



22 July 2015

ABBOT POINT GROWTH GATEWAY PROJECT

Preliminary Acid Sulfate Soil Management Plan

Submitted to:
Department of State Development

ASSMP



Report Number. 1525905-054-R-Rev0

Distribution:

1 x PDF





Record of Issue

Company	Client Contact	Version	Date Issued	Method of Delivery
Department of State Development	Project Manager	Rev A	16/7/2015	Electronic
Department of State Development	Project Manager	Rev 0	22/7/2015	Electronic



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1.0 INTRODUCTION

This Acid Sulfate Soil (ASS) Management Plan (ASSMP) has been developed for the Abbot Point Growth Gateway Project at the port of Abbot Point, Queensland. The various phases of the project include:

- Dredged Material Containment Ponds (DMCP) Construction
- Dredging including placement of dredged material in the DMCP and returning seawater back the ocean
- Management of dredged material within the ponds post dredging
- Management for reuse

Acid Sulfate Soil (ASS) is a general term applying to both a soil horizon that contains sulfides (i.e. Potential Acid Sulfate Soil - PASS) and an acid soil horizon affected by oxidation of sulfides (i.e. Actual Acid Sulfate Soil - AASS). ASS may be peats, silts, clays, or sands.

The ASSMP has been based on available soils and water quality investigations previously completed for offshore works at Abbot Point and the results of recently completed ASS investigations across the DMCP footprint. The Procedures contained within this ASSMP should be updated and revised to address conditions encountered that vary from those indicated by investigations or where alternative construction methodologies are adopted.

The ASSMP was prepared with consideration of the following documents:

- *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0*, 2014. Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. Department of Science, Information Technology, Innovation and the Arts, Queensland Government;
- *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland*, 1998; Ahern, CR., Ahern, M.R. and Powell;
- State Planning Policy, July 2014
- State Planning Policy – state interest guideline, Water quality, August 2014
- Environmental Protection Act 1994; and
- Environmental Protection Policy (Water) 2009

The purpose of the ASSMP is to mitigate or control potential impacts relating to:

- Earthworks and construction of the proposed DMCP
- On-shore placement of dredged material associated with the proposed Terminal 0 (T0) capital dredging at the port of Abbot Point

2.0 PROJECT OVERVIEW

The proposed capital dredging of approximately 1,100,000 m³ in-situ material for the expansion of T0 at Abbot Point is expected to result in approximately 2.4 million m³ (bulked volume) of dredged material. Onshore disposal of dredged material will require the construction of the DMCP to hold the dredged material and to manage seawater received as part of the dredging process to a standard where it can be returned back to the ocean in accordance with approval conditions.

The DMCP has a surface area of approximately 630,000 m² and approximately 5.2 km of perimeter embankments. The floor of the DMCP will have a surface level of about 2.84 m AHD. The average thickness of dredged material to be placed across the DMCP is about 4m. It is expected that the DMCP will have an internal bund dividing the DCMP into a primary and secondary pond to assist in the settlement of sediment. Dredging discharge will occur into the primary pond resulting in the containment of coarser sediments, captured fines in the coarse matrix, and clay “balls” whilst finer sediments will be predominantly flushed into the secondary pond.



Following the completion of dredging the dredged material may be beneficially re-used as part of future port developments. This may either be by using the material within the T2 site and adjacent industrial land (e.g. to raise the level of the land), construction over the reclaimed areas or by excavation and reuse of the material at other locations within the port (e.g. for use as general or construction fill).

3.0 DMCP SITE

3.1 Topography

The proposed DMCP site is bordered by the existing Abbot Point Coal Terminal settlement pond to the north, beyond which is Bald Hill and then Dingo Beach and the Pacific Ocean. West and south of the site are the Caley Valley wetlands. The Abbot Point Coal Terminal is to the east.

The majority of the proposed DMCP site is located on a relatively level “terrace” area which is about 1m to 2m higher than the surface levels in the Caley Valley wetlands. From the middle of the site, there is a gentle slope from the south to the north ranging in elevation from approximately 5.2 m AHD to 3.0 m AHD.

3.2 Geology

The 1:250,000 scale Geological Map of the Ayr region indicates that the site is underlain primarily by Quaternary coastal dunes and sand plains (Qr) derived primarily from wind action (aeolian). To the south and south west of the site (Caley Valley Wetland) the geology is comprised of Quaternary age marine coastal mud flats (Qm) comprising clay, silt, sand, estuarine and deltaic deposits.

Near surface Quaternary aged sediments have been deposited in recent geological time (0 – 2 Myr). Quaternary materials can be subdivided into recent Holocene materials (<10 kyr) which are typically loose, or soft normally consolidated materials that are deposited above Pleistocene soils (10 kyr – 2 Myr) which are stiffer, or denser over consolidated materials. The latter were deposited during sea level conditions which oscillated around 120 m below present levels.

Sub-types of Quaternary soils may also be classified by their depositional environment such as marine, estuarine, alluvial or colluvial soils. Other Quaternary aged soils include *in-situ* residual soils which are a remnant weathering product derived from the underlying rock.

3.3 Previous Investigations

In 2009, a detailed ASS investigation was undertaken by Aurecon Hatch on behalf of Ports Corporation Queensland (PCQ) for the Abbot Point Coal Terminal upgrade works (X80/X100 expansion). This investigation covered portions of and areas adjacent to the current subject site. The investigation was limited to 4 m below ground level (bgl) at all locations. The findings of the Aurecon Hatch report indicated the following:

- The area had not previously been mapped by QASSIT for AASS or PASS.
- Ground conditions across the X80/X100 expansion area generally encountered alluvial sandy clays and clayey sands interbedded with sands to depths of at least 4 m bgl.
- Field pH screening results indicated that AASS were not present under the X80/X100 expansion area within the samples collected. Field screening results indicated the possible presence of PASS in the soil profile along the margin of the Caley Valley wetland, generally greater than 3 m below the existing ground surface. Field screening results did not indicate the possible presence of PASS over the remainder of the more elevated terrace area.
- Soil laboratory results were consistent with the field screening and confirmed the absence of AASS in the samples analysed, the presence of PASS in the soil profile below 3 m in the soil profile along the margin of the Caley Valley wetland, and the absence of PASS across the terrace areas to depths of at least 4 m bgl. Lime neutralisation treatment rates for identified PASS ranged from 1 kg/m³ to >25 kg/m³.



- Locations where PASS was identified are situated outside of the proposed DMCP footprint.

The Aurecon Hatch report also referenced an earlier preliminary ASS investigation of the Stage 3 Expansion by WBM Pty Ltd (WBM) in 2005. The WBM investigation involved sampling to maximum depths of 1.3m at 20 locations and confirmed the absence of PASS over that shallow depth range.

3.4 Ground Conditions

An ASS investigation was undertaken across the proposed DMCP site by Golder between 19 and 24 May 2015). The investigation comprised 25 boreholes to depths of up to 5m depth across the footprint of the pond area including a series of locations spaced at about 100m intervals along the south-western footprint boundary (i.e., closest to the Caley Valley wetland) where the highest risk of encountering ASS was expected due to water level fluctuation associated with the wetland.

The results from this investigation confirmed the absence of AASS and PASS within the upper 5m across the proposed DMCP site. Excavation below this depth is not proposed. The materials to be excavated are considered suitable for excavation and reuse without ASS restriction / management requirements.

3.5 Groundwater

Six shallow groundwater monitoring wells were installed across the DMCP footprint during recent ASS investigations by Golder Associates.

Groundwater sampling conducted during the ASS investigation generally indicates a relatively stable and neutral environment with a high buffering capacity. Test results do not indicate that groundwater has been affected by historical oxidation of sulphides; although relatively high levels of aluminium and iron were detected in some groundwater samples. Dewatering groundwater from the DMCP footprint will not be required to construct the DMCP and therefore monitoring and possible treatment of groundwater is not required during construction.

4.0 DREDGED MATERIALS

GHD (2012) conducted ASS analysis on samples collected from 69 locations across the proposed T0, T2 and T3 dredging areas. A total of 12 of these locations are within the T0 dredging area (the subject of this plan) however samples from the adjacent T2 and T3 sites are considered representative of the T0 dredged material due to their proximity and similarity of soil characteristics.

The GHD (2012) investigation across all the dredging areas were relatively consistent and generally indicated the following:

- Soil profiles across the areas to be dredged is generally comprised of about 2m of marine sediments (loose/soft sands, clayey sands and sandy clays) overlying alluvial deposits of firm to very stiff sandy clays.
- Laboratory tests on recovered samples indicated that the marine sediments were PASS with a natural neutralising capacity greater than the acid generating capacity, likely due to the presence of shell and other calcareous materials throughout the sediment. This suggests that these marine sediments are “self-neutralising”.
- Laboratory tests on recovered samples indicated that the underlying firm to very stiff alluvial deposits are not acid sulfate soils. ASS management measures are not required for these materials.

GHD (2011) conducted offshore geotechnical investigations for a proposed Multi Cargo Facility (MCF) about 3 km east of the T0 dredging area. This investigation encountered a similar surface layer of marine sediments and these samples may also be considered representative of the material to be dredged. Again ASS testing on the marine sediments from the MCF indicated that these were self-neutralising PASS.

Whilst the investigation conducted across the T0 dredging area does not meet spatial requirements of QASSIT, relatively homogenous conditions (across the T0, T2 and T3 dredging area) were encountered and the findings are considered to be suitable to develop an ASSMP for the project.



The available ASS investigation results indicate that the marine sediments offshore of Abbot Point are self-neutralising. The combination of the acid generating potential and the volume of material to be dredged places this project in the extra high treatment level category (*Soil Management Guideline, 2014*).

This Preliminary Acid Sulfate Soil Management Plan outlines management measures including additional sampling and analysis of dredged material and associated water, and describes contingency options to be considered for neutralisation treatment, if required.

