of considerations made to avoid disturbance of ASS and sound rationale for choosing to disturb ASS.

PLANNING TO AVOID ASS

Local Government planning strategies should recognise the elevated risks associated with particular developments in areas that have a high probability of containing ASS. Land uses such as extractive industries, golf courses, marinas, canal estates, agricultural uses requiring drainage and land uses with below-ground car parking all carry higher risk of disturbing / exposing ASS and should be avoided. Consideration should be given to re-location of such developments to low risk sites. However, if the ASS occur at a significant depth, the above land uses may be appropriate if they are unlikely to result in the disturbance of ASS layers. A technical assessment of the specific risks and management responses must be detailed in the ASS Management Plan.

COVER IN SITU SOILS WITH CLEAN FILL

If earthworks will not affect groundwater levels, undisturbed *in situ* PASS may be covered with clean fill. This strategy can be used to provide adequate depth for building foundations, infrastructure trenches or other incidental excavations such as swimming pools if the sulfides are located close to the soil surface (Ahern *et al.* 1998b). A minimum depth of fill cannot be specified. It will be related to the depth to ASS, concentrations of sulfides, flood levels, proposed land use and depths of any future disturbance. It is always preferable to use clean non-ASS fill rather than using treated ASS on site from a risk minimisation point of view.

However, caution is required as in some cases, filling activities may disturb in situ ASS by:

- bringing groundwater into contact with the AASS (and thus potentially mobilising and transporting existing acidity out of the AASS into the groundwater);
- displacing or extruding previously saturated PASS above the watertable and aerating these soils or sediments (e.g. aeration may occur at the margins of the filling area if the weight of fill exceeds the failure limit of the underlying soil or sediment); and/or
- displacing acidic groundwater into waterways (figures 4 & 5).

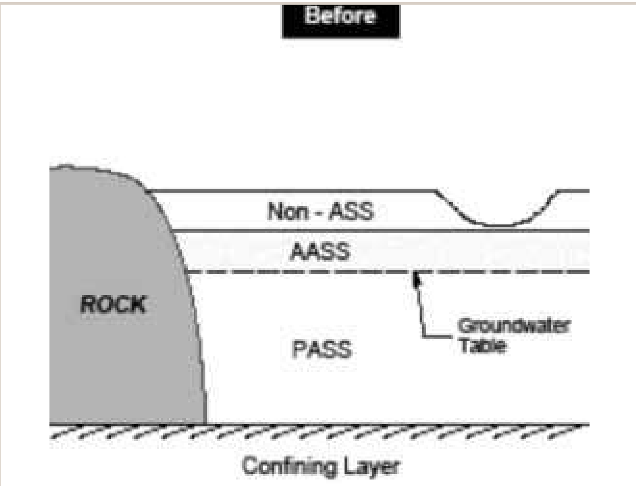

Figure 4. Schematic cross-section of an ASS prior to filling. AASS is above the water table and PASS is below.

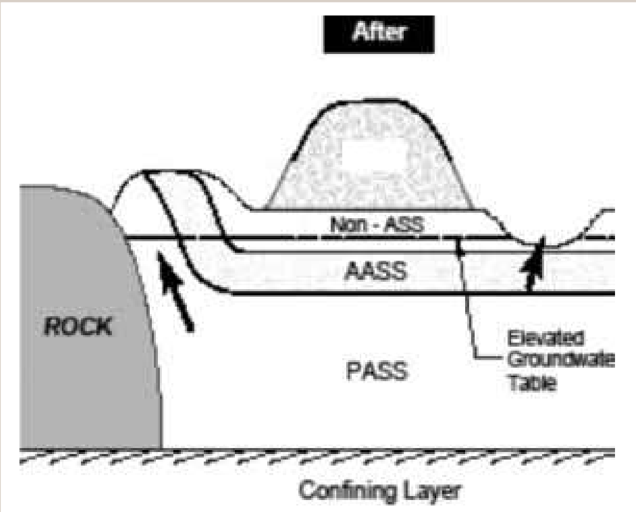

Figure 5. Schematic cross-section of an ASS after filling. The water table is raised, the groundwater is brought into contact with the AASS, and PASS and AASS are displaced above the water table.

Loading fill on clayey ASS can be problematic because some clayey soils have a high water content (up to 70 to 80% on a volume basis), and low hydraulic conductivities. Under load, such clayey soils may flow like gels resulting in subsidence at the load point. Some of the displaced soils may be pushed upwards outside the load areas into oxidising environments. In extreme situations, the fill materials may sink into the mud. This is of particular concern in areas where houses, rail, roads or other heavy infrastructure is constructed on such material. This can also be an issue in poorly-managed dredging sites where dredge fines are placed above the watertable and buried under clean sands. Historic dredging sites should be investigated for the presence of such materials prior to making changes to land use that may cause such subsidence.

Both geotechnical and hydrological investigations may be necessary to assist in devising management strategies including any pre-loading and management of potential impacts on groundwater levels and acidity. See the Queensland *Water Treatment and Management Guidelines* with respect to hydrological investigations.

Untreated ASS should not be used as pre-load material.

4.2 MINIMISATION OF DISTURBANCE

The minimisation of disturbance is a preferred management option where disturbance of ASS is unavoidable. Completion of a detailed ASS investigation is essential for minimisation of disturbance to be effective. This includes an assessment of the concentration and spatial distribution of potential and existing acidity, and groundwater characteristics. Refer to the *Sampling Guidelines* (Appendix B). Once the site has been adequately characterised, strategies that minimise the disturbance can be investigated and may include:

REDESIGN EARTHWORKS LAYOUT

Individual sites may contain areas of low, medium or high sulfides. An effective minimisation strategy may entail the redesign of an earthworks plan or agricultural enterprise to avoid the ASS with high sulfide levels, and focus disturbance into the areas with low or negligible levels. Alternative uses such as 'open space' or wildlife corridors may be allocated to the areas of high sulfide concentration. This approach is likely to be suitable for large construction sites or farms containing variable soil types. Agricultural drainage works require detailed evaluation of soil type and sulfide levels in view of the potential for drains to intersect areas where sulfides are located close to the surface. In situations where avoidance of all ASS is not possible and the project is to proceed, then the earthworks should be designed so areas with the highest levels of sulfide are not or minimally disturbed, and overall ASS disturbance is minimised (Ahern *et al.* 1998b).

Effective earthworks redesign requires planning for future management of the site and detailed ASS investigations including soil type investigations, stratigraphic mapping of the sediments and an understanding of groundwater hydrology and oxidation.

SOIL TEXTURE

Soil texture has a significant influence on risk minimisation strategies. Sandy areas might be considered lower risk for excavation / extraction as the sandy material could be removed using a floating dredge allowing the watertable to be maintained, and the soils might then be treated by hydraulic separation techniques (ref. Ahern *et al.* 1998 for details of this method).

Excavation of large areas of clay material that are difficult to work would require dewatering or drainage of large areas to permit dry excavation. Dewatering/drainage poses a higher risk to drainage of adjacent in situ PASS, which may then require remediation. In such circumstances higher risk and even more intensive management would be involved. Clays may be difficult to break up to allow effective treatment by neutralisation or hydraulic separation.

SHALLOW DISTURBANCES

The extent of earthworks on site can be altered to ensure that only shallow disturbances are undertaken and the ASS remains undisturbed. This is particularly important for the installation of 'hump and hollow' drainage for dairy / beef production in the North West of Tasmania. However, this strategy relies on an in-depth understanding of the spatial distribution of ASS, and is only viable in situations where sulfidic soils are located in the deeper horizons within a soil profile.

REDESIGN EXISTING DRAINS

Existing drains may need to be redesigned so that they are shallower and wider and do not penetrate the sulfide layers. Shallow and wide drains can increase the efficiency of surface water drainage, while reducing the drain density (number and spacing of drains) and drain depth. Hydrological studies may be required to ensure the drains are effective at removing stormwater or floodwater from the site. In undertaking 'hump and hollow' drainage works, care is required to avoid scalded areas, the base of existing drains, and areas where sulfides are less than 0.5 m below soil surface. If sulfides are greater than 0.5 m from the soil surface, the vertical distance between the lower level of cut and the sulfides should be at least 0.5 m (Tulau 2000). In situations where the sulfides cannot be avoided, these areas should be neutralised before earth works associated with 'hump and hollow' drainage commence.

The relevant local government should always be consulted and appropriate permits obtained prior to undertaking any works that may change floodwater hydrology.

MINIMISE GROUNDWATER FLUCTUATIONS

Activities that result in fluctuations of groundwater and in particular permanent lowering of the groundwater table should be avoided, as these may lead to exposure of in situ PASS to oxygen. Acidic groundwater can be brought to the surface as a result of groundwater rise through capillary rise or as a result of fill emplacement. The possible health implications of ASS impacts on groundwater, particularly arsenic contamination, should be noted. In areas with known ASS potential, it is preferable to maintain the groundwater levels in a steady state and works to be avoided include:

- construction of deep drains and canals which can considerably lower the water table;
- operation of drains which do not have gates or 'drop boards' to maintain groundwater levels;
- significant water level fluctuations during dry periods caused by the operation of drains;
- installation of new groundwater extraction bores in ASS areas, and use of existing groundwater extraction bores if they will expose ASS to oxidising conditions;
- dewatering or drainage of construction sites, mines, or sand and gravel extraction pits;
- changes in vegetation type from pastures to trees (lowers groundwater level), or replacement of native vegetation with crops (increases groundwater level); and
- construction of on-farm water storages or sediment/nutrient ponds in acid sulfate soils.

4.3 NEUTRALISATION

A technique commonly used in ASS management is neutralisation where alkaline materials are physically incorporated into the soil. Sufficient neutralising agent(s) needs to be used to ensure that there is the capacity to neutralise all existing acidity that may be present and all potential acidity that could be generated from complete oxidation of the sulfides over time. Note: if there is existing acidity, no effective natural buffering capacity remains.

4.3.1 ENVIRONMENTAL RISK

There can be significant risks to the environment if a neutralisation treatment is poorly managed. The following issues that can affect the environmental risk need to be considered when neutralisation treatment is being proposed.

SOIL TEXTURE

There are inherent risks associated with the neutralisation of coarse sandy soils as these soils may dry quickly and oxidise within hours of exposure to air. If there is a rainfall event while the soils are stockpiled the generated acid is likely to be mobilised. Large-scale neutralisation of highly-sulfidic sandy material requires careful management.

