Contents

5 Topography, geology and soils

5.1 Chapter content

The Project impact assessment for topography, geology and soils was provided in Chapter 5 of the Project EIS.

This chapter provides additional information to address the submissions received during the statutory public display period of the Project EIS. The key issues raised from the Project EIS submission process relevant to the topography, geology and soils assessment are summarised Table 5.1.

Table 5.1 Summary of submission issues received in relation to the Project EIS topography, geology and soils assessment chapter

Submitter ID number (refer Appendix A)	Summary of submission issue raised	Project EIS section (public notification version)	AEIS section containing information to address submission comments	Complete replacement section for Project EIS	Supplements the Project EIS information
10.1	The Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines (Dear et al. 2014) requires that action criteria in Queensland be based on existing plus potential acidity, not net acidity. Therefore liming rates should be based on existing plus potential acidity (and safety factor), and not net acidity.	Section 5.6.1	Section 5.2		✓
12.16	Justify the density of sediment sampling undertaken to characterise acid sulfate soil (ASS), compared to the planned density of sediment sampling	Section 5.4.4 Appendices E4 to E6	Section 5.3		✓
10.02 10.03 12.17	Prepare a comprehensive ASS Management Plan as part of the Project approval process	Section 5.6.1	Section 5.4		✓
10.04	Define ‘significant length of time’ and ‘regular auditing’	Section 5.6.1.3	Appendix F Appendix G	✓	
10.05	Confirm if the groundwater baseline pH values have already been determined. If monitoring detects groundwater pH values outside of 6.5 to 8.5, it can be difficult to remedy this. In addition, groundwater pH values in coastal areas are often outside of this range.	Section 5.6.1.3 Section 10.4.2	Section 5.5		✓

Submitter ID number (refer Appendix A)	Summary of submission issue raised	Project EIS section (public notification version)	AEIS section containing information to address submission comments	Complete replacement section for Project EIS	Supplements the Project EIS information
10.06	Provide an explanation as to why no mitigation measures for minimising the PASS impacts are necessary for the placement of maintenance dredging material in the existing East Banks Dredge Material Placement Area	Section 5.6	Section 5.6		✓
12.04	Potential impacts and risk assessment tables in each draft EIS chapter should be amended to include effective mitigation measures, to assist with their interpretation.	Section 5.7.2	Section 5.7	✓	

5.2 Liming rates for treatment of acid sulfate soils

This section supplements the Project EIS Section 5.6.1 (Acid Sulfate Soil Management Plan).

The *Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines* (Dear et al. 2014) is based on the treatment and management of material in a terrestrial setting, where all potential acid sulfate soil (PASS) will be exposed to oxygen and become actual ASS (AASS).

In the case of dredging and reclamation works in the marine environment, multiple other factors need to be considered. This includes where a safety factor for liming is applied, that there is potential for pH to be increased to a level where there may be impacts.

The calculation of liming rates based on existing plus potential acidity (and safety factor) is a requirement developed to manage disturbance in a terrestrial setting, and locations where pH sensitivities are not present, and the addition of extra lime and potential movement of the pH into the alkaline range, would not be an impact.

The proposed WBE reclamation area is in a marine environment where pH that is too alkaline, as a result of over liming or the use of liming safety factors generated for terrestrial environments, has the potential to cause impacts to the marine environment.

The larger shell fragments present in the Project material to be dredged will be crushed due to the mechanical nature of dredging and reclamation, which will provide additional neutralising capacity above the calculated net acidity.

In order to manage potential Project impacts on the environment, pH will be monitored in the existing Western Basin and WBE reclamation areas, as per the Dredging EMP, with adjustments made to the pH should the water within the reclamation areas be too acidic or alkaline, prior to release.

In addition, the *Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines* (Dear et al. 2014) state that where sediment has a pH >6.5 and an appreciable acid neutralising capacity identified (ANC) by the approved laboratory methods, and the neutralising material detected is fine enough to be environmentally effective (< 2 millimetres (mm)), net acidity may be used instead of the sum of existing and potential acidity in calculating liming rates. Where the pH is found to be below 6.5 and/or ANC is determined to not be effective, ANC would not be used in the calculation of liming rates.

Other factors relevant to treatment is the placement of material below the water table within the WBE reclamation area and therefore not being exposed to oxygen, as well as the proposed dredging methodology, where significant portions of the dredged material will not be exposed to oxygen.

An Acid Sulfate Soil (ASS) Management Plan has been developed for the Project at a level of detail that is commensurate with the preparation of management plans for an EIS under the EPBC Act and SDPWO Act (refer Section 5.6.1 of the Project EIS).

A detailed site-specific ASS Management Plan will be developed for the Project at least three months prior to the commencement of Project activities, and will be subject to approval from Queensland Government.