In developing this Preliminary ASSMP the potential for overstated available neutralising capacity has been considered, including the following:

- The marine sediments are saturated and / or have very high moisture contents with saltwater filling the pore spaces between the soil particles. The saltwater provides some buffering capacity which may overstate the available neutralising capacity indicated by laboratory tests, in the very long term as the saltwater will leach out of placed dredge materials.
- As part of the laboratory testing process for ASS, samples are dried and ground. If large particles of shell and coral are not removed prior to grinding, the available neutralising capacity may be overstated as, in the field, these large particles would develop a gypsum coating in the presence of acid and are not a fully available neutralising source.

During operation of the DMCP, placement and associated particle size segregation and subsequent remixing of dredged material will be dependent on the methods and equipment in use by the contractor. This ASSMP has considered the effects of:

- Segregation of dredged material due to the predominantly coarser particles (with minor trapped fines) dropping out of suspension close to the dredge material discharge location within the primary pond. These materials may form 'beaches' close to the discharge point, with the sediment size tapering to finer materials away from the discharge.
- Shell material is also expected to be deposited non-uniformly due to particle size and density.
- The secondary pond is expected to capture the finer particles. It is possible that these fine particles may not have the same neutralising capacity as indicated from offshore sampling and represent the highest risk of producing "pockets" of PASS that may generate future unbuffered acidity when dried.

The risk of dredged materials generating acid (should PASS be present) under saturated conditions during placement is very low as the presence of sufficient oxygen is required to result in acid generation.

5.0 MITIGATION STRATEGIES AND CONTINGENCY OPTIONS

Potential environmental considerations associated with ASS disturbance or onshore placement of dredged material are summarised in Table 1 below. Also included are proposed management strategies and contingency options that may be used individually or in combination to mitigate potential impacts if required.



PRELIMINARY ASSMP - ABBOT POINT GROWTH GATEWAY

Table 1: Summary of mitigation strategies and contingency options based on expected behaviour of ASS Material

Activity	Issue	Expected Behaviour of ASS Material	Perceived Level of Impact to the Environment	Mitigation Strategies	Contingency Options
DMCP Construction	Suspected ASS materials are encountered during DMCP excavation works	No ASS materials or conditions where ASS may be expected have been encountered during investigations across the DMCP footprint.	Negligible to low potential for environmental impact.	Construction inductions to include training on the identification of possible ASS materials. Testing of possible ASS materials observed during construction.	Lime neutralisation treatment of any confirmed ASS.
Off-shore marine sediments during dredging	Aeration of ASS materials during dredging operations.	Marine sediments which are disturbed during the dredging activities but not recovered for onshore disposal will remain saturated and will not oxidise. Therefore these residual materials will not generate acid and do not represent a risk to the marine environment.	Negligible to low potential for environmental impact.	Water quality monitoring as outlined in separate Dredging Management Plan	Not required
Dredged Material Placement in the DMCP	Acid generation from dredged material and release to soil and groundwater. Release of acidic and/or metals impacted tailwater through return water outflow.	As dredged material is placed in the DMCP, the dredge contractor will manage supernatant water within the DMCP to maximise settling of suspended sediments to ensure return water quality objectives can be met. Accordingly, the dredged material will generally remain saturated and these saturated conditions represent a low potential for acid generation. The groundwater investigations indicate that the groundwater in the vicinity of the DMCP is alkaline, contributing to additional buffering capacity. The active operation of the DMCP during dredging may result in temporarily exposed beaches of coarse dredged material (e.g. in the Primary pond) where PASS, if present, could oxidise and generate acidity. However, the presence of shell material and seawater is expected to continue to provide substantial buffering capacity and would rapidly neutralise this acid, if generated.	Testing to date indicates that the ASS materials to be dredged are “self-neutralising”. There is a low to moderate potential for these materials to generate excess acidity. There is a low potential for ASS materials to generate acid during the placement works whilst they remain saturated with sea water. Low to moderate potential for environmental impact	Laboratory testing of historical vibrocore samples from the Multi Cargo Facility offshore investigations (GHD 2011). Strategies to be reviewed and updated if self-neutralising ASS is not confirmed. Lime guard layer to be placed over the base of the secondary pond. Phased characterisation/verification testing of placed dredged materials, by visual identification, field screening and subsequent laboratory testing, if warranted. Initial focus on fine materials segregated during placement. Strategies to be reviewed and updated if a higher level of risk is indicated. Groundwater quality monitoring surrounding the ponds. Tailwater monitoring and management.	Lime dosing during placement or lime treatment post placement. Treatment of tailwater prior to discharge.



PRELIMINARY ASSMP - ABBOT POINT GROWTH GATEWAY

Activity	Issue	Expected Behaviour of ASS Material	Perceived Level of Impact to the Environment	Mitigation Strategies	Contingency Options
<p>Dredged Material in the DMCP, Post – Dredging</p>	<p>Acid generation from dredged material and release to soil and groundwater.</p> <p>Acid generation from dredged material and release to soil and surface water from the final landform.</p>	<p>The fine particles that settle in the secondary pond may not have the same neutralising capacity as indicated from offshore sampling and represent a potential to produce “pockets” of PASS that may generate future unbuffered acidity when dried</p> <p>Post-dredging, the dredged material may remain in the DMCP for some time. Over time, the fine dredged material in the secondary pond will be subject to both drainage and surface evaporation, resulting in a caked crust which will crack and provide oxidized conditions around the cracks. Where PASS is present, this can result in acid formation in these exposed materials which may be mobilised by rainfall and require surface runoff to be treated. Deeper materials (at least the bottom 2m) are expected to remain saturated for at least several years and are unlikely to generate acid, where PASS is present, within this time frame.</p> <p>Post-dredging, where acid is leached through the soil, it can strip heavy metals from the soils and could result in groundwater impacts. The presence of saltwater in the underlying saturated dredge materials will initially contribute to buffering this acid. However, seasonal rainfall and continuous drainage conditions will eventually leach the saltwater from these soils and the buffering capacity will be progressively reduced at rates that are difficult to predict. Additionally, the groundwater beneath the DMCP has significant buffering capacity and is expected to neutralise incidental acid leaching and precipitate metals from solution. It is not intended that saltwater and/or groundwater buffering capacities would be relied upon as the primary neutralisation mechanisms.</p>	<p>Testing to date indicates that the ASS materials to be dredged are “self-neutralising” and groundwater is alkaline. There is a low to moderate potential for these materials to generate excess acidity, varying with time and location within the pond. Oxidised soil that has been “flushed” with rainwater has a higher potential to generate acidity.</p> <p>Low to moderate potential for environmental impact</p>	<p>Characterisation/verification testing of placed dredged materials.</p> <p>Lime guard layer to be placed over the base of the secondary pond to address potential acid leaching and to precipitate metals from solution, if acid conditions occur.</p> <p>Placement of crushed limestone at surface water discharge points and monitoring of water quality at these locations.</p> <p>Groundwater quality monitoring surrounding the ponds.</p>	<p>In-DMCP treatment by lime addition and mixing</p> <p>Excavation and treatment within the DMCP; redistribution and mixing</p> <p>Excavation and treatment external to the DMCP; redistribution and mixing</p> <p>Limed trench at relevant sections of embankments</p> <p>Treatment of surface water runoff from the DMCP using lime dosing.</p>



PRELIMINARY ASSMP - ABBOT POINT GROWTH GATEWAY

Activity	Issue	Expected Behaviour of ASS Material	Perceived Level of Impact to the Environment	Mitigation Strategies	Contingency Options
Removal of Dredged Material for Re-use	Acid generation from dredged material and release to soil and groundwater.	Future removal of dredged material from the DMCP for reuse will result in aeration of these materials and could result in acid generation from untreated PASS materials, if present, in their final placement location.	Testing to date indicates that the ASS materials to be dredged are “self-neutralising”. There is a low to moderate potential for these materials to generate excess acidity. Low to moderate potential for environmental impact.	Characterisation/verification testing of placed dredged materials to confirm non-ASS, or treatment of ASS prior to removal, if necessary.	In-DMCP treatment prior to removal. Adopt management and treatment measures at placement site.