Marine clays can be difficult to work, treat and dry and may contain variable levels of sulfide within horizons that have a similar appearance. In high rainfall areas such as the north-west of Tasmania it may be particularly difficult to dry and treat these soils. A pilot trial may be appropriate to demonstrate that consistent and efficient treatment of the clay can be achieved.

Monosulfidic black oozes are highly reactive organic-rich gels that accumulate in waterways. They have extremely high moisture contents and can be difficult to work, treat and dry, and can oxidise readily once in contact with oxygen. They are commonly enriched in ultra-fine-grained reactive iron sulfides e.g. amorphous FeS, greigite ~Fe2S3 and mackinawite ~Fe9S8, which are intermediate products in the formation of pyrite. Monosulfidic black oozes may also contain pyrite. They can form as thick accumulations (e.g. greater than 1 m thick) in drains and waterways that drain ASS landscapes, and are easily mobilised or resuspended during runoff events. Monosulfidic black oozes can oxidise readily once exposed to the atmosphere or oxygenated waters, and can cause severe acidification and / or deoxygenation of floodwaters (Sullivan and Bush 2002; Bush *et al.* 2002). The management of monosulfidic black oozes warrant special attention in any environmental management strategy.

NEUTRALISING AGENTS

Gypsum and other by-products of sulfide oxidation may form coatings on the grains of the neutralising agent during neutralisation. These coatings may reduce the neutralising capacity of the agent and can affect the level of risk associated with large-scale neutralisation. Care should be taken when using more soluble neutralising agents such as hydrated lime, Ca(OH)2, to avoid the possibility of 'overshooting' the required pH to levels of alkalinity that may impact on the receiving environment. Soluble neutralising agents may also be more readily flushed from the system before full oxidation of the PASS occurs. There are additional workplace health and safety issues associated with soluble neutralising agents such as hydrated lime and quicklime, CaO.

DEWATERING OR DRAINAGE

Large sites utilising neutralisation treatments are sometimes dewatered for considerable periods to allow dry excavation. Dewatering or drainage poses a high risk to adjacent in situ PASS and these will then require remediation if oxidisation occurs (ref. Dear *et al.* for more detail).

IMPACTS ON WILDLIFE

Ideally, ASS in or adjacent to the habitat of particularly sensitive protected species (e.g. acid frogs and fish) should not be disturbed due to the potential threat to the species. Provisions of state legislation including the Environment Management and Pollution Control Act 1994 and the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999 must be addressed when making decisions that may impact on protected species.

Mildly acidic aquatic environments occur naturally in some coastal areas and treatment by neutralisation may impact on these areas if incorrectly administered. This can increase the inherent risks of using this technique in coastal areas. Greater detail on both these risks and managing them is provided in the Queensland Water Treatment and Management Guidelines.

4.3.2 PERFORMANCE CRITERIA AND VERIFICATION TESTING

The following performance criteria must be attained for soil that has been treated using neutralisation:

1) 1. The neutralising capacity of the treated soil must exceed the existing plus potential acidity of the soil; and
2) 2. Post-neutralisation, the soil pH is to be greater than 5.5 (see discussion below); and
3) 3. Excess neutralising agent should remain within the soil until all acid generation reactions are complete and the soil has no further capacity to generate acidity.

Samples of the treated soil should be taken and laboratory analysed to demonstrate compliance with the performance criteria (i.e. verification testing). These performance criteria equate to there being no net acidity in the soil following neutralisation. Soil that has been treated by neutralisation techniques and has not met these criteria must be retreated until the above performance criteria are met.

4.3.3 MANAGEMENT CONSIDERATIONS

When neutralisation treatment is proposed as a form of ASS management, the following issues are important to consider.

SITE CHARACTERISATION

It is essential to undertake an accurate and thorough ASS investigation (i.e. pre-excavation sampling and laboratory analysis in accordance with Appendix B). Adequate sampling prior to earthworks must be completed to provide decision-makers with sufficient information on which to confidently conclude that the soils can be managed in an ecologically sustainable manner. The level of sampling is likely to vary depending on the site and proposal. Phase 2 (i.e. sampling and laboratory analysis during excavation), and Phase 3 sampling (i.e. verification sampling and laboratory analysis of treated material after earthworks to ensure appropriate rates of neutralising agents are applied for soil neutralisation) are also a significant component of such a management strategy. Sampling options are discussed in more detail in Appendix B.

The better the characterisation of the site, the better the understanding of the stratigraphy of the soils on site, and the lower the environmental risks if a large volume of material is to be neutralised.

pH RANGE

The solubility of iron and aluminium is controlled in part by pH; the solubility of iron is also influenced by the oxidation / reduction potential. Under neutral soil conditions the solubility of iron and aluminium is low. McElnea and Ahern (2000) demonstrated that leaching of iron and aluminium can be controlled by maintaining the soil pH above 5.5 with fine aglime. Consequently the pH of soil needs to be raised above 5.5 when neutralising ASS; an upper pH limit of 8.5 should not be exceeded. The upper limit may need to be lower if revegetation with native pH-sensitive flora is proposed or if a lower pH is more appropriate to the surrounding environment.

Coastal soils in some locations may have a natural pH of 8.5 or greater. These soils should not be treated with an agent to reduce the pH below 8.5.

REDOX (OXIDATION / REDUCTION) POTENTIAL

The redox potential is a quantitative measure of the tendency of a particular system to accept or donate electrons (i.e. produce or maintain reducing or oxidising conditions). For some iron reactions, solution pH and redox potential determines the stable phase (Willett 1983).

This is a complex issue but in general, reducing conditions prevail in the absence of oxygen and the presence of organic matter and/or sulfate reducing bacteria. Oxidising conditions prevail when the material is in direct contact with air or permits the ready diffusion of oxygen into soil masses. Other oxidising or reducing agents can also occur in the soil or the soil water.

NEUTRALISING AGENTS

A variety of neutralising agents are available to increase the pH of soil to acceptable levels and neutralise potential and/or existing acidity from the oxidation of sulfides. Factors to consider when choosing a neutralising agent include solubility, pH, neutralising value, fineness/coarseness of the product, Ca:Mg balance of the soil, spreading and transport costs, and chemical composition and purity of the agent.

Fineness and Effective Neutralising Value (ENV) are particularly important in ASS management. By-products of sulfide oxidation (particularly gypsum and iron and aluminium compounds) may form insoluble coatings on the neutralising agent (particularly larger limestone or marble particles). Such coatings reduce the neutralising capacity of the agent. Neutralising agents for treating ASS should be slightly alkaline, with a low solubility, and a pH ranging from 7 to 9. Such products will not flush out with the first heavy rain event, and have minimal potential to contaminate surrounding waterways and groundwater.

The preferred agent for treating ASS is fine aglime, $CaCO^3$. However, there can be difficulties in effectively mixing fine aglime with wet, lumpy, clayey or cohesive sediments. Furthermore, wind or water erosion of stockpiles must also be prevented to minimise impacts on receiving environments. Other agents with low solubility include dolomite $(Ca,Mg)CO^3$, magnesite $MgCO^3$ and burnt magnesite MgO. Caution must be taken with these magnesium compounds as they can react to produce magnesium sulfate during neutralisation reactions. Magnesium sulfate is quite soluble and may impact on water quality in waterways if large quantities are mobilised. The production of calcium sulfate (gypsum) during neutralisation reactions involving fine aglime avoids such environmental problems because of its lower solubility (Ahern and Watling 2000).

More soluble neutralising materials such as hydrated lime, $Ca(OH)^2$ or sodium bicarbonate $NaHCO^3$ can be used to neutralise acidity at depth in soil profiles where excavation and mechanical mixing are not feasible. However, there may be potential risks to the environment (and workers) when such products are used. Subsequent rain events also may dissolve and wash these materials out of the treated soil before all the sulfides have oxidised, leaving the soil with long-term net acid-generating potential and effectively polluting the site. Soluble neutralising agents that generate high pH values should be added in small amounts on a more regular basis to avoid over-shooting the target pH range. *Note: ensure that soluble neutralising agents can meet performance criterion 3 (see section 4.3.2).*

Other neutralising agents such as lime amended biosolids, cement kiln dust, crushed concrete and other industrial by-products may be appropriate for some sites, subject to their associated risks being addressed. For more detailed discussion on specific neutralising agents, refer to the Queensland *Information Sheets on Neutralising Agents.*

AGLIME REQUIREMENTS

Calculations of fine aglime requirements to effectively treat soils can be obtained from Appendix C. It is important to remember that the fineness, purity of the neutralising agent and its neutralising value need to be considered when determining liming rates. For example fine aglime typically has an acid neutralising value of about 97% CaCO3. Accordingly a correction factor of 100/97 = 1.03 needs to be applied to reach the equivalent of pure fine aglime.

LIME USE AND SUSTAINABILITY

It should be noted that the use of lime products to treat ASS will generate carbon dioxide in production, transport, spreading and in neutralisation reactions. This may be a consideration in selecting the management strategy for large disturbances. Larger sites may also need to consider measures to reduce greenhouse gases e.g. planting and maintenance of local endemic trees.

THE SAFETY FACTOR

Soils require neutralisation with an agent at 1.5 to 2 times the theoretical acid production potential. This 'safety factor' is used because in most situations the neutralising agent is not fully mixed with the soil regardless of the method used. Furthermore, agents such as fine aglime have a low solubility and hence a low reactivity. Also, as discussed above, issues relating to the reduction of neutralising efficiency from coatings of gypsum, and iron and aluminium compounds forming on the grains of neutralising agents need to be considered. In 'high risk' situations greater safety factors may be warranted.

Ahern *et al.* (1998b) stated that an excess of neutralising agent within the soil tends to prevent a build up of extreme acidity within the soil despite some oxidation occurring as a result of the drying of the sediments. Furthermore, bacterial assisted oxidation may occur in disturbed ASS when the pH is less than 4, accelerating oxidation by a factor of 103 if oxygen is readily available. Consequently, the acid production rate will be kept low if the pH is maintained at levels greater than 5.5. This will also favour more complete neutralisation of acid by the added neutralising agent. Thus, an excess of neutralising agent in the soil is important. The table in Appendix C has incorporated a safety factor for fine aglime requirements.

It should be noted that fine aglime, $CaCO^3$ is impure in most situations. Consequently, higher quantities of fine aglime will be required to neutralise the soils than what is stated in Appendix C. The effective neutralising value of coarser aglime (>0.03 mm) is further reduced by the coarser grainsize (i.e. there is lower grain surface area available for reaction). Procedures to account for impurity and coarseness are detailed in the Queensland Information Sheets on Neutralising Agents. *Note: the safety factor does not take these into account.*

TREATMENT PAD DESIGN

For treatment of large volumes of material, neutralisation should be carried out on a treatment or liming pad. The issues to be considered in the treatment pad design are detailed in Appendix D.

