Attachment D – Acid Sulfate Soil Investigation

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Proposed Disturbance within the Wetland Linkage between Lake Seppings and Oyster Harbour - Preliminary Acid Sulfate Soil Investigation Findings

Dear Austin

1. Introduction

GHD Pty Ltd (GHD) was engaged by the City of Albany (the City) to undertake a preliminary acid sulfate soil (ASS) investigation for an area of proposed clearing and soil disturbance within Closed Road Reserve (PIN 588431), Collingwood Park. The proposed linear disturbance area is approximately 300 m long and 5 m wide and is located within a wetland linkage between Lake Seppings and Oyster Harbour (the site) as presented on Figure 1.

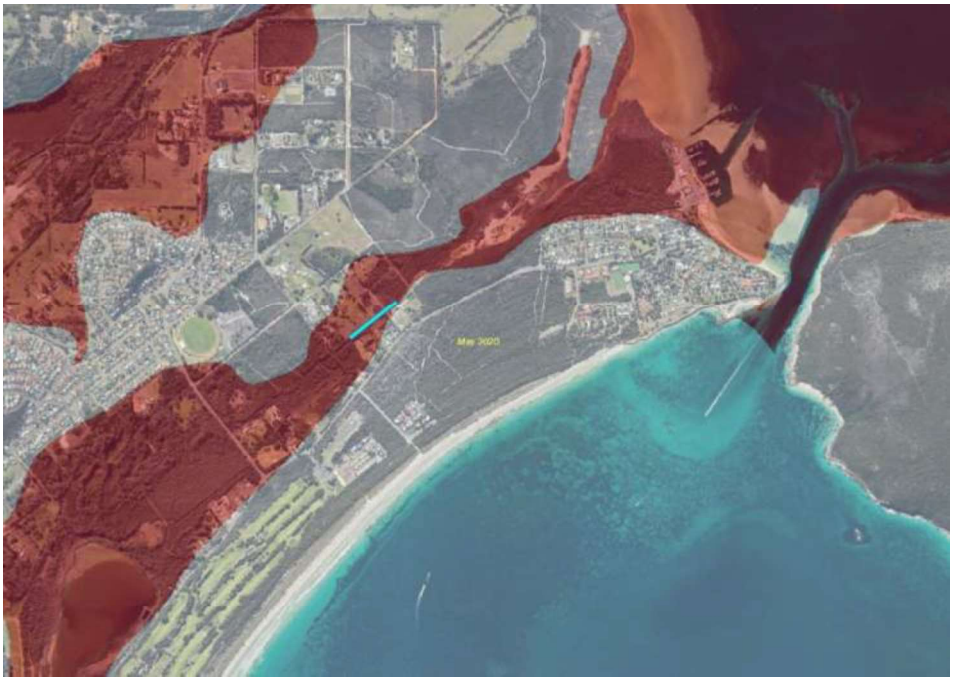

Figure 1 DWER ASS Risk Mapping of area (project area in blue)

1.1 Background

The City previously submitted an application in 2018 to the Department of Water and Environmental Regulation (DWER) to clear 0.115 ha of native vegetation within the site. The intent of the previous proposal (which remains the current intention) was to restore a more even drainage function within the wetland linkage between Lake Seppings and Oyster Harbour of which adjoining property owners had been reporting more frequent inundation during winter and for longer periods post-storm events.

The flow path is part of an Ecological Linkage connection Lake Seppings, a conservation category wetland to Oyster Harbour, a Nationally Important Wetland in Western Australia.

The original clearing application was not approved by DWER with one of the reasons cited in relation to the potential risk posed by ASS disturbance associated with the initial project clearing/ grubbing works.

1.2 Proposed disturbance

The proposed clearing and grubbing works associated with the project involves the removal of native sedges (via sedge scalping) in areas of an existing flow path to a maximum width of 5 m and will not involve the clearing of any trees.

The proposed disturbance is for a linear area less than 300 m in a northeast to southwest alignment, with excavation to a proposed maximum depth of 0.25 m below ground level (bgl). Overall, the maximum volume of material (i.e. sediment/ soil, sedge root mass) to be removed from the area will be <300 m^3.

1.2.1 Self-assessment form

The completed Western Australian Planning Commission (WAPC) ASS Self-Assessment Form is provided as Attachment 1.