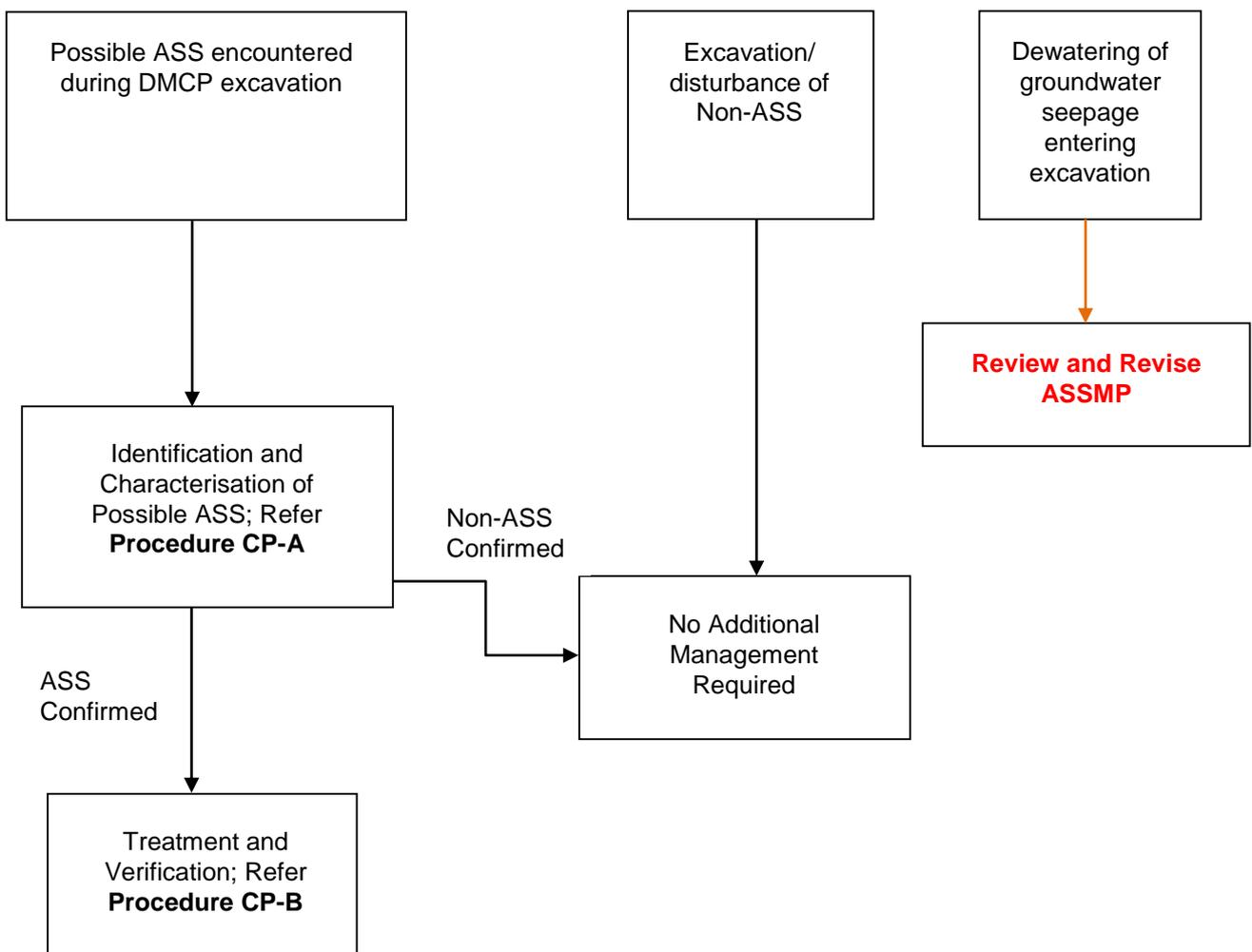
6.0 MANAGEMENT PROCEDURES

The following provides representative management procedures related to phases of activity by use of a visual summary of the mitigation strategies and contingency options identified for the ASS materials in the DMCP. These procedures will be reviewed and revised as the project matures and additional information becomes available.

6.1 DMCP Construction

Flow Chart 1 summarises the mitigation strategies, including contingency options for identified ASS materials underlying the DMCP.

Flow Chart 1: Summary of DMCP Construction ASS Management



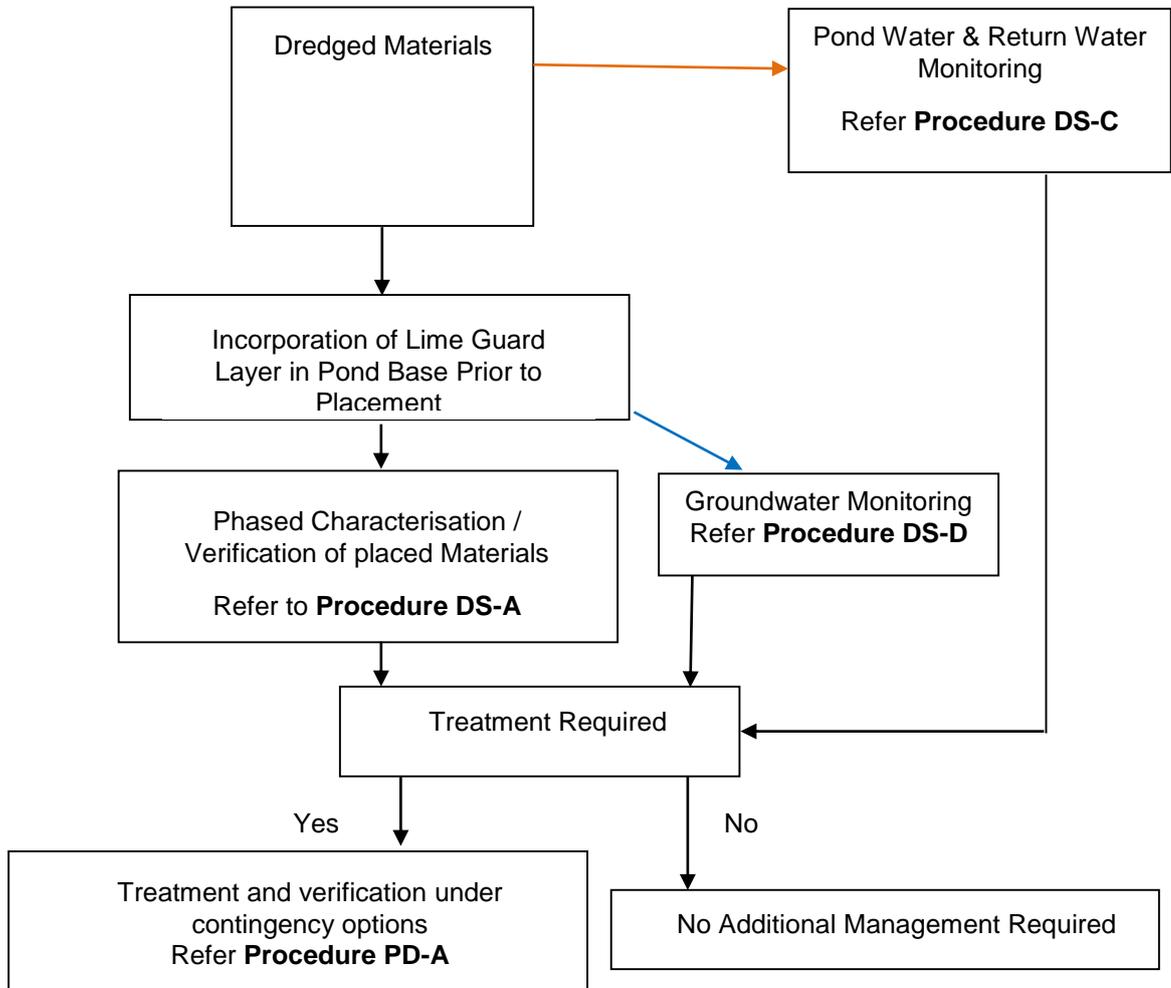
The management procedures and contingency measures to address the unexpected discovery of ASS during DMCP construction are presented in Appendix A.



6.2 Dredged Material

Flow Chart 2 summarises the mitigation strategies, including contingency options, for dredged materials to be placed on shore during dredging operations.

Flow Chart 2: Summary of Dredged Material ASS Management



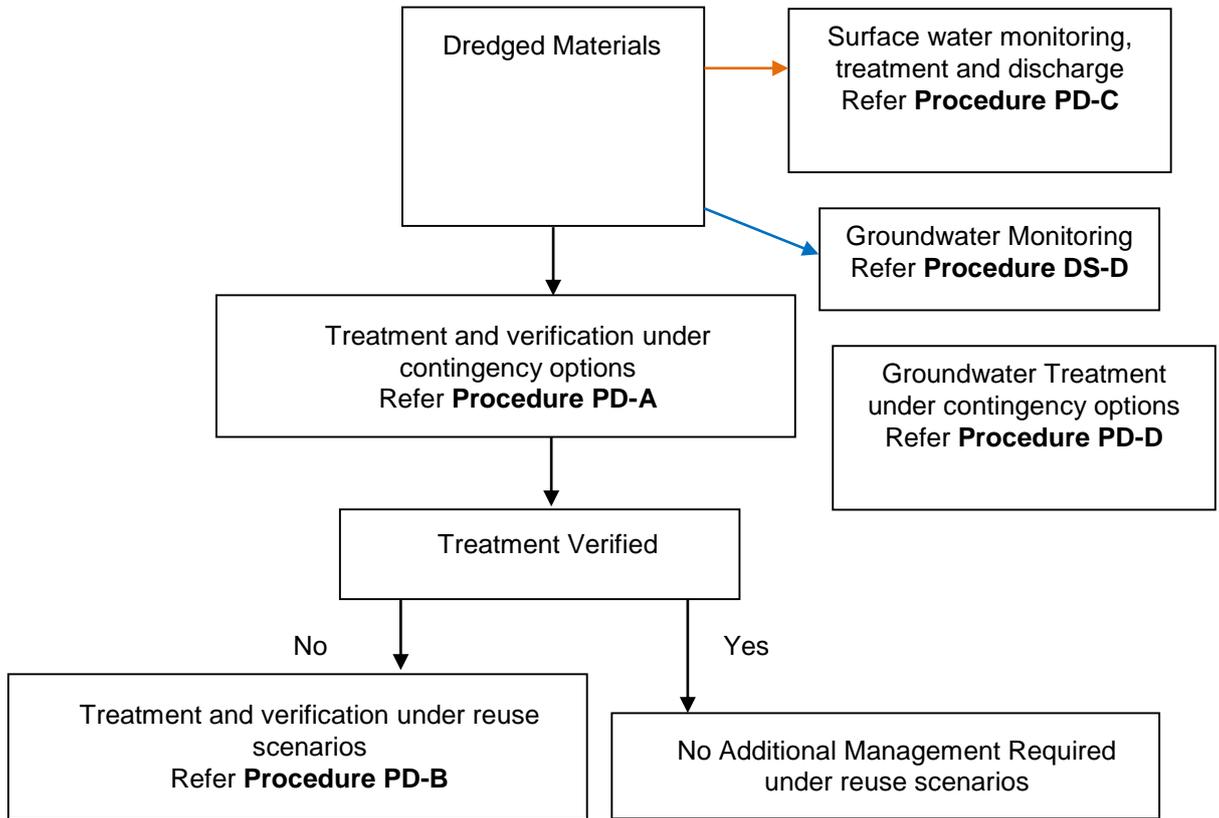
The management procedures and contingency options to address characterisation / verification of dredged ASS are presented in Appendix B.