DRAINAGE LINES

Neutralising agents can be incorporated into artificial drainage lines in contained treatment areas to aid the neutralisation of acidic stormwater runoff, and to neutralise acidic water from acidified groundwater inflows. Such design measures will prevent development of highly acidic waters and the transport of mobilised metals. By treating acid as close to its source as possible, the volumes of contaminated waters requiring treatment should be minimised. This reduces treatment costs and environmental risks.

Consideration should be given to the type of drain and potential flow rates in determining the particle size of the neutralising agent, and how it will be applied. In slow flow drains fine aglime can be incorporated into a sand bund, which water will infiltrate through to a drain. Alternatively, fine aglime applied directly to the drain base, in a sand mixture, or through use of coarser limestone blends may be considered. The neutralising agent will need to be replenished if it is scoured from the drain (into other treatment areas) or as it develops gypsum, iron and/or aluminium coatings that reduce its neutralising efficiency by preventing contact with water.

Because contact of acidified water with the neutralising agent will cause precipitation of metals from solution, consideration should be given to capturing and removing such metals; for example by constructing settlement ponds or silt fences across drains at intervals. These will require cleaning and maintenance from time to time. See the Queensland *Water Treatment and Management Guidelines* for more information.

It is inappropriate to apply neutralising agents into natural watercourses or water bodies unless carefully planned and approved. Refer to the Queensland Remediation Guidelines. Site containment should be designed to prevent potentially-contaminated waters from entering such areas in the first place.

This is particularly important for waters where pH-sensitive wildlife may be present such as in acidic coastal wetlands or black water (highly coloured, organic-stained water; Reeve and Fergus 1982) creek ecosystems. Refer to the Queensland Water Treatment and Management Guidelines for more information.

TREATMENT OF WATER

When significant volumes of water require pH adjustment, as opposed to cautionary applications of neutralising agent to drainage lines, then more soluble neutralising agents are more effective. Refer to the Queensland *Water Treatment and Management Guidelines.*

APPENDIX A. LEGISLATION AND POLICY RELEVANT TO ASS IN TASMANIA

ENVIRONMENTAL MANAGEMENT AND POLLUTION CONTROL ACT 1994

PART 2A - Environmental duties
23A. General environmental duty

1) A person must take such steps as are practicable or reasonable to prevent or minimise environmental harm or environmental nuisance caused, or likely to be caused, by an activity conducted by that person.
2) In determining whether a person has complied with the general environmental duty, regard must be had to all the circumstances of the conduct of the activity, including but not limited to –
   (a) the nature of the harm or nuisance or likely harm or nuisance; and
   (b) the sensitivity of the environment into which a pollutant is discharged, emitted or deposited; and
   (c) the current state of technical knowledge for the activity; and
   (d) the likelihood and degree of success in preventing or minimising the harm or nuisance of each of the measures that might be taken; and
   (e) the financial implications of taking each of those measures.
3) Failure to comply with **subsection (1)** does not itself constitute an offence or give rise to a civil right or remedy, but if a person has failed to comply with that subsection an environment protection notice may be issued to that person.
4) Where a person, in relation to an environmentally relevant activity, takes all measures specified, in a code of practice made and approved in accordance with the regulations, as meeting the requirements for compliance with the general environmental duty in respect of the activity, the person is taken to have complied with the general environmental duty in respect of the activity.

RELEVANCE TO THE ISSUE OF ACID SULFATE SOILS

This Act sets out a general duty of care to avoid environmental impacts. Such impacts could be caused by allowing acid and associated contaminant discharge into the environment through inappropriate excavation, neutralising, stockpiling or disposal activities.

COASTAL POLICY

The recently released State Coastal Policy 2006 also may cover ASS. It aims to facilitate:

- The conservation of intrinsic assets, values and processes of the coastal area; and
- The sustainable use or development of the coastal area.

There is no explicit mention of ASS in the policy, but it does appear in the attached documents:

- State Coastal Policy 2006 – Implementation Guidelines. This document lists ASS as one of the hazards that should be considered in planning schemes.
- State Coastal Policy 2006 – Model Standards. This document mentions ASS in the model standards for water quality and coastal management.

COMMONWEALTH LEGISLATION

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

INTRODUCTION

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) commenced on 16 July 2000 and is the centrepiece of the Commonwealth's environmental regulatory regime. The following objectives of the EPBC Act are relevant to ASS:

- to provide for the protection of the environment, especially those aspects of the environment that are matters of national environmental significance (NES);
- to promote: ecologically sustainable development through the conservation and ecologically sustainable use of natural resources; the conservation of biodiversity; and a co-operative approach to the protection and management of the environment involving governments, the community, landholders and indigenous peoples; and
- to assist in the co-operative implementation of Australia's international environmental responsibilities.

Administering Authority: Department of Environment and Heritage.

Jurisdiction: Australia.

Availability: The EPBC Act is available on the web at www.deh.gov.au/epbc. Information regarding the act can be found at www.deh.gov.au/epbc. Hard copies are available from Comprint by phoning 1300 656 863.

RELEVANCE TO THE ISSUE OF ACID SULFATE SOILS

Under the EPBC Act, approval is required for actions which have, will have or are likely to have a significant impact on a matter protected under the Act. The matters protected which are likely to be impacted by ASS disturbance include World Heritage areas, Ramsar Wetlands, listed species and Commonwealth marine areas.

Actions that involve the disturbance of ASS and their management clearly may trigger the provisions of the EPBC Act. For example, development that may disturb ASS in proximity to a Commonwealth marine area may lead to significant impact. Such proposed actions may require referral and may require approval under the EPBC Act. Many activities that are to be carried out in ASS areas will come within the definition of 'action' and must be carefully evaluated in relation to their likely impacts. A proponent may have confidence that proposed actions involving ASS may be satisfactorily managed to minimise impacts on matters of NES. When in doubt they should still refer the proposed action to the Minister.

ENVIRONMENT PROTECTION (SEA DUMPING ACT) 1981

INTRODUCTION

The *Environment Protection (Sea Dumping Act) 1981* regulates the deliberate loading and dumping of wastes and other matter at sea. This Act potentially relates to the dumping of ASS material including dredge spoil into the sea.

Administering Authority: Department of Environment and Heritage.

Jurisdiction: All Australian waters (other than waters within the limits of a State or the Northern Territory), from the low water mark out to the limits of the Exclusive Economic Zone.

Availability: The *Sea Dumping Act* is available at www.austlii.edu.au. Hard copies are available from Comprint by phoning 1300 656 863. Further information about the *Sea Dumping Act* can be found at www.deh.gov.au.

RELEVANCE TO ASS

The dumping of dredged sulfidic/acidic materials, which may include the disposal of excess sulfidic sand from maintenance dredging in existing canals, may require a permit under the Act. The protocol requires an assessment of waste or other matter that may be considered for dumping. This includes an assessment of the chemical, physical and biological properties of the waste. The protocol also provides for the consideration of alternatives to the dumping of a waste. It is foreseeable that waste containing ASS could be regarded as a controlled material, and hence its loading and dumping would require an application for a permit.

APPENDIX B. SOIL SAMPLING AND ANALYSIS GUIDELINES

(summarised from the Queensland *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998* and adapted for Tasmanian conditions).

1. MAPPING AND SAMPLING

MAPPING

A detailed map of acid sulfate soil occurrence/absence and an assessment of sulfide/pyrite content by depth is an essential prerequisite for deciding whether a proposed development/disturbance is feasible from an environmental, engineering and economic perspective. The proposal may have to be abandoned, modified, or planned excavations redesigned, if acid sulfate soils with substantial sulfide content are encountered.

Initial assessment of the likelihood of ASS occurring can be made using existing acid sulfate risk maps, aerial photography, maps and information on geomorphology, soils, geology, height above sea level, land use, hydrology and any soil or water tests previously done in or around the area, (Smith and Ahern, 1996; Naylor *et al.*, 1995). Generally, projects that disturb soils located above 20m AHD should be relatively safe and require only some confirmatory investigation. Common exceptions to this generalisation include activities that involve deep disturbance such as sand mining and construction of deep on-farm dams above 20m AHD (Anderson *et al.*, 1996).

Soil sample intensity is dependent on the nature, depth and size of the disturbance proposed and the sensitivity of the surrounding environment. Most ASS investigations will require sufficient sampling to create three-dimensional maps and cross sectional diagrams for presentation in the ASS report.

SAMPLING INTENSITY

A typical intensity of profiles or boreholes required is shown in Table 1 below:

Table 1. Number of sampling holes

Area of site	Number of boreholes
Up to 1 ha	4 holes
1-2 ha	6 holes
2-3 ha	8 holes
3-4 ha	10 holes
> 4 ha	2 holes/ha

More detailed transect sampling (50m intervals) may be required along proposed excavations, e.g. canals, lakes, drainage channels and borrow pits. Additional samples may need to be taken in areas of more intensive disturbance or in potential 'hot spots'. In these areas, sampling may be required on a 50-75 metre grid. This sampling intensity is not expected on areas of the site where the likelihood of acid sulfate soils occurring is low, e.g. located above 20m AHD or soils on hard rock. However, justification for reduced sampling intensity and some confirmatory investigation will still be required for these areas.

Sampling of material to be **dredged** from coastal rivers, lakes, dams and wetlands should be undertaken according to the transect spacing described above. Samples should be collected to at least one metre below the maximum depth of expected material extraction, ensuring that samples from all sedimentary layers are included. Careful attention must be paid when collecting underwater sediment samples to ensure that all sediment particle sizes are collected (a vibro-suction corer is usually suitable). The fine silt and clay fraction of the dredged material may contain high concentrations of sulfide, however this material can easily drain from the sample during collection. In some wet dredging operations, acid sulfate material (usually silt and clay) can separate from the bulk material (sand) during stockpiling.

Assessment of such dredged material may require that the constituent fractions of the resource be separated and tested accordingly, as interpretation of soil analysis on the dredge material may be complicated due to the neutralising influences of shell or seawater in the sample. Conventional laboratory analysis must include the measurement of calcium, (optionally magnesium and sodium) in the SPOCAS test (Method code 21X) and/or the HCl extract of the TOS method (Method 20Bh). Acid Neutralising Capacity (ANC, e.g. Method 19B1) may assist. Where considerable difference exists between the results of the acid trail and the sulfur trail, kinetic type tests involving leaching columns and incubation may be required.