As per Attachment 1, and in accordance with Table 2 from the DWER ASS Guidelines (2015), the project is classified as a 'Class 1 Risk' triggering the need for an ASS investigation to be undertaken. To this end, the Site is located within a high to moderate risk of ASS occurring within 3m of the natural soil surface, the proposed earthworks will disturb more than 100 m^3 of soil and the site is within 500 m of a wetland.

1.3 Purpose of this report

The purpose of this report is to document the findings of the preliminary ASS investigation undertaken at the Site, and provide recommendations with regards to the management measures (if required) to ensure that the proposed works do not adversely impact the environment through unmanaged acid generation.

Please refer to Attachment 2 for the limitations of this report.

1.4 Scope of works

The ASS investigation has been prepared in accordance with the following DWER guidance documents:

- Department of Environment Regulation (DER – antecedent to the Department of Water and Environment Regulation [DWER]) *Acid Sulfate Soil Guideline: Identification and investigation of acid sulfate soils and acidic landscapes* (DWER 2015a).
- DER Acid Sulfate Soil Guideline: *Treatment and management of soil and water in acid sulfate soil landscapes* (DWER 2015b).

As part of the investigation, the following scope of works was undertaken:

- Review of existing information with regards to the environmental setting and the proposed site development/ disturbance activities and development of an appropriate sampling and analysis program in accordance with the DWER guidelines
- Excavation of four soil bores (using a hand auger) with the collection of soil samples from the surface and at every 0.25 m depth interval. One dredged soil stockpile grab sample was also collected during the assessment resulting in a total of 19 primary samples.
- The following analysis was undertaken:

- Field test analysis of all 19 primary soil samples collected including; pH_F, pH_{FOX} and reaction ratings.
- Chromium Reducible Sulfur (S_{CR}) and titratable peroxide acidity (TPA) for seven samples (approximately 40%) selected based on the field test results and based on providing good representation laterally, vertically and across all soil units intercepted.

– Review of the investigation results against the DWER guidelines to ascertain if Actual Acid Sulfate Soil (AASS) and/or Potential Acid Sulfate Soil (PASS) exist in the soil proposed to be disturbed by the site works.

2. Methodology

The approach, methodologies and assessment criteria used for the investigation are in accordance with DWER 2015 guidance and outlined in the following sections.

2.1 Soil sampling methodology

A Senior Environmental Scientist from GHD undertook a site inspection and soil sampling program on 1 March 2022. The investigation comprised four (4) locations along the transect of the proposed disturbance corridor distributed approximately 100 m apart. Refer to Figure 2 (below) for indicative sample locations assessed.

Figure 2 Soil sample locations

The soil at each location was excavated using a hand auger (50 mm in diameter) with a target depth of 1.25 m below ground level (bgl) based on achieving a final depth of 1m below the maximum extent of proposed disturbance (as per the DWER guidelines).

Samples were collected at the surface and every 0.25 m intervals to the base of hole achieved at each location. GHD also collected one (1) grab sample direct from a stockpile of old dredge material located on Lot 355, 321 Emu Point Drive, from a private pond construction adjacent to the proposed disturbance area and considered representative of aged, excavated soil from the wetland area.

GHD logged the encountered subsurface conditions and undertook sampling of recovered materials from the hand auger locations with completed soil logs provided as Attachment 3 and site photographs provided as Attachment 4.

Soil samples were collected from the surface and at 0.25 m intervals to a maximum depth of 1 m bgl. The target depth of 1.25 m bgl was not able to be achieved at the locations due to the saturated nature of the sub-surface soils. In total, 19 primary soil samples were collected across the five locations.

Soil samples consisted of approximately 200 grams of material and were placed directly into a clearly labelled, laboratory supplied, plastic zip-lock bag. Air was extruded to limit oxidation of the soil. Samples were immediately placed into a pre-chilled esky for the duration of the fieldwork. Samples were then frozen at the end of the day prior to being dispatched to ALS Environmental the following day via overnight courier for analysis, ensuring that all holding times were met.