6.3 Post Dredged Material Placement/Reuse

Flow Chart 3 summarises the mitigation strategies, including contingency options, for dredged materials post placement in the DMCP and during reuse, if necessary.

Flow Chart 3: Summary of Post Dredged Material Placement/Reuse Management



The management procedures and contingency options to address post dredging monitoring and management of dredged ASS are presented in Appendix C.



7.0 RESPONSIBILITIES

This section outlines the responsibilities to manage, document and report on ASS issues for the project.

- The *Site Manager* is responsible for ensuring that all requirements of the ASSMP are met during the project.
- The *Site Foreman* is responsible for ensuring the strategies and procedures prescribed in the ASSMP are implemented at the site in accordance with the specified performance criteria.
- The *Environmental Manager* is responsible for reviewing compliance with the ASSMP and development of actions to address non-conformance.
- All other site personnel are responsible for implementing strategies and procedures prescribed in the ASSMP, as applicable to their work activities.

8.0 NON-CONFORMANCE AND CORRECTIVE ACTION

Any non-conformance to the ASSMP must be addressed as soon as is practical. The personnel responsible for the non-conformance must be notified immediately for purposes of issuing rectification instructions.

9.0 AUDITING

The Environmental Manager will be responsible for ensuring that an auditing program is implemented for construction and treatment works. The audit program shall aim to ensure compliance with the ASSMP and relevant statutory requirements.

The Environmental Manager shall appoint an experienced ASS practitioner to conduct regular auditing of activities and ASS management measures. Given the expected construction period a weekly, auditing schedule is recommended. The frequency of these audits may gradually decrease if a high level of compliance with the ASSMP is evident.

The audit shall take the form of a visual inspection of the works and treatment sites and associated control measures and a review of monitoring data. A written record of auditing undertaken shall be maintained, including details on the date of the audit, activities undertaken, observations made and any non-conformances identified. A copy of the audit report shall be forwarded to the Environmental Manager within 2 days of the audit.

10.0 COMMUNITY RELATIONS

Concerns or complaints raised by the community (or other parties) in relation to ASS will be directed to the Environmental Manager for action.

The Environmental Manager shall maintain a concern register recording the following information:

- 1) Details: Name, address and phone number of party raising the concern.
- 2) Nature of concern: Detail of issue, date of incident, people involved, and location.
- 3) Action taken or required: Any action proposed or undertaken to address the concern, including time and date.
- 4) Response to action: Was the complainant satisfied with the outcome of the actions taken, if not, what else needs to be done, or is it outside the scope of the development works.
- 5) Prevention or re-occurrence: What action has been taken by the nominated responsible person to ensure the problem will not re-occur.



11.0 TRAINING

All equipment operators, supervisors and subcontractors engaged in excavation works shall participate in induction training for ASS. This training will include basic recognition and identification of ASS, plus an outline of the requirements of the ASSMP. The Site Foreman shall verify attendance at induction training prior to commencement of site works.

12.0 REFERENCES

Geotechnical Investigation Report Abbot Point Bulk Coal Terminal X80/X110 Expansion, Ports Corporation of Queensland, Connell Hatch 2009.

Acid Sulfate Soil Investigation Report and Management Plan Abbot Point Coal Terminal - X80 and X110 Ports Corporation of Queensland, Connell Hatch May 2009.

Abbot Point, Terminals 0, 2 and 3 Capital Dredging Sediment Sampling and Analysis Plan Implementation Report, GHD July 2012.

Report No. 41-23408-C-RP-003 Rev. 2, North Queensland Bulk Ports Corporation, Abbot Point Multi Cargo Facility Offshore Geotechnical Investigations, Factual Geotechnical Report, May 2012

Geotechnical Investigation Factual report, Abbot Point Offshore Geotechnical Investigation - Fieldwork Report, Golder Associates 2012.



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APPENDIX A

Acid Sulfate Soil Management Procedures – DMCP

Procedure CP-A: Identification and Characterisation of Possible ASS

Procedure CP-B: Treatment and Verification of Identified ASS



CP-A1. GENERAL

The procedure outlined below is provided for the identification and characterisation of possible ASS materials encountered during DMCP construction works.

CP-A2. OBJECTIVES

- Correct identification of ASS materials.
- Comply with conditions of licences, permits or other approvals issued for the project.

CP-A3. STATUTORY REQUIREMENTS AND GUIDELINES

- 1) *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0, 2014. Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. Department of Science, Information Technology, Innovation and the Arts, Queensland Government;*
- 2) *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland, 1998; Ahern, CR., Ahern, M.R. and Powell;*
- 3) *Environmental Protection Act 1994;*
- 4) *Environmental Protection Policy (Water) 2009*

CP-A4. IDENTIFICATION OF ASS

Where suspected ASS is encountered during excavation works, this procedure shall be used to characterise such materials.

Acid Sulfate Soil (ASS) is a general term applying to both a soil horizon that contains sulfides (i.e. Potential Acid Sulfate Soil - PASS) and an acid soil horizon affected by oxidation of sulfides (i.e. Actual Acid Sulfate Soil - AASS). ASS may be peats, silts, clays, or sands.

A suspect PASS material will typically have one or more of these indicators –

- Dark coloured soils (particularly dark grey or black soils).
- Wet (saturated sand or clay) located below the groundwater table.
- Soft clay or loose sand (stiff or very dense materials will not be PASS)
- A sulfurous smell e.g. hydrogen sulfide or 'rotten egg' gas

A suspect AASS material will typically have one or more of these indicators –

- pH of <4.5
- Presence of a yellow and/or red mottling (jarosite/iron oxide)
- A sulfurous smell e.g. hydrogen sulfide or 'rotten egg' gas

Visual examples of PASS and AASS materials are shown on Plates 1 and 2, respectively.



Plate 1 - Potential Acid Sulfate Soils



Plate 2 - Actual Acid Sulfate Soils

CP-A5. MANAGEMENT MEASURES

Training – Equipment operators and supervisors shall be trained in the basic recognition of ASS as part of a site induction presentation. An experienced ASS practitioner shall be appointed to conduct site inspections and assist in the identification of ASS on an ‘as required’ basis.

Soil Handling – Where possible ASS is encountered, this material must be excavated separately and segregated from non-ASS materials. An experienced ASS practitioner will attend site to provide additional guidance on possible ASS on an as required basis.

Field Screening – Where suspected ASS is encountered a field test (pH_f and pH_{ox}) shall be conducted to provide an initial assessment of the materials. Field screening tests shall be conducted at a minimum rate of one per 100 m³ (or part thereof) and on each suspected material encountered.

If field screening tests show strong indicators of ASS, the suspect materials shall be transported directly to a treatment area and measures described in Procedure CP-B shall be followed.

If field tests show low or moderate indicators of ASS, then this material shall be excavated and separately stockpiled within a bunded area until confirmatory tests have been completed.

Confirmatory tests shall comprise sample analysis for the Chromium Suite of tests. Materials returning net acidity less than 0.03%S shall be removed from the stockpile area and used without further acid sulfate management. Where net acidity greater than 0.03%S is found, the materials shall be transported directly to a treatment area and measures described in Procedure CP-B shall be followed.

Guidance on interpreting Field Screening Tests is provided below:

A pH_f of less than 4 is likely to indicate the presence of AASS.

A combination of three indicators is considered in arriving at a ‘positive field sulfide identification’ (i.e. the presence of PASS):

- A reaction with hydrogen peroxide - the strength of the reaction with peroxide is a useful indicator but cannot be used alone. Organic matter, coffee rock and other soil constituents such as manganese oxides can also cause a reaction. Care should be exercised in interpreting a reaction on surface soils and high organic matter soils such as peats and coffee rock and some mangrove/estuarine muds and



PROCEDURE CP-A Identification and Characterisation of Possible ASS

marine clays. This reaction should be rated, e.g. L = Low reaction, M = Medium reaction, H = High reaction, X = Extreme reaction, V = volcanic reaction.

- The actual value of pH_{FOX} . - If $pH_{FOX} < 3$, and a significant reaction occurred, then it strongly indicates a PASS. The more the pH_{FOX} drops below 3, the more positive the presence of inorganic sulfides.
- A much lower pH_{FOX} than field pH_F - The lower the final pH_{FOX} value and the greater the difference between the pH_{FOX} compared to the pH_F , the more indicative of the presence of PASS. This difference may not be as great if starting with an already very acid pH_F (close to 4), but if the starting pH is neutral or alkaline then a larger change in pH should be expected. Where fine shell, coral or carbonate is present the change in pH may not be as large due to buffering. The 'fizz test' (effervescence with 1 M HCl) should be used to test for carbonates and shell.

Of these three factors, the final pH_{FOX} value is the most conclusive. The following interpretation shall be adopted for field screening tests:

- Strong Indicator of PASS – All three indicators present ($pH_{FOX} < 3$; M to H reaction, $pH_F - pH_{FOX} > 3$)
- Moderate Indicator of PASS – $pH_{FOX} > 3$ and the remaining two indicators are positive
- Low Indicator of PASS – $pH_{FOX} > 3$ and one or none of the remaining indicators are positive

CP-A6. MONITORING AND REPORTING

The Site Foreman or their delegated representative shall keep a record of all equipment operators and supervisors who are trained in the basic recognition of ASS as part of induction training.

The Site Foreman shall maintain a register of test results and a record of inspections.



PROCEDURE CP-B Treatment and Verification of Identified ASS

CP-B1. GENERAL

The procedures outlined below are provided as a **contingency measure** for the on-site treatment and verification of ASS materials, if identified during DMCP construction.