Each borehole should be sampled and details recorded as follows:

i. The **location of each borehole** using Map Grid Australia (MGA/GDA94 to 2.5 m) or Latitude and Longitude (to 0.1 of a second) **and its existing surface height** (AHD) **must be determined and recorded in the report.** This assists in identifying sulfide-bearing layers which comprise essential data in development of proposed earthworks and management plans. The expected accuracy (± x metres) of the GPS or survey equipment used must be also specified. Investigations involving only minor disturbance may derive sufficient location information and contour data from detailed orthophoto maps which are available for some areas.

ii. Field descriptions of horizons using the nomenclature of the Australian Soil and Land Survey Field Handbook (McDonald *et al.*, 1990 or NCST 2009) for each site/borehole should be submitted in the report. Soil descriptions in accordance with the Unified classification System as outlined in AS1726 are also acceptable. Field texture, colour, mottles (particularly presence of straw yellow jarosite) and field pH are essential measurements. See section 4 of this Appendix for field pH tests that must be recorded by horizon or every 0.5m depth interval. **Field pH (pHf) and peroxide pH (pH_{fox}) must be recorded at every soil texture or colour change.** Any presence of shell or carbonate material in the soil must be recorded, along with a measure or estimate of their abundance and size distribution. Suspected carbonate material can be tested in the field by a positive reaction/effervescence with 1M HCl.

iii. Starting from the present soil surface, collection of soil samples should not exceed 0.5 m intervals down the profile, **to at least one metre (1 m) below the depth of the proposed disturbance or to at least two metres (2 m) below the land surface, whichever is greater** (i.e. at least four samples would be required when sampling a profile to a depth of 2 m). Where distinct horizons occur, then sampling should be confined to within that horizon but sampling intervals should not be greater than 0.5 m apart. Where alteration of the watertable height by drainage, pumping, etc. is envisaged then sampling to at least one meter below the depth of the final estimated water table height is required. **Ensure all depths/horizons are collected** (even when field assessments indicate the absence of ASS). Ideally, soil samples should constitute at least 0.5kg each to allow sufficient sample for physical and chemical analysis. Their analysis may be requested as part of the assessment, such as an audit process, or other unforeseen uses. Quantitative laboratory tests may need to be conducted on every 0.5m depth interval, unless strong justification is provided. Laboratory analysis confirming the absence of sulfides is often just as important as determining the actual sulfide content on a positive sample.

   The depth below the surface of any watertable must be recorded and where encountered, a water sample collected for analyses. Depending on flow rates and tidal influences, this may require returning to the site some hours later. The water sample should be analysed for at least pH, Electrical Conductivity (EC), chloride, sulfate, aluminium, calcium and iron. For those users with field equipment, EC and pH (and redox and DO if available) should be measured immediately.

Quantitative laboratory tests should be conducted on all soil samples. The texture action category, (coarse, medium, fine; see McDonald *et al.*, 1990) needs to be clearly indicated to laboratories for all soil samples as this affects method selection, the detection limit required and general interpretation of the result. As sampling and laboratory analyses can be an expensive process, **a staged approach to sampling is suggested.** When selecting samples for comprehensive laboratory analysis in Stage 1, a number of profiles should be analysed for each 0.5 m interval or horizon rather than selecting random samples from many profiles. The emphasis should be on those sites most likely to be affected by development and most likely to contain sulfides based on elevation, soil type and results of field tests.

Subject to assessment of Stage 1 sampling and analytical results, the sampling intensity may be adjusted or reduced. However, the onus will be on the applicant, developer or consultant to provide information demonstrating that less sampling and laboratory analysis is justified and that if sampling is reduced the potential for environmental harm will not be increased.

In addition to preliminary mapping, some operations such as **dredging or sluicing** may require sampling at the output pipe every 500 m^3 of material for analytical determination to calculate lime requirements.

SAMPLING EQUIPMENT

Various manual and mechanical sampling equipment may need to be employed. Choice of equipment will depend on soil texture, wetness and layers in the profile. Commonly used equipment are listed and commented on below:

MANUAL

- Jarret auger - usually restricted to the upper profile of dry and moist soil only and generally not suitable for sands.
- Tapered gouge auger - suitable for soft muds, but not sands.
- Push tube with tapered tip - limited sample retention as suction is created on extraction and sample loss can be a problem (adding a sealable cap before extraction improves retention). It is generally not suitable for saturated sands.
- Dormer sand auger - acceptable for many soils but saturated sands may fall out and the walls of the borehole may collapse.
- Piston sampler - good for saturated sands but limited to the length of the piston as walls collapse as it is withdrawn. Using a suitable size PVC/HDPE pipe for casing can increase the depth of excavation on saturated sands but care is needed to limit contamination or sample mixing.

MECHANICAL

- Hydraulic push tube - hard to remove sample from tube on sticky soils, wet sands fall out (adding a sealable cap before extraction improves retention).
- Spiral auger- mixes sample, **generally unsatisfactory**
- Hollow-flight screw auger incorporating an internal 'split tube' sampler - uses a hollow screw auger with an internal sampler that can be withdrawn regularly. The internal sampler is fitted with a 'split tube' and takes suitable good cores but can have trouble with compression of muds and loss of sample on sands below the watertable. A "catcher" often improves retention on sands. Some well-equipped drilling rigs can also use within the hollow auger a thin walled 50 mm diameter tube designated U50 (undisturbed, 50mm diameter) for sampling.
- Backhoe, excavator - Excellent until the watertable is reached, sampling taken at measured intervals down the face. Once below 1.5m wall collapse is a substantial problem for effective sampling and personal safety. Good for sites with lots of shell as it allows a larger sample to be collected without shattering the shell - a common problem with most other sampling techniques. **Work place safety issues** need to be addressed when digging pits. If entering a pit for sampling one needs to **consider the possibility of poisonous hydrogen sulfide gas** overcoming the person. A rope and harness should be used and one member must always remain outside the pit to pull the other person up should such an occasion arise. Do not enter a pit to assist a gas affected person without proper breathing apparatus.
- Wash bore drilling combined with a driven Standard Penetration Test (SPT) split tube sampling - a bentonite and polymer solution which is continually pumped under pressure usually holds the borehole walls intact for deep drilling on saturated sands. Contamination of sample can be a problem even when the upper part of the core is rejected and it is not possible to observe groundwater inflows or levels.
- Core sampling employing a suction and vibrating technique – is recommended and ideal on wet sands, muds and soft soils, giving accurate depths and intact cores. Compressed air is used to remove the sample from the tube. If the upper profile is hard and dry, a hydraulic push tube or auguring device may be required until soft moist material lower in the profile is encountered.

Sands below the watertable are difficult to sample, while those sites encountering gravel layers are the most challenging. At present sampling using an excavator is recommended for gravels. The further the sampling is below the watertable the more difficult it is likely to be. Gravel and sand fractions immersed in a 'pyritic soup' have been found to contain pyrite framboids in their fine pores and fractures or as mud coatings (Saffigna *et al.*, 1996). Such materials are difficult to sample representatively.

Washing down and cleaning of sampling equipment is essential to avoid sample contamination. A high-pressure washing system is essential for mechanical drilling equipment. Trace amounts of sulfidic material from previous sampling may contaminate a sample with no sulfide present, resulting in a positive test. This can lead to unnecessary and costly earthworks and liming procedures being required on soils with no acid producing potential. Therefore an ASS consultant or a trained ASS technician must be present and supervise all drilling and sampling.

Specialised sampling equipment capable of taking uncontaminated core samples from the specified depths is a vital component of any ASS investigation. ***Inappropriate equipment/sampling procedure will render the laboratory results unrepresentative and hence invalidate the ASS component of the report.***

STAGED SAMPLING

It can be cost-efficient to **stage** the approach on large projects. When the results of the initial sampling are known and presented at an informal meeting, all parties can decide on the most efficient and cost effective sampling measures (if any) that are required to complete the ASS investigation and or ASS management plan. Authorities may ultimately insist on full sampling and analyses as per these Guidelines. The onus is on the proponent to justify that sufficient sampling has been undertaken to understand and manage the site without causing environmental harm. Many proposals contain site-specific issues that cannot possibly be covered within the general guidelines. Consultation will help eliminate rejection on the grounds of a technically inadequate EIS and EMP.

2. SOIL SAMPLE CARE/PREPARATION

In the field, all **visible shell** should be removed from soil samples. It is essential that shell material be removed in the field at the time of sampling otherwise it must be sieved out (2 mm sieve) prior to sample grinding. This is usually difficult on clayey samples as they often set hard on drying making removal of shell without breakage/shattering extremely difficult. Broken or ground shell creates fresh exposure, increases the actual reactive surface area, overestimates the true neutralising capacity and hence falsely reduces the TPA result. Most drilling techniques shatter some shell and this should be considered when selecting appropriate sampling methods for a site. Additionally, shells found in ASS commonly have a coating of relatively insoluble gypsum, silica or iron compounds, rendering much of their carbonate content ineffective for neutralisation. If large quantities of coarse shell occur at a site and it is intended to use shell materials to reduce potential liming rates, then extra tests may be useful. Extra tests may include incubation of a portion of undried sample including any shells for a number of months to provide some measure of oxidation and neutralisation rates, or determining (with separate large bulk samples) the percentage of shell present in the soil and the neutralising capacity of the uncrushed shell.

Waterproof labels, capable of withstanding oven drying at 850C, are essential due to the high moisture content of most samples. These can be pre-printed with appropriate name and job description on waterproof paper using a laser printer, then labelled in the field with site and depth using a **waterproof marking pen**. Samples and the correct label should be placed without delay into **sealable polyethylene bags** (with air excluded). Sample bags must also be externally labelled and all depths from the one hole/profile placed in a larger bag to improve efficiency and limit possible mistakes on receipt at the laboratory.

Immediately place the entire profile into a **portable freezer** (or **esky containing block ice**) to quickly cool the samples and minimise sulfide oxidation (when block ice or a freezer is not available ordinary ice or freezer blocks are the next best but are less efficient, and some minor oxidation may occur). Samples must be kept cold and transported in an insulated container to a laboratory within 24 hours of sampling. If this is not possible then they must be frozen until ready for insulated transport to the laboratory for pre-analysis drying. The laboratory should be notified prior to receipt of soil samples. This will reduce the risk of samples sitting in loading bays for extended periods of time (potentially oxidising). Separate field samples may be required to determine bulk density to convert gravimetric results to a volumetric basis for field management plans (e.g. rates of lime per m^3). A sample of known volume can be sampled using equipment such as a cut off syringe. Volumetric samples are sometimes used for 'field laboratory' measurements of TPA using a time-shortened version of Dent and Bowman (1996a, 1996b). Such an approach may be useful for quick site management decisions once earth moving operations are under way, but results should be calibrated by regular dispatch of a subsample to a laboratory for complete analysis.