2.2 Laboratory analysis

The soil investigation included the following laboratory analysis:

- pH screening tests – all 19 samples (100%)
- Chromium reducible sulphur (S_{cr}) and Titratable Peroxide Acidity (TPA) for seven (7) samples (35%)

The pH screening tests provide important preliminary information in regard to the existing acidity of the soil (pH_F) and the stored (potential) acidity of the soil (pH_{FOX}). The soil pH trigger values in accordance with DWER guidelines (DER 2015a) were used as a preliminary screening tool to identify suspected actual acid sulfate soils (AASS) and potential acid sulfate soils (PASS) and to support the selection of samples for detailed analysis.

The pH field screening method is indicative only and cannot determine the presence or absence of ASS. The pH field screen may provide *'false positives'* and *'false negatives'* therefore overestimating and underestimating the true acidity potential of a soil.

2.3 Soil assessment criteria

2.3.1 Topsoil criteria

Topsoil can present acidic characteristics with pH typically below 7.0 and generally within the range of pH 5.1 to 6.0 according to the DWER guidelines (DWER 2015b). The DWER guidelines also recommend that topsoil with a pH value above 4.0 does not require any treatment and/or management strategies to be implemented (DWER 2015b). However, for the purposes of this investigation GHD has not considered any of the material proposed to be disturbed as 'topsoil' irrespective of its high organic material content.

2.3.2 ASS action criteria

The acid-based accounting equation, as outlined in DWER guidelines (DWER, 2015a) is:

Net Acidity = Potential Acidity + Existing Acidity – Acidity Neutralising Capacity (ANC)

The trigger levels based on net acidity (excluding ANC) and soil texture are outlined in DWER guidelines (DWER 2015a) and are presented in Table 1.

Generally, materials (excluding topsoil) containing net acidity in excess of the values presented in Table 1 are deemed to be soils that require treatment. An action criterion of 18.0 mol H^+/tonne or 0.03%S has been adopted regardless of the soil texture range (see shaded criteria in Table 1).

Table 1 Acid sulfate soil action criteria (adopted from Table 10, Texture based ASS 'action criteria' - DWER 2015a)

Type of material		Net acidity action criteria			
Soil texture range	Approx. clay content (%)	<1,000 ton of material disturbed		> 1,000 ton of material disturbed	
		Equivalent Sulfur (% S)	Equivalent Acidity (mol H^+/tonne)	Equivalent Sulfur (% S)	Equivalent Acidity (mol H^+/tonne)
Coarse Texture Sands to Loamy sands	< 5	0.03	18.0	0.03	18.0
Medium Texture Sandy Loams to Light Clays	5 – 40	0.06	36.0	0.03	18.0
Fine Texture Medium to Heavy Clays and Silty Clays	> 40	0.1	62.0	0.03	18.0

Soil results are presented against the assessment criteria in Table 1, Attachment 5.

2.4 Quality assurance and quality control

Quality Assurance (QA) involves all of the actions, procedures, checks and decisions undertaken to ensure the representativeness and integrity of samples and accuracy and reliability of analytical results. Quality Control (QC) involves protocols to monitor and measure the effectiveness of QA procedures. The QA/QC measures employed during the current investigation are outlined below.

2.4.1 Field quality control measures

During the investigation, the following actions were undertaken to ensure the quality control of the data being collected:

- Decontamination between sample points - samples were collected using new disposable gloves, and placed directly into labelled, laboratory provided sample bags and put into a chilled esky.
- Chain of custody (CoC) documentation - sample details were entered on to a CoC form that accompanied the samples to the nominated NATA accredited laboratory – ALS Environmental.
- Field duplicate (soil) – one blind duplicate sample was sent to the laboratory for duplicate analysis (equivalent to one sample per twenty primary samples) for the purposes of QA/QC. Relative Percent Difference (RPD) - a quantitative measure of the precision of the analytical results is made by calculating the RPD between primary and duplicate results in accordance with the procedure described in AS4482.1 *Guide to the sampling and investigation of potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds* (2005).

2.4.2 Laboratory QA/QC

ALS Environmental is accredited by the National Association of Testing Authorities (NATA) for the analyses performed with the exception of the pH field testing (pH_F and pH_{FOX}) which is used as a preliminary screen only.

The laboratory also performs an internal laboratory Quality Control review on the work order which is independently reviewed by GHD. The laboratory's Quality control report for soil and samples is provided with the Certificates of Analysis in Attachment 6.

3. Soil investigation results

The results from the soil investigation are discussed in the following sections.