CP-B2. OBJECTIVES

- Appropriately treat and manage excavated ASS materials so as to minimise adverse effects on the natural and built environment (including infrastructure).
- Comply with conditions of licences, permits or other approvals issued for the project.

CP-B3. STATUTORY REQUIREMENTS AND GUIDELINES

- 1) *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0, 2014. Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. Department of Science, Information Technology, Innovation and the Arts, Queensland Government;*
- 2) *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland, 1998; Ahern, CR., Ahern, M.R. and Powell;*
- 3) *Environmental Protection Act 1994;*
- 4) *Environmental Protection Policy (Water) 2009*

CP-B4. TREATMENT MEASURES

CP-B4 (a) Stockpiling of Identified ASS

Stockpiling and treatment of excavated ASS materials shall only be conducted within the site of works of the DMCP.

CP-B4 (b) Treatment Facility

A treatment facility shall be constructed within the DMCP area in general accordance with the requirement detailed in *Soil Management Guidelines, 2014* (refer Figure CP-B1) and the following additional requirements:

- The treatment area shall be prepared by stripping vegetation, topsoil and soil containing significant amounts of organic material and compacting the surface with a smooth drum roller. An area of at least 2 m width shall be left between the treatment areas and bunds to allow collection of runoff and direction to sumps.
- A guard layer of fine ground agricultural lime shall be applied to the treatment areas prior to placement of soils at a rate 5 kg/m² for each 1m height of soil to be treated.

The treatment facility shall be inspected on a daily basis and maintained to prevent escape of soils or water from the facility.



PROCEDURE CP-B Treatment and Verification of Identified ASS

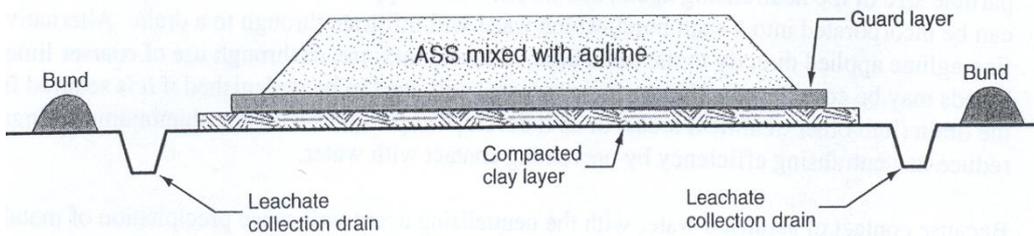


Figure CP-B1: Schematic cross-section of a treatment pad, including a compacted clay layer, guard layer, leachate collection system and containment with bund

Excavated ASS materials shall be placed into appropriately identified treatment lots at the treatment facility where the material shall be spread in layers and allowed to dry (if required).

The overall layer thickness shall not exceed 250 mm thickness unless effective treatment over a greater thickness can be demonstrated. Where required, drying shall be enhanced by mechanical methods (rotary hoe, disc plough, etc.) to create a relatively homogenous, friable material prior to addition of lime for neutralisation.

Fine ground agricultural lime (or other approved neutralising agent) shall be applied to the ASS surface in each treatment lot using a spreader truck or other approved method. Following lime application, the lime shall be mixed into the ASS layer using mechanical methods (disc plough, rotary hoe, etc.).

CP-B4 (c) Liming Rates

The liming rates as determined from testing during Procedure CP-A can be adopted for treatment of confirmed ASS. The highest indicated rate shall apply to a treatment lot.

CP-B4 (d) Verification Testing

Verification samples shall be collected for each treated lot (1 per lot). The samples shall be formed by compositing materials from three randomly selected locations across the allotment. Samples shall be collected over the full thickness of the treated lot. The Chromium Suite shall be conducted on each sample to confirm net acidity by Acid Base Accounting.

CP-B5. PERFORMANCE CRITERIA

To confirm adequate lime treatment, laboratory testing must demonstrate the following:

- A neutralising capacity of more than 1.5 times the sum of existing plus potential acidity, all measured in the same units (and using a minimum safety factor of 1.5).

Some individual samples may vary from these criteria, as outlined below:

- No single sample shall exceed a net acidity of 18 mol H⁺/tonne (0.03% S); **and**
- If any single sample has a net acidity between 0 and 18 mol H⁺/tonne (0.00 to 0.03% S), then the average of any four spatially adjacent samples (including the exceeding sample) shall have an average net acidity of zero or less.

CP-B6. CONTINGENCY MEASURES

Additional lime treatment and further verification testing shall be conducted where adequate neutralisation is not initially indicated.



PROCEDURE CP-B Treatment and Verification of Identified ASS

CP-B7. PERFORMANCE INDICATORS

Item	Performance Indicator
Earthworks strategy	<ul style="list-style-type: none">■ An appropriate earthworks strategy has been prepared to track the treatment of ASS (appended to the ASSMP)
ASS treatment	<ul style="list-style-type: none">■ Treatment procedure employed is in accordance with section CP-A4
Liming rates	<ul style="list-style-type: none">■ Correct liming rates are applied for each treatment lot.
Treatment verification	<ul style="list-style-type: none">■ Verification of treatment on each of treated material.■ Correct verification laboratory analysis used.■ If verification shows performance criteria in section DS-A5 are not met, additional treatment has been employed.
Non conformance	<ul style="list-style-type: none">■ All non-conformances are reported and rectified.

CP-B8. MONITORING AND REPORTING

Records shall be kept to track excavated materials identified as ASS, volumes transported to the treatment facility, treatment rates applied. The Site Foreman shall conduct an inspection of the treatment areas including bunds and sumps on a weekly basis.

The Site Foreman shall be responsible for ensuring lime neutralisation and verification tests are completed for each lot of excavated ASS.

The Site Foreman shall maintain a register of testing results and a record of inspections.

A summary report of all test results and inspections shall be compiled by the Site Foreman each week and submitted to the Environmental Manager.



APPENDIX B

Acid Sulfate Soil Management Procedures – Dredged Material

Procedure DS-A: Characterisation and Verification of Dredged Materials

Procedure DS-B: Treatment and Verification of Dredged ASS

Procedure DS-C: Groundwater Quality Monitoring



DS-A1. GENERAL

The procedure outlined below is provided to further characterise dredged materials (identified self-neutralising ASS) placed in the DMCP during and post placement and to confirm they are self-neutralising.

DS-A2. OBJECTIVES

- 1) Implement a phased process from field screening to laboratory testing, as required to appropriately characterise dredged materials to confirm whether treatment is needed or whether the material is self-neutralising.
- 2) Comply with conditions of licences, permits or other approvals issued for the project.

DS-A3. STATUTORY REQUIREMENTS AND GUIDELINES

- 1) *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0, 2014. Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. Department of Science, Information Technology, Innovation and the Arts, Queensland Government;*
- 2) *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland, 1998; Ahern, CR., Ahern, M.R. and Powell;*
- 3) *Environmental Protection Act 1994;*
- 4) *Environmental Protection Policy (Water) 2009*

DS-A4. MANAGEMENT MEASURES

As phased approach will be undertaken, such that it indicate

- Visual identification and field screening of samples across the DMCP during placement.
- If field screening indicates, samples of finer materials deposited in the secondary pond will be collected early in the placement works using a long arm excavator, using a piston sampler from a punt/boat, or other suitable method. These samples will be analysed for the Chromium Suite of tests to evaluate if other than self-neutralising materials (i.e. PASS) is being deposited.
- Kinetic tests (column leaching tests) using fresh water will be conducted on these samples of finer materials deposited in the secondary pond from early in the placement works to confirm the potential for longer term risk associated with storing these materials in the DMCP.
- Based on field screening results, an earthworks strategy may be developed to spatially identify the locations of appropriately sized "lots" of placed dredged materials. Samples of the dredged material shall be collected on a 1 per lot basis. It is expected that the coarser materials in the primary pond should be accessible by foot or light equipment to enable sampling. In areas where finer materials are present sampling using a piston sampler from a punt/boat or other suitable sampling methods will be employed to collect characterisation/verification samples. Characterisation/verification samples will be analysed using the Chromium Suite of tests, following removal of shells and shell fragments larger than 2 mm.

DS-A5. PERFORMANCE CRITERIA

To confirm dredged materials as self-neutralising ASS materials or non-ASS, laboratory testing must demonstrate one of the following:

- Sum of existing plus potential acidity (excluding neutralising capacity) of less than 18 mol H⁺/tonne (0.03% S); or
- A neutralising capacity of more than 1.5 times the sum of existing plus potential acidity, all measured in the same units (and using a minimum safety factor of 1.5).



Some individual samples may vary from these criteria, as outlined below:

- No single sample shall exceed a net acidity of 18 mol H⁺/tonne (0.03% S); and
- If any single sample has a net acidity between 0 and 18 mol H⁺/tonne (0.00 to 0.03% S), then the average of any four spatially adjacent samples (including the exceeding sample) shall have an average net acidity of zero or less.

DS-A6. CONTINGENCY MEASURES

Where the performance criterion is exceeded, the lot represented by the sample shall be lime treated as outlined in Procedure PD-A.

DS-A7. MONITORING AND REPORTING

Records shall be kept by the Site Manager or their delegated representative to verify volumes of sampling. Specific records of volumes, origin, material type and placement, including photos, shall be maintained by the Site Manager or their delegated representative.

The Site Manager or their delegated representative shall develop the materials tracking register plan and maintain a register of test results.



DS-B1. GENERAL

The procedures outlined below are provided to monitor pond water quality for discharge to the environment during dredging works. Management and monitoring relates to ASS indicators only. Reference should be made to the project Environmental Management Plan for other water quality parameters that may need to be managed and monitored.

DS-B2. OBJECTIVES

- Appropriately monitor waters within the DMCP for ASS parameters.
- Appropriately manage, monitor and treat (if required) waters to be discharged from the DMCP.
- Comply with conditions of licences, permits or other approvals issued for the project.