Oven dried samples and full laboratory analyses will be required for preparing the ASS report and site mapping.

At the time of sampling, **soil colour, soil texture, field pH** (pH_f ; method 21Af, see section 4 of this Appendix) and **field pH after oxidation with 30 % peroxide** (pH_{fox}; method 21Bf) should be determined within 0.5 m depth intervals or soil horizons in the profile and at least on all depths sampled for further laboratory analyses. These field tests together with the strength of the peroxide reaction can indicate those depths where sulfides occur. This may assist in allocating like samples to particular batches in the laboratory, optimising procedures and improving the accuracy and detection limits. The field pH can be measured on saturated soil using a combination **spear point pH probe and field pH meter**. If pH_{KCl} is substantially lower than pHf then some oxidation of the sample during transport or drying may have occurred. Typically, pH reductions of 0.2 to 1 unit have been recorded on oven drying, without any measurable oxidation of sulfides. Oxidation of black iron monosulfides (FeS) and other unstable sulfide and iron compounds commence on disturbance and specialised sampling equipment is required to prevent oxidation. Fortunately, such compounds rarely occur in significant amounts. The use of volumetric sampling and analytical methods may be more suitable when highly unstable compounds are abundant. A method for Acid Volatile Sulfur (AVS) is contained in the Queensland *Laboratory Methods Guidelines* (Ahern *et al.*, 1998a).

All soil samples collected in the field for ASS investigations should be well marked and retained for possible future call or audit purposes. Storage in an oven-dried state as described in the next section is the safest and preferred approach, although most laboratories will charge a fee for drying and storage. Where not all samples are sent to the laboratory, particularly when conducting a staged approach, a less desirable method of storage is freezing. All samples or a subsample of approximately 50 g must be retained until the end of the project unless they become an unreasonable impost then approval to discard should be negotiated with the regulatory authority. Stored samples could be important in defence of legal action. Special arrangement may need to be made with the laboratory to retain at least 50 g of sample, as most commercial laboratories would discard samples about a month after results are reported.

3. LABORATORY ANALYSES AND ACTION CRITERIA

On arrival at the laboratory, soil samples must be either immediately oven-dried or kept frozen until ready to oven-dry. Refrigeration will not prevent oxidation as jarosite can be seen forming in refrigerated samples stored for some weeks.

Wet muddy/clayey cores should be placed on **waterproof non-metallic dishes** (high density microwave cookware is usually suitable) and cut into smaller pieces as soon as partial thawing allows. Quick oven-drying in a **forced air draft, high capacity oven at 80-85 °C** (to prevent oxidation of pyrite) for at least 48 hours is required (Ahern *et al.*, 1996a). Bulkier clay samples may require several days longer to ensure complete drying. If an estimate of field moisture is required, retain a representative portion of the soil, place in a suitable non-metallic moisture container, and weigh and determine moisture content as per method 2B1 (Rayment and Higginson, 1992).

After drying, any coarse material not previously removed (especially **shell and gravel**) should be extracted or removed by preliminary sieving (2 mm). When required, the weight of the residual coarse material (>2 mm) may be measured and calculated as a percentage of the total sample weight. Samples which do not easily break up after oven drying (such as some heavy clays), should be rolled/crushed/ground to pass through a 2 mm sieve. It is recognised that grinding equipment is laboratory-specific but it is recommended that samples for ASS analyses be fine-ground (<0.5 mm or finer), to ensure greater homogeneity. This means a smaller sample weight and less volume of reagents can be used during analysis, reducing costs. The sample should be stored in a cool dry place in an air-tight plastic or inert container for subsequent laboratory use.

SAMPLES CONTAINING 'MONOSULFIDES'

Some common locations of material containing significant monosulfides are bottom sediments of quiet coastal lakes and streams and weed-infested drains where a fresh source of organic material causes the active formation of sulfides, particularly characterised by a 'smelly black ooze'.

Samples suspected of containing **metastable sulfides** ('monosulfides') should be frozen immediately after they are sampled in the field with the use of dry ice then **freeze-dried** in the laboratory. Bush and Sullivan (1997) showed that greigite ($FeS_{1.34}$ or Fe_3S_4) readily oxidises within hours at room temperature and oxidises in minutes on drying at 88°C. Special precautions to prevent oxidation at sampling and drying are costly and laborious and generally used on research samples rather than routine samples. Provided monosulfide content is low then any oxidation on drying should be detectable by a significant lowering (>1 unit) of laboratory pH compared to field pH. The change would not be easily detectable using the sulfur trail but the acid trail should show a high Total Actual Acidity (TAA) result. Dioxane replacement of moisture (Crockford and Willett, 1995) may be useful where no freeze drying facilities are available. Greigite is relatively stable once dried (Bush and Sullivan, 1997). See also Bush and Sullivan (1998) Acid Volatile Sulfur Method in *NSW ASS Manual* (Stone *et al.*, 1998).

SAFETY

As dried ASS may contain dusty, strongly-acidic substances such as jarosite, workers involved in grinding such soils should use eye protection and carry out the operation in a dust extraction cabinet or wear a suitable dust mask.

APPROVED LABORATORY METHODS

A set of standard methods has been under development for routine laboratory use on soil samples (ASSMAC, 1996; Ahern *et al.* 1996b). These earlier versions were updated at a national methods workshop in October 1996. After some minor amendments and trials by Government, University and private laboratories two methods were approved at a combined meeting in Sydney on 29 August 1997, for standard use in all future ASS environment impact assessments to be submitted to NSW and Qld Government authorities. These methods are also required for all future ASS environment impact assessments submitted to Tasmanian authorities. They have been published in Ahern *et al.* (1998a) in the *NSW ASS Manual.*

These methods now comprise AS4969 as the agreed standard for preparation and analysis of ASS. These standards now incorporate the previously approved methods POCAS Peroxide Oxidation Combined Acidity & Sulfate (Method 21) and TOS Total Oxidisable Sulfur (Method 20) and these must now be used for quantifying the acid producing effects of sulfidic material in soils.

It should be noted that the TOS method is a useful screening method for pyrite content of soils and gives **no measure** of acidity present in partially-oxidised and actual acid sulfate soils. Field pH, conducted at the time of sampling, can assist identification of soil acidity but not quantification of actual soil acidity which can be a significant environmental issue if the acid, iron or aluminium leachate drains into streams. Thus, in many situations, TOS will not provide sufficient data to fully understand the complexity of ASS.

Where clear relationships between the 'acid trail' and the 'sulfur trail' have been established in the Environmental Impact Statement (EIS) authorities may consider an individual project basis, requests to use the 'acid trail' only of POCAS during the earth works/construction stage. This would assist in reducing costs, facilitating a quicker turn around of results, allowing earlier liming calculations and management of exposed PASS material. When permission for using such an approach is granted, an agreed percentage of samples must be submitted for full laboratory assessment to monitor the calibration.

All analytical data presented in the report must have its analytical method clearly stated using the approved codes (see Appendix). The full list may be found in Ahern and Rayment (1998). If variations to the approved methods are used, the detail must be clearly documented in the report along with the reason or benefit of the variation. Providing **additional** data, using other methods or techniques, is acceptable and necessary in some situations.

ACTION LEVELS OF OXIDISABLE SULFUR

Tasmanian authorities should use indicator or action levels recently agreed to at the national workshop (and modified recently by ASSMAC Technical Committee) as a guide to call for an ASS management plan, or the appropriate treatment for small disturbances. As clay content tends to influence a soil's natural pH buffering capacity, the action levels are grouped by three broad texture categories - coarse, medium and fine, as defined in Table 2.

Table 2. Action criteria based on ASS soil analysis for three broad texture categories.

Type of Material		Action Criteria 100-1000 tonnes disturbed		Action Criteria if more than 1000 tonnes disturbed	
Texture range. McDonald et al. (1990)	*Approx. clay ontent (%<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 Texture Sands to loamy sands	≤5	0.03	18	0.03	18
Medium Texture Sandy loams to light clays	5-40	0.06	36	0.03	18
Fine Texture Medium to heavy clays and silty clays	≥40	0.1	62	0.03	18

INTERPRETATION OF THE RESULTS - ACTION CRITERIA TRIGGERING THE NEED FOR A MANAGEMENT PLAN.

The *Action Criteria* in Table 2 should trigger the need to prepare a management plan based on the percentage of oxidisable sulfur (or equivalent TPA, TAA) for broad categories of soil types. Works in soils that exceed these action criteria should require preparation of a management plan and development consent. For projects that disturb ≥1000 tonnes of ASS soils with ≥0.03 % oxidisable sulfur or equivalent existing or potential acidity, a detailed management plan and development consent should be required.

Table 3 provides an indication of the treatment or risk category that disturbed acid sulfate soils would entail, based on soil analysis. This allows a quantity of lime to be estimated provided the total volume/mass of acid sulfate soils to be disturbed is known and soil analysis has been performed. The table is based on the quantity of lime required to neutralise the acid that could potentially be produced and includes the minimum industry safety factor of 1.5.

For example, if 100 tonnes of clay material with 0.4 % oxidisable sulfur is to be disturbed, the landowner/contractor should observe best practice, bund any extracted material and fully mix at least 1.9 tonnes of lime with the excavated material. This example would fall into the 'High Treatment category' on Table 3 and may require Local Government approval, a management plan and depending on sensitivity of the site possibly some monitoring.

If 1,000 tonnes of the same material is to be disturbed, a more detailed management plan will be required, along with development consent before the works can be undertaken. In these circumstances approximately 19 tonnes of lime will be required to treat the material. This latter example would be in the 'Very High treatment category' of Table 3. A Development Application should be needed with the Local Government (and depending on site sensitivity possibly an EIS).

Table 3. Treatment categories and lime required to treat a weight of disturbed acid sulfate soils – based on soil analysis.