It is not intended as part of the management measures to utilise marine water to neutralise any acid generated. Laboratory data indicates that there is sufficient acid neutralising capacity within the sediments to achieve self neutralisation of the dredged material.

5.3 Sediment sampling undertaken to characterise acid sulfate soils

This section supplements the Project EIS Section 5.4.4.2 (acid sulfate soils, methodology).

During the Project ASS investigations, at each borehole location (as described in the Project EIS Chapter 6 (sediment quality)), grab samples of approximately 200 grams (g) were collected at 0.25m intervals along the length of the core and placed in plastic bags for ASS analysis. Samples collected at 0.0m, 0.5m, 1.0m and every 0.5m interval along the core were analysed for Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS), while samples collected at 0.25m, 0.75m, etc. were analysed for field pH.

These tests were conducted along the length of the core until refusal. It is noted that the vibrocore was unable to achieve the full depth of dredging, despite three attempts at each location, due to encountering consolidated natural geological materials (i.e. rock, dense sands/gravels or stiff to very stiff clays). However, sufficient information has been able to be collected through the Project EIS and previous investigations to assess potential risk and develop suitable management actions to manage potential risk.

Compliance with the Queensland Government approved Project Sampling and Analysis Quality Plan (geochemical sampling and analysis, including ASS) is discussed in the Project EIS Section 6.4.3.3 (sample collection) and Project EIS Appendix E4 (sampling and analysis plan implementation report (area to be dredged)).

5.4 Acid Sulfate Soil Management Plan

This section supplements the Project EIS Section 5.6.1 (Acid Sulfate Soil Management Plan).

As stated in the Project EIS Section 5.6.1 (Acid Sulfate Soil Management Plan), the Project ASS Management Plan will be developed in accordance with the *Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines* (Dear et al. 2014). The Project ASS Management Plan included in the Project EIS includes key objectives, performance indicators, mitigation actions, monitoring, reporting and correction actions to be implemented during the WBE reclamation area bund wall and BUF construction (refer Project EIS Section 5.6.1.3), dredging activities and placement of dredged material (refer Project EIS Section 5.6.1.4), stabilisation and maintenance activities on the reclamation area (refer Project EIS Section 5.6.1.5), and other mitigation measures to be implemented during Project dredging activities, barge unloading and placement of dredged material (refer Project EIS Section 5.6.2).

A more detailed site-specific Project ASS Management Plan will be prepared as part of the post Project EIS environmental applications required under Queensland legislation, once detailed design of the WBE reclamation area has been undertaken, and a Dredging Contractor has been engaged, as part of the dredging works. This will provide additional detail on timings, monitoring, neutralisation methods, as well as closure reporting and handover.

5.5 Groundwater baseline pH values

This section supplements the Project EIS Section 5.6.1.3 (bund wall and barge unloading facility construction) and Section 10.4.2 (groundwater).

As stated in the Project EIS Section 2.5.1 (reclamation area capacity, timeframe and workforce), Project dredged material will be placed within the existing Western Basin and WBE reclamation areas.

Groundwater quality data for the existing Western Basin reclamation area has been collected and analysed since 2013 with the objective of assessing and changes in groundwater quality that could be attributed to PASS materials (EnvironMine 2017; 2018). The results of the monitoring program through to September 2018 show the groundwater pH to be above the low threshold of pH 6.5 for the majority of the sampling events with values predominantly stable throughout the monitoring period.

It is not possible to establish the pH values for groundwater within the proposed WBE reclamation area due to the existing intertidal and marine environment within this area.

As stated in the Project EIS Section 10.6.1 (mitigation measures, construction phase), the following will be implemented to minimise potential Project groundwater impacts:

- Implementation of an ASS Management Plan (refer Dredging EMP (AEIS Appendix F) and Project EMP (AEIS Appendix G))
- Provide emergency spill control materials at the Western Basin and WBE reclamation areas and BUF, including spill kits, booms and absorbent materials, to control any event of chemical spill
- Educate relevant site personnel in appropriate chemical handling and response techniques
- Installation of piezometers on the perimeter of the WBE reclamation area once earthworks are completed. Ensure the piezometers are installed in the dredged material and not the bund wall to ensure the accuracy of results. Piezometers are not able to be installed earlier due to the required movement and shaping of the dredged material during dredging activities.
- Development of a Western Basin and WBE reclamation areas groundwater monitoring program to be implemented once dredging and earthworks have been completed and the Western Basin and WBE reclamation areas are stable. Monitoring to include sites within the coastal strip of land adjacent to the WBE reclamation area would be installed prior to construction commencing. Groundwater monitoring piezometer installation will not be undertaken during the construction of the WBE reclamation area as piezometers are likely to be broken/demolished prior to finalisation of earthworks.

5.6 Mitigation measures for minimising potential acid sulfate soil impact during maintenance dredging

This section supplements the Project EIS Section 5.6 (mitigation measures).