DS-B3. STATUTORY REQUIREMENTS AND GUIDELINES

- 1) *State Planning Policy – state interest guideline, Water quality*, August 2014;
- 2) *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0*, 2014. Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. Department of Science, Information Technology, Innovation and the Arts, Queensland Government;
- 3) Environmental Protection Act 1994;
- 4) Environmental Protection Policy (Water) 2009.

DS-B4. IMPLEMENTATION MEASURES

DS-B4 (a) Monitoring of Water in DMCP

Water within the DMCP shall be monitored prior to discharge.

Where pH is within the range of 6.5 and 8.5 pH measurements shall be conducted using a calibrated meter twice daily at each nominated monitoring location, when water is present.

Where pH is below 6.5 is detected, continuous pH measurement shall be conducted using a calibrated meter and datalogger at each nominated monitoring location,

Where pH of less than 5.5 is detected, the water shall be treated by addition of hydrated lime and/or liquid caustic to achieve a pH of between 6.5 and 8.5. Inline pH adjustment pumps are to be utilized for treatment of low pH waters (<pH 5.5) prior to discharge.

DS-B4 (b) Discharge to Surface Water Bodies

Return from the DMCP shall be discharged to the ocean via the return water pipeline.

Prior to discharge from the DMCP, water must meet the criteria performance criteria listed in Section DS-B5.

- Waters not meeting required performance criteria shall be treated until these criteria are met.
- Treatment shall not be permitted as part of direct discharge.
- The pH and turbidity (presence of iron floc) in the DMCP return water inlet shall be monitored during discharge events.
- Discharge shall be ceased immediately on discovery of non-conformance with performance criteria.
- An appropriate supply of hydrated lime and/or liquid caustic shall be kept on site at all times for the treatment of acidic waters. Neutralising agents shall be stored in a covered and bunded area to prevent accidental release to waters.
- All monitoring of water quality shall be carried out by a suitably qualified person, using calibrated equipment on samples that are representative of the discharge or background.



- The Project Environmental Management Plan should also be consulted for guidance on additional monitoring parameters and performance limits not directly related to ASS.

DS-B5. PERFORMANCE CRITERIA

The State Planning Policy lists the following as acceptable outcomes in relation to ASS and disposal of wastewater to waterways

- i) the pH of any wastewater discharged is maintained between 6.5 and 8.5 to avoid mobilisation of acid, iron, aluminium, and metals, and
- ii) holding times of neutralised wastewaters ensures the flocculation and removal of any dissolved iron prior to release, and
- iii) visible iron floc is not present in any discharge, and
- iv) precipitated iron floc is contained and disposed of, and
- v) wastewater and precipitates that cannot be contained and treated for discharge on site are removed and disposed of through trade waste or another lawful method.

In addition to the above, if the pH drops below 5 at any time then this Procedure will need to be reviewed and the monitoring parameters will be increased to include, total acidity, total alkalinity, ferrous iron and aluminium.

DS-B6. PERFORMANCE INDICATORS

Item	Performance Indicator
1. Water Treatment Systems	Treatment systems maintained and operated according to manufacturer's specifications.
2. Water Quality	No uncontrolled releases of water from the site. Water discharge within performance indicators in Section DS-B5.
3. Non conformance	All non-conformances are reported and rectified.

DS-B7. MONITORING AND REPORTING

The Site Foreman shall be responsible for ensuring monitoring is conducted at the required frequency.

The Site Foreman shall maintain a register of testing results and a record of inspections.

A summary report of all test results and inspections shall be compiled by the Site Foreman each week and submitted to the Environmental Manager.

The Site Foreman shall inform the Environmental Manager of non-compliance upon detection. The Environmental Manager shall inform EHP of such non-compliances as soon as practicable and instigate an assessment of the impact.



DS-C1. GENERAL

The procedure outlined below is provided to monitor groundwater quality around the DMCP during and post placement of dredge materials.

DS-C2. OBJECTIVES

- Appropriately monitor groundwater to identify water quality changes that may indicate ASS impact.
- Comply with conditions of licences, permits or other approvals issued for the project.

DS-C3. STATUTORY REQUIREMENTS AND GUIDELINES

- 1) *State Planning Policy – state interest guideline, Water quality*, August 2014;
- 2) *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0*, 2014. Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. Department of Science, Information Technology, Innovation and the Arts, Queensland Government;
- 3) Environmental Protection Act 1994;
- 4) Environmental Protection Policy (Water) 2009.

DS-C4. IMPLEMENTATION MEASURES

A series of monitoring wells shall be installed external to the DMCP and prior to the commencement of any ground disturbance works to construct the DMCP. The number and location of these monitoring wells will be confirmed following completion of the groundwater assessment reporting.

The following groundwater monitoring program shall be adopted:

- Baseline groundwater quality data shall be collected before the construction of the DMCP. This shall comprise at least 2 monitoring events of
 - Field measurements of pH, redox potential (Eh or ORP), dissolved oxygen, standing water level, electrical conductivity (EC), total titratable acidity and total alkalinity.
 - Laboratory measurements chloride, sulfate, dissolved aluminium (filtered), dissolved arsenic (filtered) and dissolved iron (filtered).
- During dredging works monitoring of groundwater shall comprise:
 - Water level, pH and EC (field readings) every second day.
- Post construction monitoring shall comprise:
 - Weekly water table level, pH, EC for at least 6 months following completion of dredging. Extension of the monitoring program beyond this and final parameters will be determined by a suitably qualified Environmental Consultant following review of these results.

Performance indicators and response actions for water quality in groundwater wells are listed in DS-C5. Contingency options to groundwater treatment are discussed in Procedure PD-D.



DS-C5. PERFORMANCE CRITERIA

	Parameter	Monitoring Frequency	Performance Indicator	Action (after performance indicator exceedance)
Field Measurement	Water Level	Every 2 nd Day	-	All results to be reviewed by Environmental Consultant to confirm the level of risk and need for control measures.
	pH	(during construction and dredge placement)	>5.5 pH (and less than 0.5 pH drop below baseline)	
	redox potential		-	
	EC		-	
	DO	Every week for	-	
	total titratable acidity	6 months post	-	
	total alkalinity	(dredging)	-	

DS-C6. MONITORING AND REPORTING

The Site Foreman shall be responsible for ensuring monitoring listed in Section DS-C4 is conducted at the required frequency.

The Site Foreman shall maintain a register of testing results and a record of inspections.

A summary report of all test results and inspections shall be compiled by the Site Foreman each week and submitted to the Environmental Manager.

The Site Foreman shall inform the Environmental Manager of non-compliance with performance criteria upon detection. The Environmental Manager shall instigate an assessment of the impact within 2 days of such detections.

A groundwater monitoring report shall be prepared for the Environmental Manager by suitably qualified Environmental Consultant 6 months after completion of dredge spoil placement. The report shall include assessment of the results and recommendations for termination or continuation of the monitoring program. The report shall be submitted to EHP.



APPENDIX C

Acid Sulfate Soil Management Procedures – Post Dredging

Procedure PD-A: Treatment and Verification of Dredged ASS

Procedure PD-B: Treatment and Verification for Material Reuse

Procedure PD-C: Post Dredging Surface Water Monitoring

Procedure PD-D: Contingency Options for Groundwater Treatment



PD-A1. GENERAL

The procedures outlined below provide contingency options for on-site treatment and verification of placed dredged material, confirmed as not self-neutralising ASS. This procedure should be reviewed and revised should other treatment options be considered.

PD-A2. OBJECTIVES

- Appropriately treat and manage ASS materials so as to minimise adverse effects on the natural and built environment (including infrastructure).
- Comply with conditions of licences, permits or other approvals issued for the project.

PD-A3. STATUTORY REQUIREMENTS AND GUIDELINES

- 1) *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0, 2014. Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. Department of Science, Information Technology, Innovation and the Arts, Queensland Government;*
- 2) *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland, 1998; Ahern, CR., Ahern, M.R. and Powell;*
- 3) *Environmental Protection Act 1994;*
- 4) *Environmental Protection Policy (Water) 2009*

PD-A4. TREATMENT OPTIONS

PD-A4 (a) In-line Dosing

Where initial testing of fine grained material in the secondary pond (Procedure DS-A) indicates ASS with insufficient self-neutralising capacity, in-line application of additional neutralising agents may be trialled to negate the need for other in-DMCP or ex-DMCP treatment. A low soluble neutralising agent will need to be adopted.

PD-A4 (b) Earthwork Strategy

An earthworks strategy shall be developed to plan and track movement, treatment and verification of each appropriately sized "lot" of ASS material, where self-neutralisation performance criteria are not met.

PD-A4 (c) In-DMCP Treatment

Where conditions permit, it is preferable for treatment of ASS materials to be conducted within the DMCP.

- Shallow (0-0.5 m from surface) treatment – Where ASS is indicated in near surface soils within a characterised earthworks "lot", lime or other neutralising agent may be applied directly to the drained surface to provide a buffering source. In areas of coarser material that are accessible on foot or using light equipment, the neutralising agent should be incorporated into the surface layer by mechanical methods (rotary hoe, disc plough, excavator bucket etc.).
- Deep (0.5-4 m from surface) treatment – Deeper materials maybe reworked using a small slurry pump to mix lime/neutralising agent into the material. This could be conducted within the existing DMCP. A material tracking and verification testing as outlined in Procedure DS-A would be required. Alternatively, neutralising agent injection and soil mixing could be undertaken with mechanical mixing methods (e.g. excavator bucket mixing, jet grouting and shallow soil mixing equipment, cutter soil mixer, etc.).
- Consideration may be given to mixing of coarse material within the DMCP with either fines and/or silty sand material stockpiled from construction of the DMCP.