Disturbed Soils	Soil Analysis - Oxidisable Sulfur (S %) or equivalent TPA/TAA													
(tonnes)	0.03	0.06	0.1	0.2	0.4	0.6	0.8	1	1.5	2	2.5	3	4	5
100	0.1	0.3	0.5	0.9	1.9	2.8	3.7	4.7	7.0	9.4	11.7	14.0	18.7	23.4
200	0.3	0.6	0.9	1.9	3.7	5.6	7.5	9.4	14.0	18.7	23.4	28.1	37.5	46.8
500	0.7	1.4	2.3	4.7	9.4	14.0	18.7	23.4	35.1	46.8	58.5	70.2	93.6	117.1
750	1.1	2.1	3.5	7.0	14.0	21.1	28.1	35.1	52.7	70.2	87.8	105.3	140.5	175.6
1000	1.4	2.8	4.7	9.4	18.7	28.1	37.5	46.8	70.2	93.6	117.1	140.5	187.3	234.1
2000	2.8	5.6	9.4	18.7	37.5	56.2	74.9	93.6	140.5	187.3	234.1	280.9	374.6	468.2
5000	7.0	14.0	23.4	46.8	93.6	140.5	187.3	234.1	351.2	468.2	585.3	702.3	936.4	1170.5
10000	14.0	28.1	46.8	93.6	187.3	280.9	374.6	468.2	702.3	936.4	1170.5	1404.6	1872.8	2341.0

L	**Low treatment level:** <0.1 t lime
M	**Medium treatment level:** >0.1 to 1 t lime
H	**High treatment level:** >1 to 5 t lime
VH	**Very High treatment:** >5 tonne lime

The tonnes (t) of pure fine lime required to fully treat the total weight/volume of acid sulfate soil can be read from the table at the intersection of the weight of disturbed soil (row) with the soil sulfur analysis (column). Where the exact weight or soil analysis figure does not appear in the heading of the row or column, use the next highest value (or calculate values exactly). Lime rates are for pure fine $CaCO_3$ using a safety factor of 1.5. A factor that accounts for Effective Neutralising Value is needed for commercial grade lime. An approximate volume (cubic m) can be obtained by dividing weight (tonne) by bulk density (t/m^3).

NOTES ON ASSESSMENT OF RISKS BASED ON THE LEVEL OF OXIDISABLE SULFUR

Levels of oxidisable sulfur within a soil or sediment can indicate the level of risk to the environment if the soil is disturbed. For all soils with oxidisable sulfur values greater than the "*Action Criteria*" in Table 2, a management plan should be developed to manage the potential harm to the environment. As a general rule, the highest result (by either the "sulfur "or the "acid" trail) should be used as the action criteria. Existing acidity (TAA) needs to be included in the assessment. If it is proposed to use the lower result of the 'acid' or 'sulfur' trail, this will require justification in advance, e.g. the acid trail may be higher than the sulfur trail for organic rich surface material.

NOTES ON ASSESSMENT OF RISKS BASED ON THE TYPE OF MATERIAL TO BE DISTURBED

The potential impacts from disturbance of acid sulfate soils can vary considerably depending upon its texture and mineralogy (e.g. the fineness of the soil particles and reactivity of naturally occurring neutralising material such as shell). In addition, due to the natural buffering capacity of clay soils, the level of clay in the soil can also influence the net level of sulfuric acid likely to be produced when the soil is disturbed.

As a result, this buffering process can moderate the potential impacts from the disturbance of soil with a particular level of oxidisable sulfur. Therefore, the levels of oxidisable sulfur that warrants management action will vary with the clay content. For assessment purposes, the criteria (based on oxidisable sulfur) which should trigger management action are grouped into three broad texture categories in Table 2. Lower criteria may be necessary if large quantities are to be disturbed as in Table 3. Soil samples that meet or exceed these criteria present a risk if disturbed and require management action if earthworks are to be undertaken.

Extreme care must be taken with interpretation of results from the analysis of 'coarse material', particularly low sulfur sands as lower detection limits are required. Sands have a lower action level because they can oxidise rapidly and usually have little or no pH buffering capacity. Preferably, more than one analytical method may be needed when analysing sands with the 'SPOCAS' method the recommended approach.

The interpretation of results of samples from peaty soils, highly organic material, coffee rock (humicrete) and indurated sands can also be difficult. Sulfides commonly occur inside old root channels and sulfide formation is usually closely associated with organic matter, which if abundant, may form sulfidic peats. However, it may be possible to get a positive laboratory result on peats, by both the sulfur and acid trail testing methods where there is no identifiable mineral sulfide under the electron microscope. The positive oxidisable sulfur result in these cases may be attributed to a high organic sulfur content in the organic matter. Such organic sulfur compounds are less of an environmental risk.

Coffee rock is expected to be fully oxidised due to its pedological and geomorphological history and in many circumstances do not pose environmental risks. However, this is not the case for all coffee rock. The chromium reducible sulfur method (Method 22 B) Chapter 9 of the *ASS Laboratory Methods Guidelines* (Ahern *et al.*, 1998) may be useful in assisting to improve information on the contribution of organic sulfur to these complex situations.

ASSESSMENT OF RISKS BASED ON THE MAXIMUM LEVEL OF ACID THAT COULD BE PRODUCED

The analysis of the oxidisable sulfur in the soil samples can be used to calculate the theoretical maximum amount acid that can be generated as result of the complete oxidation of sulfides.

The assumption is that the entire oxidisable sulfur in the sample is pyrite (FeS_2) and it produces 2 mol of sulfuric acid per mol of pyrite and no soil buffering is available. A number of methods of determining oxidisable sulfur are available (e.g. S TOS and S POS) and their results are normally expressed as % S (or kg H_2SO_4 / t), (Table 4). Methods for titrating acidity (TAA, TPA) are usually expressed in mole of acidity / t and approximate conversions between the various units are shown in Table 4. This analysis can provide an indication of the quantity of lime that could be required to neutralise all the acid. The data in Table 4 includes a 1.5 safety factor.

Table 4. Acid sulfate soil conversions.
(based on 1 mol pyrite (F_eS_2) producing 2 mol sulfuric acid and corresponding liming rates)

Oxid. S (%)	*moles H^+ /kg (S % x 0.6237)*	*moles H^+ /t or moles H^+ /m^3 (S % x 623.7)*	*kg H_2SO_4 /tonne or kg H_2SO_4 /m^3 (S % x 623.7)*	*kg lime/tonne soil or kg lime/ m^3 Safety factor = 1.5*	*Approx. lime cost/tonne soil or Cost/ m^3 of soil $*	*Cost/ha/m/depth of soil @ $50/t of lime $*
0.02	0.0125	12.47	0.51	0.94	0.05	468
0.03	0.0167	18.71	0.92	1.4	0.07	702
0.06	0.0374	37.43	1.84	2.8	0.14	1,404
0.1	0.0624	62.37	3.06	4.7	0.23	2,340
0.2	0.1247	124.7	6.12	9.4	0.47	4,680
0.3	0.1871	187.1	9.18	14.0	0.70	7,020
1.0	0.6237	623.7	30.6	46.8	2.34	23,410
5.0	3.119	3119	153.0	234.0	11.70	117,000

Note:

- Assumes a bulk density of 1.0 g /cm^3 or 1 tonne/m^3 (bulk density range can be 0.7-2.0 g/cm^3 and as low as 0.2 for peats). Where bulk density is > 1 g /cm^3 or 1 tonne/m^3 then the correction factor for bulk density will increase for lime rates/m^3 soil (eg. if BD=1.6, then 1 m^3 of soil with 1.0 % S_{POS} will require 75 kg lime/m^3 instead of 47 kg).
- Correction factors for lime purity, neutralising value or effective neutralising value where some particle size > 0.03 mm are also required.

It is essential to provide adequate neutralising material to neutralise all acid that may be produced and to bring the pH of the soil to well above 5.5. In most cases, there is only limited justification for raising the soil pH to neutrality (pH 7) as a pH above 5.5 is adequate to avoid most acid sulfate problems (Dent, 1992). However the pH of leachate should be above pH of 5.5 at all times and should ideally be in the range 6.5-8.5 to remove toxic forms of aluminium and other heavy metals.

Table 4 provides an indication of the quantities of lime required and the likely financial implications and practicability of managing the disturbance of the soil. Even when an "oxidation" mitigation strategy is not proposed, the quantity of lime required provides a signal as to the likely environmental hazards from undertaking the proposed works. Using a cost of $50 per tonne for lime, (the actual cost of lime could vary from $40 to $150 per tonne depending on the location and quality), a rough understanding of the likely economic costs from disturbance of the soils (earthworks not included) can be gained.

NOTES ON THE ASSESSMENT OF RISKS BASED ON THE QUANTITY OF MATERIAL TO BE DISTURBED

The amount of lime required to neutralise a certain quantity of acid sulfate soil can be used as an approximation to determine the degree of risk associated with disturbing acid sulfate soil. Where the volume of acid sulfate soil is small and the concentration of oxidisable sulfur is low, the risks are considered to be relatively minor. Conversely, where large volumes of acid sulfate soils are to be disturbed, the potential cumulative risks are high. A treatment rating has been developed in Table 3 based on the calculated quantities of lime required per tonne of soil. This table provides a rough guide only. It is a useful tool for those proposing the project and as an aid to the regulators in deciding the acceptability of the project.

Considerable care should be taken when using Table 3 to justify activities that disturb acid sulfate soil. Table 3 may be used as a rough risk indicator between projects with contrasting levels of soil disturbance and different concentrations of oxidisable sulfur. Individual works have their own environmental characteristics and should always be assessed on all the information available for that site and proposed works.

IMPACTS ASSOCIATED WITH THE PHYSICAL CHARACTERISTICS OF ACID SULFATE SOILS

The physical characteristics of the subsoils and the potential for compaction and subsidence of unripe acid sulfate clays should be considered for projects that involve extensive landfilling, and heavy structures such as roads, bridges, dams or major buildings. Some potential acid sulfate soil clays have the consistency of a gel with up to 80% water content and hence low bearing capacity.

When these soils are loaded, considerable lateral movement or subsidence can be expected under load. For these types of projects, geotechnical data should be analysed to consider the extent of possible movement of the sulfidic material under load and appropriate management strategies developed. Preloading of the site may need to be considered. If preloading or loading of the site is to be undertaken, hydrogeological analysis should also be carried out to consider the effects of compaction on groundwater levels and clay gel material flows and the potential for discharge of acid. The material used for preloading should be non-ASS and if it is to be removed in the future, it should be separated by geotextile fabric to allow final removal without ASS contamination.