As stated in the Project EIS Section 2.11.4 (maintenance dredging methodology), a TSHD is the most appropriate type of dredger to undertake the Port maintenance dredging. It is anticipated that the dredged material from annual Port-wide maintenance dredging (including the Channel Duplication Project areas to be dredged) will be placed within the existing East Banks dredged material placement area (DMPA) (until full capacity is achieved). The Port-wide maintenance dredging and offshore placement will be subject to the relevant Commonwealth Government approval process (e.g. Sea Dumping Permit) and other approvals as required at the time of dredging.

Due to the placement of maintenance dredged material offshore utilising a TSHD, the material will remain saturated within the TSHD's hopper resulting in no oxidisation of the PASS (if present) within dredged material. The dredged material will also be dredged and then placed in the offshore placement area within a period of less than 12 hours, which is within the *Queensland Acid Sulfate Soil Technical Manual Soil Management Guidelines* timeframes, effectively limiting the potential for any oxidation to occur.

The material that accumulates in the Port shipping channels comprises of fine sediment that has settled out of the water column, rather than undisturbed sediment that contains ASS. This fine material generally originates from either longshore drift or from freshwater waterways that discharge into the Port of Gladstone, and is sediment that has been in the water column for extended periods of time, and therefore is unlikely to contain ASS.

5.7 Summary of risk assessment

This section replaces the Project EIS Section 5.7.2 (summary of risk assessment). The risk assessment methodology is provided in Section 5.7.1 of the Project EIS.

The implementation of mitigation measures (refer Section 5.6 of Project EIS) will result in the ASS and land contamination impacts being generally assessed as a low to medium risk.

AEIS Appendix F (Dredging EMP) and AEIS Appendix G (Project EMP) provide a range of mitigation measures to reduce the potential topography, geology and soils impacts of the Project. As part of the risk assessment, the management plans and associated mitigation measures below have been applied to determine the post mitigation hazard risk grade (HRG) shown in Table 5.2.

- Dredging EMP (refer AEIS Appendix F)
  - General environmental management measures (refer Section 8)
  - Acid sulfate soils (refer Section 9.1)
  - Vegetation Management Plan (refer Section 9.4)
  - Waste Management Plan (refer Section 9.9)
  - Water Quality Management Plan (refer Section 9.10)
- Project EMP (refer AEIS Appendix G)
  - Acid sulfate soils (refer Section 8.1)
  - Vegetation Management Plan (refer Section 8.6)
  - Waste management (refer Section 8.9)
  - Water Quality Management Plan (refer Section 8.10).

The potential sediment impacts risk assessment is summarised in Table 5.2.

Table 5.2 Potential soil impacts and risk assessment ratings

Potential impact	Project phase					Preliminary HRG			Post mitigation HRG		
	Reclamation area and BUF establishment	Dredging	Navigational aids	Demobilisation	Maintenance	Likelihood	Consequence	HRG	Likelihood	Consequence	HRG
Oxidation of PASS during bund wall and BUF construction											
■ Mobilisation of metals and contamination of marine water ■ Increased acidity of marine water ■ Toxicity to marine and/or intertidal flora and fauna ■ Public health risks	✓					Likely	Moderate	High	Unlikely	Moderate	Medium
Oxidation of PASS within dredged material during dredging activities											
■ Mobilisation of metals and contamination of marine water ■ Increased acidity of marine water ■ Toxicity to marine and/or intertidal flora and fauna ■ Public health risks		✓				Possible	Moderate	High	Rare	Moderate	Medium
Oxidation of PASS within dredged material during unloading and placement											
■ Mobilisation of metals and contamination of marine water ■ Increased acidity of marine water ■ Iron staining in marine water, infrastructure and boats/vessels ■ Toxicity to marine and/or intertidal flora and fauna ■ Increased algal blooms ■ Public health risks		✓				Likely	High	High	Unlikely	High	Medium

Potential impact	Project phase					Preliminary HRG			Post mitigation HRG		
	Reclamation area and BUF establishment	Dredging	Navigational aids	Demobilisation	Maintenance	Likelihood	Consequence	HRG	Likelihood	Consequence	HRG
Oxidation of PASS during stabilisation and maintenance activities of the reclamation area											
▪ Mobilisation of metals and contamination of marine water ▪ Increased acidity of marine water ▪ Iron staining in marine water, infrastructure and boats/vessels ▪ Toxicity to marine and/or intertidal flora and fauna ▪ Increased algal blooms ▪ Public health risks					✓	Unlikely	Low	Low	Rare	Low	Low
Land contamination from use and storage of oils, fuels and chemicals											
▪ Contamination of soil and sediment through leaching ▪ Contamination of marine waters ▪ Health risks to construction workers ▪ Public health risks ▪ Toxicity to marine and/or intertidal flora and fauna ▪ Odours	✓				✓	Unlikely	High	Medium	Rare	Moderate	Low