PD-A4 (d) Ex-DMCP Treatment Facility

Where identified ASS cannot be feasibly spread and treated within the DMCP, an ex-DMCP treatment facility shall be constructed in general accordance with the requirement detailed in *Soil Management Guidelines, 2014* (refer Figure PD-A1) and the following additional requirements:

- Treatment areas shall be located at least 30 m from the banks of waterways.
- The treatment area shall be prepared by stripping vegetation, topsoil and soil containing significant amounts of organic material and compacting the surface with a smooth drum roller. If sandy materials are exposed in the stripped surface, a layer of low permeability material shall be placed over the stripped surface (compacted clay or other acceptable low permeability material). An area of at least 2 m width shall be left between the treatment areas and bunds to allow collection of runoff and direction to sumps.
- Treatment pads shall be contained within a bunded area. Bund walls shall be constructed with clean material approved by the Supervisor (i.e. not ASS or acidic soils). Bund walls should be a minimum of 0.5 m in height.
- A guard layer of fine ground agricultural lime shall be applied to the treatment areas prior to placement of soils at a rate 5 kg/m² for each 1m height of soil to be treated.

The treatment facility and bund walls shall be inspected on a daily basis and maintained to prevent escape of soils or water from the facility. Where feasible, the layers of treated and verified material may be compacted in place to progressively build a final fill platform for development use.

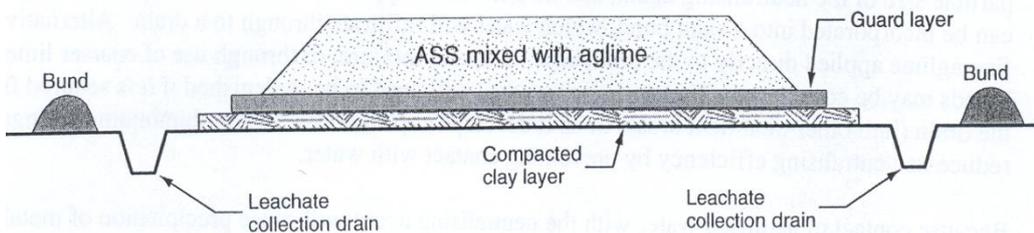


Figure PD-A1: Schematic cross-section of a treatment pad, including a compacted clay layer, guard layer, leachate collection system and containment with bund

ASS materials shall be placed into identified treatment lots at the treatment facility where the material shall be spread in layers and allowed to dry (if required).

The overall layer thickness shall not exceed 250 mm thickness unless effective treatment over a greater thickness can be demonstrated. Where required, drying shall be enhanced by mechanical methods (rotary hoe, disc plough, etc.) to create a relatively homogenous, friable material prior to addition of lime for neutralisation.

Fine ground agricultural lime (or other approved neutralising agent) shall be applied to the ASS surface in each treatment lot using a spreader truck or other approved method. Following lime application, the lime shall be mixed into the ASS layer using mechanical methods (disc plough, rotary hoe, etc.).

Calculations for determining appropriate liming rates are provided in Section PD-A4(e)



PD-A4 (e) Liming Rates

Lime neutralisation rates for each treatment lot shall be determined from the initial characterisation result.

The liming rate required to neutralise the Net Acidity (Existing Acidity + Potential Acidity) shall be calculated by:

- Multiplying Net Acidity by a safety factor of 1.5 to allow for mixing deficiencies and poor reactivity of the lime;
- Multiplying the above result by the bulk density of the soil to arrive at the liming rate (kg/m³).
- Multiplying the above result by 1.03 (to account for an agricultural lime neutralising value of 97%).
- Calculating surface application rate (kg/m²) by multiplying the above result by the thickness of soil being treated.

PD-A4 (f) Verification Testing

Verification samples shall be collected for each treated lot. The samples shall be formed by compositing materials from three randomly selected locations across the allotment. Samples shall be collected over the full thickness of the treated lot. The Chromium Suite shall be conducted on each sample to confirm net acidity by Acid Base Accounting.

PD-A5. PERFORMANCE CRITERIA

To confirm adequate lime treatment, laboratory testing must demonstrate the following:

- A neutralising capacity of more than 1.5 times the sum of existing plus potential acidity, all measured in the same units (and using a minimum safety factor of 1.5).

Some individual samples may vary from these criteria, as outlined below:

- No single sample shall exceed a net acidity of 18 mol H⁺/tonne (0.03% S); **and**
- If any single sample has a net acidity between 0 and 18 mol H⁺/tonne (0.00 to 0.03% S), then the average of any four spatially adjacent samples (including the exceeding sample) shall have an average net acidity of zero or less.

PD-A6. CONTINGENCY MEASURES

Additional lime treatment and further verification testing shall be conducted where adequate neutralisation is not initially indicated. Alternatively, where it can be demonstrated that the residual risk can be managed within the DMCP, residual lime treatment can be conducted as part of future material removal/reuse.

PD-A7. PERFORMANCE INDICATORS

Item	Performance Indicator
Earthworks strategy	■ An appropriate earthworks strategy has been prepared to track the treatment of ASS (appended to the ASSMP)
ASS treatment	■ Treatment procedures employed
Liming rates	■ Correct liming rates are applied for each treatment lot.
Treatment verification	<ul style="list-style-type: none"> ■ Verification of treatment on each lot of treated material. ■ Correct verification laboratory analysis used. ■ If verification shows performance criteria in section PD-A5 are not met, additional treatment has been employed.
Non conformance	■ All non-conformances are reported and rectified.



PD-A8. MONITORING AND REPORTING

Records shall be kept to verify volumes of soils treated. Where exsitu treatment is conducted records shall be kept of volumes transported to the treatment facility. The Site Foreman shall conduct an inspection of the treatment areas including bunds and sumps on a weekly basis.

The Site Foreman shall be responsible for ensuring lime neutralisation and verification tests are completed for each lot of ASS.

The Site Foreman shall maintain a register of testing results and a record of inspections.

A summary report of all test results and inspections shall be compiled by the Site Foreman each week and submitted to the Environmental Manager.



PD-B1. GENERAL

The procedures outlined below are provided as contingency measures for the treatment and verification of dredged materials confirmed as not self-neutralising ASS but not adequately treated in the DMCP prior to reuse.

PD-B2. OBJECTIVES

- Appropriately treat and manage ASS materials so as to minimise adverse effects on the natural and built environment (including infrastructure).
- Comply with conditions of licences, permits or other approvals issued for the project.

PD-B3. STATUTORY REQUIREMENTS AND GUIDELINES

- 1) *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0, 2014. Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. Department of Science, Information Technology, Innovation and the Arts, Queensland Government;*
- 2) *Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils in Queensland, 1998; Ahern, CR., Ahern, M.R. and Powell;*
- 3) *Environmental Protection Act 1994;*
- 4) *Environmental Protection Policy (Water) 2009*

PD-B4. TREATMENT MEASURES

In addition to lime neutralisation, consideration may be given to mixing of coarse dredged material with fine dredged material and/or silty sand material stockpiled from construction of the DMCP.

PD-B4 (a) Treatment Facility

Where identified ASS cannot be feasibly spread and treated within the dredge ponds an ex-DMCP treatment facility shall be constructed in general accordance with the requirement detailed in *Soil Management Guidelines, 2014* (refer Figure PD-B1) and the following additional requirements:

- Treatment areas shall be located at least 30m from the banks of waterways.
- The treatment area shall be prepared by stripping vegetation, topsoil and soil containing significant amounts of organic material and compacting the surface with a smooth drum roller. If sandy materials are exposed in the stripped surface, a layer of low permeability material (compacted clay or other acceptable low permeability material) shall be placed over the stripped surface. An area of at least 2m width shall be left between the treatment areas and bunds to allow collection of runoff and direction to sumps.
- Treatment pads shall be contained within a bunded area. Bund walls shall be constructed with clean material approved by the Supervisor (i.e. not ASS or acidic soils). Bund walls should be a minimum of 0.5m in height.
- A guard layer of fine ground agricultural lime shall be applied to the treatment areas prior to placement of soils at a rate 5 kg/m² for each 1m height of soil to be treated.

The treatment facility and bund walls shall be inspected on a daily basis and maintained to prevent escape of soils or water from the facility. Where feasible, the layers of treated and verified material may be compacted in place to progressively build a final fill platform for development use.



PROCEDURE PD-B Treatment and Verification for Material Reuse

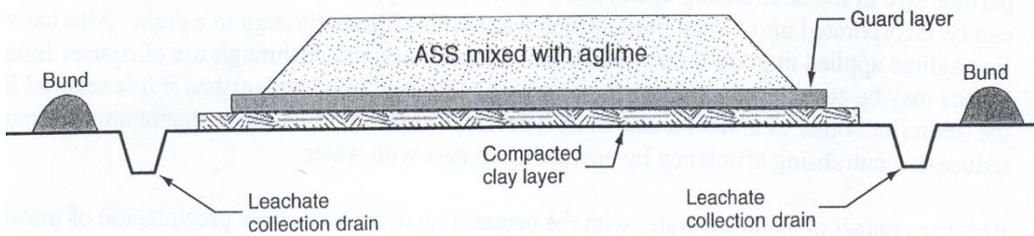


Figure PD-B1: Schematic cross-section of a treatment pad, including a compacted clay layer, guard layer, leachate collection system and containment with bund

ASS materials shall be placed into identified treatment lots at the treatment facility where the material shall be spread in layers and allowed to dry (if required).

The overall layer thickness shall not exceed 250 mm thickness unless effective treatment over a greater thickness can be demonstrated. Where required, drying shall be enhanced by mechanical methods (rotary hoe, disc plough, etc.) to create a relatively homogenous, friable material prior to addition of lime for neutralisation.

Fine ground agricultural lime (or other approved neutralising agent) shall be applied to the ASS surface in each treatment lot using a spreader truck or other approved method. Following lime application, the lime shall be mixed into the ASS layer using mechanical methods (disc plough, rotary hoe, etc.).