Extreme care must be taken with sampling and laboratory methodology for the 'coarse category', particularly low sulfur sands as lower detection limits are required. For confident interpretation of results, usually more than one analytical method is needed on sands and hence the 'POCAS' method is the recommended approach (using at least double the minimum sample weight). Each case needs careful consideration. Sands have a lower action level because they can oxidise rapidly, may have little or no pH buffering capacity and often occur in sensitive environments. Conversely, clean quartzose sands may have anomalously low pH_{fox} and TPA due to the acid buffering of the peroxide solution, although the results of the sulfur trail results should be accurate.

Management plans will need to demonstrate that all soils with oxidisable sulfur values greater than the action levels can be managed without harm to the environment. Further details on management are contained in the *ASS Assessment Guidelines* (Ahern *et al.*, 1998b), *ASS Management Guidelines* (Ahern *et al.* 1998c) and the *NSW ASS Manual* (Stone *et al.*, 1998).

CONSIDER THE PRECAUTIONARY PRINCIPLE

When designing a soil sampling program or undertaking soil analysis, the precautionary principle should be considered. Where there are doubts, be conservative. Always follow best practice. If there are uncertainties, analyse extra samples. When interpreting the results, err on the side of caution. There is a responsibility on those proposing to undertake the works, the consultants advising them and any approval authority involved in making a decision, to ensure that if there are uncertainties, both the short and long term implications of the worst case scenarios are considered.

OTHER LABORATORY TESTS

Additional laboratory analyses are useful for understanding the soil's potential acid generation and identifying potential environmental effects. Measurement of electrical conductivity, chloride, organic carbon, aluminium, iron and exchangeable cations all help to define and create a clearer picture.

Mass based measurements can be converted to volumetric measures for contractors (e.g. m3) by dividing by bulk density (see NSW Acid Sulfate Soil Manual for further details). Additionally, a measure of moisture content is often required for calculations by an appropriate method such as 2B1 or 2B2 (Rayment and Higginson, 1992) or AS1289 – Methods of testing soils for engineering purposes.

MOISTURE CODES

Code	Symbol & units	Analysis and description
Moisture Content methods from Rayment and Higginson (1992)		
2B1	W_{105} (%)	As received moisture 105°C
Methods to be added to Rayment and Higginson (1992)		
2B2	W_{85} (%)	As received water moisture content 85°C

CALCULATIONS

Sulfide/pyrite assays are used to calculate the maximum acid that can be theoretically generated by the complete oxidation of a sample. For the initial assessment (unless more expensive fractionating analyses are undertaken), it is assumed that all S_{POS} or S_{TOS} sulfur occurs as iron-disulfide (or pyrite) and that the oxidation of this iron-disulfide proceeds according to the complete reaction:

$$FeS_2 + 15/4\ 0_2 + 7/2\ H_2O = Fe(OH)_3 + 4H+ + 2SO_4^{2}-$$

Based on the stoichiometry of this reaction, the maximum amount of acid that could be produced by a sample containing 1 %S as pyrite would be 30.59 kg H_2SO_4/tonne or 623.7 moles H+/tonne of soil. Such a soil, if fully oxidised and unbuffered, would require 31.2 kg of pure fine lime/tonne of soil to neutralise the acidity generated if completely mixed and fully reacted. As even the best grade agricultural fine lime is not pure, a factor to compensate upwards for the neutralising value of the lime needs to be included in calculations. Further details are contained in Chapters 5 and 6 of *ASS Management Guidelines* (Ahern *et al.*, 1998c).

In management plans which involve liming, an engineering safety factor of at least 1.5 -2 times the theoretical lime requirements needs to be used, to allow for the slow reactivity of lime and non homogenous mixing in the field. (Some countries e.g. Canada, insist on a safety factor as high as 3). Table 4 gives some liming rates for soils with increasing sulfide content, and approximate costs of lime for a range of S_{POS}, S_{TOS}, TPA or TSA values.

FIELD PH TESTS

Field pH tests cannot be used as a substitute for laboratory ASS analysis in an EIS. Attempts to use them in an EIS to predict oxidisable sulfur levels and therefore reduce the numbers of laboratory analysis submitted is not acceptable. However, they are a useful additional tool.

I) FIELD PH IN WATER (PH_f)

Field pH tests should be conducted on the soil profile at regular intervals (0.25 m) using a field pH meter with a robust, spear point, double reference pH electrode. If the measured pH of the suspension or soil paste is pH < 4, oxidation of sulfides has probably occurred in the past, indicating that an actual acid sulfate soil (AASS) is present. Low range pH indicator papers or a field pH kit based on the specifications of Ruapach and Tucker (1959) are useful if a pH meter is not available. They are based on pH-dependent indicator solutions displaying a characteristic colour and **may** be subject to interference on some ASS resulting in substantial errors.

II) FIELD PEROXIDE PH TEST (PH_{fox})

Field pH tests do not account for any sulfide present that has not yet been oxidised. To test for sulfides or potential acid sulfate soils (PASS), oxidation of the soil with 30 % hydrogen peroxide (H_2O_2)(**pH adjusted 4.5 - 5.5** with a few drops of 0.1M NaOH) can be performed. Note the peroxide pH should be checked on every new container and also regularly before taking to the field. Analytical grade peroxide is the best to use but the pH may still be as low as 3. Manufacturers stabilise technical grade peroxide with acid and this can lead to pH < 2 and give false results on the field tests. (*Caution: 30 % Hydrogen Peroxide is a strong oxidising agent and should be handled carefully with appropriate eye and skin protection. Inhalation of vapours should be avoided.* ***This test is suitable for experienced operators only***).

The field test can be done with a few mL of peroxide and a small sample of soil in either short clear test tubes (e.g. Falcon 2070 50ml conical tubes) or clear tissue culture clusters. Heating (placing test tube in hot water) or placing in the sun may be necessary to start the reaction on cool days, particularly if the peroxide is cold. When effervescence (sometimes violent) has ceased, continue to add a few mL of peroxide at a time until the reaction appears complete. If the reaction becomes violent diluting with deionised water via a wash bottle is recommended. The test may have to be repeated with a small amount of water added to the soil prior to peroxide addition. Measure the pH_{fox} of the resultant mixture. Care is needed with interpretation of the result on high organic or reactive soils, particularly if manganese is present. In general, positive tests on 'apparently well drained' surface soils should always be treated with caution and followed up with laboratory confirmation.

The above field tests can be made more consistent if a fixed volume of soil (using a small scoop) is used, a consistent volume of peroxide is added, left to react for at least an hour or preferably overnight, then the sample moistened with deionised water before reading pHf and pHfox. However, such procedures take time in the field and are more suited to a 'field shed' situation. The peroxide test is done on two sub-samples from the same depth interval at which the field pH was measured on. **A combination of three factors is considered in arriving at a 'positive field sulfide identification'** (a) a reaction with hydrogen peroxide, (b) a much lower pH_{fox} than field pH_f (▲pH) and (c) the actual value of pH_{fox}.

(a) The **strength of the reaction with peroxide** is a useful indicator but cannot be used alone. Organic matter and other soil constituents such as manganese oxides can also cause a reaction. Care must be exercised in interpreting a reaction on surface soils and high organic matter soils such as peat and some mangrove/estuarine muds and marine clays. This reaction should be rated.

(b) A **pH_{fox} value at least one unit below field pH_f** may indicate a PASS. The greater the difference between the two measurements (▲pH), the more indicative the value is of a PASS. The lower the final pHfox value is, the better the indication of a positive result.

(c) If the **pHfox < 3**, and the other two conditions apply, then it strongly indicates a PASS. The more the pH_{fox} drops below 3, the more positive the presence of sulfides.

- A **pH_{fox} 3-4** is less positive and laboratory analyses are needed to confirm if sulfides are present. (If only low pH peroxide is available, the field test is less discriminatory, particularly for sands because of their low pH buffer capacity. Low analysis sands may give confusing field test results and must be confirmed by laboratory analysis.)
- For **pHfox 4-5** the test is neither positive nor negative. Sulfides **may** be present either in small quantities and be poorly reactive under quick test field conditions or the sample may contain shell/carbonate, which neutralises some or all acid produced by oxidation. Equally the pH_{fox} value may be due to the production of organic acids and there may be no sulfides present in this situation. In such cases, the sulfur trail would be best to check for the presence of oxidisable sulfides.
- For **pH_{fox} >5** and little or no drop in pH from the field value, little net acidifying ability is indicated. (On soils with neutral to alkaline field pH and shell or white concretions present, the fizz test with 1M HCl should be used to test for carbonates). Again the sulfur trail of the POCAS method should be used to check for any oxidisable sulfides.

All pH_f and pH_{fox} results by depth should be tabulated and reported in the ASS report/EIS. Other semi-field tests such as examination under a microscope for pyrite and its reaction with peroxide on the slide may be useful tools to identify pyrite presence, but they require experience and training.

Note: field techniques are useful exploratory tools, but are indicative only and definitely not quantitative. They are not a replacement for quantitative laboratory analyses. The field peroxide test has been found to be least useful on low analyses sands, particularly dredged sands approaching the action limit (0.03 % S). It is also difficult to interpret field tests on high organic or peat soils and coffee rock.

APPENDIX C. LIMING RATES AND SELF-NEUTRALISING SOILS

(from Queensland *Acid Sulfate Soil Technical Manual: Soil Management Guidelines*).

The formula to calculate liming rates is:

$$\%S \times 30.59 \times 1.02 \times 1.5 = \text{kg } CaCO_3\text{/tonne of soil}$$

Note: 30.59 converts to H_2SO_4; 1.02 converts to $CaCO_3$; and 1.5 is the safety factor

To convert units from tonnes to cubic metres, multiply the kg CaCO3/tonne of soil by the bulk density

To change units from %S to mol H+/tonne, multiply the %S by 623.7.

ACID SULFATE SOIL CONVERSION RATES FOR CALCULATING LIMING REQUIREMENTS:

(based on 1 mol sulfides producing 2 mol sulfuric acid)

SELF-NEUTRALISING SOILS

Some ASS are partially or completely 'self-neutralising' due to an abundance of naturally occurring calcium or magnesium carbonates (e.g. crushed shells, skeletons, coral, foraminifera15). The self-neutralising potential of a soil is an environmental safeguard. In calculating the neutralising capacity of these soils, shell size needs to be taken into consideration. The finer the shell, the more reactive. Generally, the neutralising capacity of shells <2 mm is more effective, due to large unit surface area. On larger shells, there will be a smaller unit surface area and hence gypsum and insoluble coatings of iron and aluminium are more likely to retard complete reaction. Laboratory methods can be used to detect the presence of carbonates, however if fine grinding is used during sample preparation, the neutralising component will appear more reactive than it will be in the field for reasons discussed earlier. Shells greater than 2 mm need to be removed prior to analysis. This can be relatively easy for sands, but this may be more difficult for wet clays. If the shells >2 mm can be removed, techniques are available to determine the fine (<2 mm) shell content of soils.