Calculations for determining appropriate liming rates are provided in Section PD-B4(b)

PD-B4 (b) Liming Rates

Lime neutralisation rates for each treatment lot shall be determined from the initial characterisation result.

The liming rate required to neutralise the Net Acidity (Existing Acidity + Potential Acidity) shall be calculated by:

- Multiplying Net Acidity by a safety factor of 1.5 to allow for mixing deficiencies and poor reactivity of the lime;
- Multiplying the above result by the bulk density of the soil to arrive at the liming rate (kg/m^3).
- Multiplying the above result by 1.03 (to account for an agricultural lime neutralising value of 97%).
- Calculating surface application rate (kg/m^2) by multiplying the above result by the thickness of soil being treated.

PD-B4 (c) Verification Testing

Verification samples shall be collected for each treated lot. The samples shall be formed by compositing materials from three randomly selected locations across the allotment. Samples shall be collected over the full thickness of the treated lot. The Chromium Suite shall be conducted on each sample to confirm net acidity by Acid Base Accounting.

PD-B5. PERFORMANCE CRITERIA

To confirm adequate lime treatment, laboratory testing must demonstrate the following:

- A neutralising capacity of more than 1.5 times the sum of existing plus potential acidity, all measured in the same units (and using a minimum safety factor of 1.5).



PROCEDURE PD-B Treatment and Verification for Material Reuse

Some individual samples may vary from these criteria, as outlined below:

- No single sample shall exceed a net acidity of 18 mol H+/tonne (0.03% S); **and**
- If any single sample has a net acidity between 0 and 18 mol H+/tonne (0.00 to 0.03% S), then the average of any four spatially adjacent samples (including the exceeding sample) shall have an average net acidity of zero or less.

PD-B6. CONTINGENCY MEASURES

Additional lime treatment and further verification testing shall be conducted where adequate neutralisation is not initially indicated.

PD-B7. PERFORMANCE INDICATORS

Item	Performance Indicator
Earthworks strategy	■ An appropriate earthworks strategy has been prepared to track the treatment of ASS (appended to the ASSMP)
ASS treatment	■ Treatment procedures employed
Liming rates	■ Correct liming rates are applied for each treatment lot.
Treatment verification	■ Verification of treatment on each lot of treated material. ■ Correct verification laboratory analysis used. ■ If verification shows performance criteria in section PD-B5 are not met, additional treatment has been employed.
Non conformance	■ All non-conformances are reported and rectified.

PD-B8. MONITORING AND REPORTING

Records shall be kept to verify volumes of soils treated and the volumes transported to the treatment facility. The Site Foreman shall conduct an inspection of the treatment areas including bunds and sumps on a weekly basis.

The Site Foreman shall be responsible for ensuring lime neutralisation and verification tests are completed for each lot of ASS.

The Site Foreman shall maintain a register of testing results and a record of inspections.

A summary report of all test results and inspections shall be compiled by the Site Foreman each week and submitted to the Environmental Manager.



PD-C1. GENERAL

The procedures outlined below are provided to monitor surface water quality and discharge to the environment during post dredging works. Management and monitoring relates to ASS indicators only. Reference should be made to the project Environmental Management Plan for other water quality parameters that may need to be managed and monitored.

PD-C2. OBJECTIVES

- Appropriately monitor waters within the DMCP for ASS parameters.
- Appropriately manage, monitor and treat (if required) waters to be discharged from the DMCP.
- Comply with conditions of licences, permits or other approvals issued for the project.

PD-C3. STATUTORY REQUIREMENTS AND GUIDELINES

- 1) *State Planning Policy – state interest guideline, Water quality*, August 2014;
- 2) *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0*, 2014. Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. Department of Science, Information Technology, Innovation and the Arts, Queensland Government;
- 3) Environmental Protection Act 1994;
- 4) Environmental Protection Policy (Water) 2009.

PD-C4. IMPLEMENTATION OPTIONS

PD-C4 (a) Post Dredging Works

Following completion of the dredging works, the water in the DCMP will be drawn down and additional discharge points will be formed within the DCMP walls to allow for a maximum freeboard of 0.5m over the placed dredged materials following a rainfall event.

The discharge points shall be lined with crushed limestone placed to address minor acidity in runoff.

This limestone should be inspected at least every 6 months to check for coating formation and confirm whether additional or replacement limestone is required.

PD-C4 (b) Discharge to Surface Water Bodies

Monitoring of all discharge points should be conducted; water must meet the criteria performance criteria listed in Section PD-C5.

- Waters not meeting required performance criteria shall be treated until these criteria are met.
- Treatment shall not be permitted as part of direct discharge to an external surface water body.
- The pH and turbidity (presence of iron floc) in the polishing pond shall be monitored every two hours during discharge events.
- Discharge to surface water bodies shall be ceased immediately on discovery of non-conformance with performance criteria.
- A supply of hydrated lime and/or liquid caustic shall be kept on site at all times for the treatment of acidic waters. The supply shall be at least 0.5 tonne of hydrated lime and/or 200L of liquid caustic. Neutralising agents shall be stored in a covered and bunded area to prevent accidental release to waters.
- All monitoring of water quality shall be carried out by a suitably qualified person, using calibrated equipment on samples that are representative of the discharge or background.



PROCEDURE PD-C Post Dredging Surface Water Monitoring

- The Project Environmental Management Plan should also be consulted for guidance on additional monitoring parameters and performance limits not directly related to ASS.

PD-C5. PERFORMANCE CRITERIA

The State Planning Policy lists the following as acceptable outcomes in relation to ASS and disposal of wastewater to waterways

- i) the pH of any wastewater discharged is maintained between 6.5 and 8.5 to avoid mobilisation of acid, iron, aluminium, and metals, and
- ii) holding times of neutralised wastewaters ensures the flocculation and removal of any dissolved iron prior to release, and
- iii) visible iron floc is not present in any discharge, and
- iv) precipitated iron floc is contained and disposed of, and
- v) wastewater and precipitates that cannot be contained and treated for discharge on site are removed and disposed of through trade waste or another lawful method.

In addition to the above, if the pH drops below 5 at any time then this Procedure will need to be reviewed and the monitoring parameters will be increased to include, total acidity, total alkalinity, ferrous iron and aluminium.

PD-C6. PERFORMANCE INDICATORS

Item	Performance Indicator
4. Water Treatment Systems	Treatment systems maintained and operated according to manufacturer's specifications.
5. Water Quality	No uncontrolled releases of water from the site. Water discharge within performance indicators in Section PD-C5.
6. Non conformance	All non-conformances are reported and rectified.

PD-C7. MONITORING AND REPORTING

The Site Foreman shall be responsible for ensuring monitoring is conducted at the required frequency.

The Site Foreman shall maintain a register of testing results and a record of inspections.

A summary report of all test results and inspections shall be compiled by the Site Foreman each week and submitted to the Environmental Manager.

The Site Foreman shall inform the Environmental Manager of non-compliance upon detection. The Environmental Manager shall inform EHP of such non-compliances as soon as practicable and instigate an assessment of the impact.



PD-D1. GENERAL

The procedures outlined below are provided at this time as a contingency measure to mitigate acidity if detected during groundwater monitoring.

This procedure may be reviewed and revised following further chemical analysis of the groundwater.

PD-D2. OBJECTIVES

- Appropriately capture and/or treat mobilised acidity if detected in the groundwater table.
- Comply with conditions of licences, permits or other approvals issued for the project.

PD-D3. STATUTORY REQUIREMENTS AND GUIDELINES

- 1) *State Planning Policy – state interest guideline, Water quality*, August 2014;
- 2) *Queensland Acid Sulfate Soil Technical Manual: Soil Management Guidelines V4.0*, 2014. Dear, S-E., Ahern, C. R., O'Brien, L. E., Dobos, S. K., McElnea, A. E., Moore, N. G. & Watling, K. M. Department of Science, Information Technology, Innovation and the Arts, Queensland Government;
- 3) Environmental Protection Act 1994;
- 4) Environmental Protection Policy (Water) 2009.

PD-D4. IMPLEMENTATION OPTIONS

Contingency options to mitigate mobilised acidity, if detected in groundwater, include one or a combination of the following:

PD-D4 (a) Cut-off Wall

A cut-off wall may be constructed along selected down-gradient alignments of the DMCP to capture and contain groundwater beneath the containment pond. The cut-off walls will be designed to restrict groundwater movement by extending the flow path or extend to a low permeable “confining” below the near surface water bearing layer.

PD-D4 (b) Lime Trench/PRB

A lime trench or permeable reactive barrier (PRB) could be constructed across major groundwater flow pathway(s) down-gradient of the DMCP to protect sensitive areas. The lime trench or PRB will be designed to reduce acid water or movement of metals.

PD-D4 (b) Lime Injection

Line injection could be implemented along the major groundwater flow pathway(s) down-gradient of the DMCP to protect sensitive areas.

PD-D5. PERFORMANCE CRITERIA

Groundwater monitoring as per Procedure DS-D shall be adopted to monitor performance of the implementation measures adopted.

PD-D6. CONTINGENCY MEASURES

Where performance criteria are exceeded an experienced Environmental Consultant shall be engaged to confirm the level of risk and need for additional control measures.



PD-D7. PERFORMANCE INDICATORS

Item	Performance Indicator
Contingency Option Design	■ Design and construction certified by RPEQ
Groundwater monitoring	■ pH >5.5 (and less than 0.5 pH drop below baseline)
Non conformance	■ All non-conformances are reported and rectified.

PD-D8. MONITORING AND REPORTING

Design and construction of contingency measures shall be monitored by an RPEQ. Photographic records shall be kept of construction activities.

The Site Foreman shall maintain a register of testing results and a record of inspections.

A construction report by an RPEQ shall be provided to the Site Foreman.

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