Oxid. Sulfur S%	moles H^+ /kg (S% x 0.6237)	moles H^+ /t or moles H^+ /m^3 (S% x 623.7)	kg H_2SO_4 /tonne or kg H_2SO_4 /m^3 (S% x 30.59)	kg $CaCO_3$/tonne soil or kg $CaCO_3$/ m^3 Safety factor = 1.5
0.01	0.0062	6.237	0.306	0.47
0.03	0.0167	18.71	0.92	1.4
0.05	0.0312	31.19	1.53	2.3
0.06	0.0374	37.43	1.84	2.8
0.1	0.0624	62.37	3.06	4.7
0.2	0.1247	124.7	6.12	9.4
0.3	0.1871	187.1	9.18	14.0
1.0	0.6237	623.7	30.6	46.8
2.0	1.2474	1247	61.2	93.6
3.0	1.8711	1871	91.8	140
5.0	3.119	3119	153.0	234.0

Note: Assumes the bulk density of 1.0 g/cm^3 (1 tonne/m^3); bulk density generally ranges between 0.7 to 2.0, but can be as low as 0.2 for peats. Where bulk density is >1.0 g/cm^3 (1 tonne/m^3), then the correction factor for bulk density will need to be used. This increases lime requirements (e.g. if BD=1.6, then 1 m^3 of soil with 624 moles H^4/tonnes (1.0 %S) will require 75kg lime/m^3 instead of 47kg. Correction factors for lime purity, neutralising value and effective neutralising value may also be required.

These soils may still require the addition of neutralising agents due to the potential for incomplete reaction of shells through either fineness or formation of coatings. The need for additional neutralising agents will need to be assessed on a site-by-site basis. In addition, the once common procedure of determining Acid Neutralising Capacity (ANC) by applying excess mineral acid and back titrating unreacted acid can give an inflated ANC, depending on the method used. As well as the simple net acidity derived from ANC and maximum potential acidity (MPA) the ratio of ANC over MPA is significant. Samples with a ratio of less than 1 are highly likely to be acid-producing. Samples with a ratio of greater than 2 are unlikely to produce acid.

APPENDIX D. TREATMENT PAD DESIGN CONSIDERATIONS

(from Queensland *Acid Sulfate Soil Technical Manual: Soil Management Guidelines*).

GUARD LAYERS

A guard layer of neutralising agent should be spread onto the soil surface of the treatment pad prior to the placement of soils (see Figure 6). This will reduce risk by neutralising acidic leachate generated in the treatment pile and not neutralised during the treatment process. This is especially relevant to the first layer of ASS that is placed for treatment prior to application of the neutralising agent. The guard layer will assist in protecting groundwater quality. To further reduce risk, a layer of compacted non-ASS clayey material (0.3–0.5 m thick) might be placed on the surface of the treatment pad and below the guard layer to restrict infiltration from the material being treated. In fully contained situations a physical barrier may be used as an alternative to a guard layer of neutralising agent as a means of protecting groundwater quality and preventing infiltration of acidic water; e.g. a bunded concrete slab, paved area or layer of bitumen may be placed under a temporary treatment pad.

The guard layer is not a primary means of soil treatment for the following reasons:

- gypsum and insoluble iron and aluminium coatings can form on the neutralising agent placed in the guard layer, which reduces the neutralising capacity of the layer;
- over time, excess water that is passing though the treatment pile may channel its flows through preferred paths, whereby only a fraction of the guard layer is intercepting and neutralising potential acid flows;
- it is difficult to ensure that there has been adequate mixing of the neutralising agent with the soil; and
- the amount of neutralising agent in the guard layer will generally be insufficient to treat all the acidity from the overlying soils placed on the pad.

GUARD LAYER RATE

The rate of neutralising agent used in the guard layer (per square metre) should be based on 0.2 times the average of the potential and existing acidity for every metre depth of the soil to be treated (i.e. if 2 metres of soil are to be treated in the treatment pad, then twice 0.2 times the neutralising agent required to neutralise the acidity should be spread as a guard layer). The safety factor of 1.5 to 2 is recommended for all guard layers. The safety factor may need to be increased for sands and for treatment pads that are adjacent to environmentally sensitive areas.

For example:

- SCR = 1.9%
- TAA = 125 mol H+/tonne
- Existing + Potential Acidity = (125÷623.7) + 1.9 = 2.1%
- 0.2 times the average of the potential and existing acidity = 0.2 x 2.1% = 0.42 %S
- Depth of soil on treatment pad = 2 m
- The situation would require 39 kg CaCO3/m^2 of soil as the guard layer for 2m (vertical) of fill

In all cases a minimum of 5 kg fine aglime per m^2 per vertical metre of fill should be used in the guard layer. See the Queensland *Laboratory Methods Guidelines* for information about determining existing and potential acidity.

The guard layer should be employed as a precaution to neutralise acidity that has not been adequately treated during the soil neutralisation process. The rate of neutralising agent used in the guard layer will depend on the final treatment pile height, existing and potential acidity of the sediments, and the soil texture. The rate may need to be increased where the receiving environmental values warrant higher protection. The rate may also need to be increased to enable a neutralising agent to be incorporated in situations where significant delays occur in drying soils due to soil texture or climatic conditions.

Note: Reapplication of the guard layer may be necessary under temporary treatment pads, if the guard layer is disturbed or removed with the treated soil.

SOIL TREATMENT

Soils may be neutralised on a temporary treatment pad or alternatively the soils may be neutralised as they are placed permanently. Essentially, treatment of the soils is the same process whether it is performed on a temporary treatment pad, or on a treatment pad in their permanent location. Treating soils on a temporary treatment pad may promote better mixing of the neutralising agent with the soil as the soils and agent may be further mixed as they are moved. However, there is the added expense of double-handling of the soil.

DEPTH OF SOIL

If wet materials are being placed, shrinkage may be allowed for. To allow for shrinkage, layers of greater depth may be initially placed.
Ultimately it is up to the contractor to ensure that they have appropriate equipment to incorporate the neutralising agent to the depth of fill.

Acid sulfate soil material should be placed on top of the guard layer in 150 to 300 mm-thick layers on the treatment pad, to allow drying. The appropriate amount of neutralising agent, including the calculated safety factor should be spread once the ASS are sufficiently dry. The ASS may require reworking several times to achieve adequate mixing of the neutralising agent and/or drying of the soil. The treated layer will require Phase 3 sampling (i.e. verification analysis) to confirm whether appropriate amounts of the neutralising agent have been incorporated into the soil, which should be subsequently compacted before treatment of the next layer commences, or when moved to the permanent placement area if initially mixed on temporary treatment pads.

Guard layers may need to be applied between each compacted ASS layer as a precaution in environmentally sensitive areas, areas with high levels of sulfides or where soils are difficult to mix.

EARTHWORKS STRATEGY

An earthworks strategy should be formulated to ensure that sufficient space is available to accommodate the number of treatment pads required to allow adequate drying and treatment of the ASS. Expected rates of throughput in m^3, drying, mixing and compaction times along with the capacity of the treatment pads to accept the materials, need to be identified in any strategy. The earthworks strategy should also ensure that adequate time is available to obtain the results of Phase 3 testing (i.e. verification testing) before treatment of the next layer begins. Climate, seasonal conditions, and soil texture may affect drying and treatment rates and hence the size of treatment pads required.

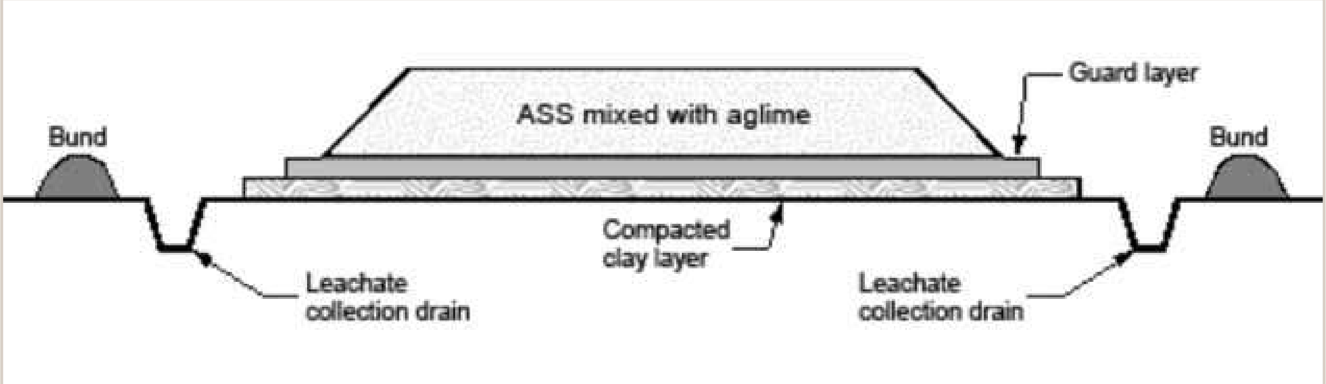

Figure 6. Schematic cross-section of a treatment pafe, including compacted clay layer, guard layer, leachate collection system and containment with bunding.

CONTAINMENT

Stormwater runoff should be contained within treatment pads by appropriate bunds and may be collected in a sump. Diversion drains should be installed to prevent stormwater run-on into the treatment pad. Surface liming of earth bunds and diversion drains can assist with neutralising any acidic stormwater. Bunds and diversion drains should not be constructed out of untreated ASS or other materials that may be a source of contaminants to the environment. The materials used should have an appropriately low permeability to avoid leakage.

SPATIAL TRACKING

The accurate spatial tracking of large volumes of ASS during the neutralisation process (e.g. survey with a hand-held Global Positioning System (GPS), differential GPS, designated lot numbers or conventional survey, depending on the level of accuracy required), is essential to ensure that initial soil testing can be correlated with prescribed treatment and any required Phase 3 sampling (i.e. verification testing). Some sites may have difficulty developing an appropriate tracking program, due to spatial constraints. In such situations, alternative management and treatment facilities should be developed.

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CONTACT DETAILS

Sustainable Land Use
Department of Primary Industries and Water

GPO Box 44
HOBART TAS 7001
Ph. 03 6233 6212
Fax. 03 6223 8603
www.dpipwe.tas.gov.au

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