3.1 Soil investigation

The location and depths achieved in the soil investigation on the 1 March 2022 are summarised in Table 2, with bore logs presented as Attachment 3 and a photograph log as Attachment 4.

The soil profile of the hand auger locations, as presented by the bore logs generally comprised dark brown peaty topsoil over light brown/grey calcareous/carbonate sands with intact shells (bivalves) and fragments throughout. At and below depths where the water table was intercepted, a sulphurous odour was noted.

Table 2 Sample location summary

ID	Coordinates (GDA 94, MGA Zone 50)		Maximum depth achieved (m bgl)	Number of primary samples
	Latitude	Longitude		
LS01	117.9288	-34.9995	0.5	4
LS02	117.9279	-35.0001	1.0	5
LS03	117.9273	-35.0005	1.0	5
LS04	117.9263	-35.0012	1.0	5
LS05	117.929	-34.9996	Grab sample from surface of stockpile	1

3.1.1 pH screening results

A total of 19 primary samples from locations LS01 to LS05 were submitted to ALS Environmental for analysis. The pH screening results have been summarised in Table 1 Attachment 5 with the laboratory Certificates of Analysis and Chain of Custody documentation presented in Attachment 6.

Overall, the screening results present the following information:

- pH_F values ranged from 7.3 to 9.0 (mean of 7.9)
- pH_{FOX} values ranged from 5.8 to 6.7 (mean of 6.3)
- Δ pH values, defined as pH_F minus pH_{FOX}, ranged between 1.2 and 2.6 (mean of 1.7)
- Observed reaction rates ranged from ‘slight’ to ‘moderate’, with the majority noted as slight (13) and the remainder noted as moderate (8).

LS05 had a Δ pH value greater than two, indicating that the potential for acid generation upon oxidation is plausible within soil profiles anticipated to be disturbed.

In regard to the overall indication of ASS risk from the averaged pH screening test results, GHD has presented a summary in Table 3.

Table 3 Summary of average field test results by location

Location	No. of primary samples	pH_F (Average)	pH_{FOX} (Average)	Δ pH (Average)	Indicative of AASS	Indicative of PASS
LS01	3	7.8	6.2	1.5	No	No
LS02	5	8.3	6.5	1.8	No	No
LS03	5	7.9	6.2	1.7	No	No
LS04	5	7.7	6.2	1.4	No	No
LS05	1	9.0	6.4	2.6	No	Possible (Δ pH)

As presented within Table 3, the averaged field test results from samples collected within each investigation area does not present a clear conclusion with regards to the potential for ASS or PASS to be present and generally indicates that ASS is not a risk based on bulk soil properties.

3.1.2 Confirmatory laboratory testing

Of the 19 primary samples analysed for the ASS pH screening test, S_{CR} suite analysis and TPA analysis was scheduled on seven primary samples. The selection of samples for detailed analysis was based on a review of the pH screening test results to target the worst-case individual samples showcasing either low pH_F, low pH_{FOX} or a large Δ pH and selected to ensure good representation of soil units laterally and vertically across the site – particularly within the soil depths proposed to be disturbed.

Results of the ASS confirmatory laboratory testing are summarised in Table 1 Attachment 5 and include the following key findings:

- Of the seven primary samples analysed for pH_{KCl} and pH_{OX}, the following observations were made:
  - pH_{KCl} values ranged from 8.6 to 9.8 (mean of 9.4)
  - pH_{OX} values ranged from 7.2 to 7.9 (mean of 7.6)
  - Δ pH values ranged between 1.5 and 2.6 (mean of 1.8)
  - Observed reaction rates ranged from 'slight' to 'moderate', with the majority noted as moderate (4) and the remainder noted as slight (3).
  - The pH results were approximately 1 pH unit higher than the screening results for both pH_{KCl} and pH_{OX}
- Of the seven primary samples analysed for TAA, none recorded concentrations above the DWER ASS action criteria of 18 mol H^+/tonne (equivalent 0.03% S)
- Of the seven primary samples analysed for S_{CR}, none recorded concentrations above the DWER ASS action criteria of 18 mol H^+/tonne (equivalent 0.03 % S) and furthermore, were all less than the laboratory LOR of <10 mol H^+/tonne. The highest reported concentration of S_{CR} above the LOR was at LS04 0m and reported 0.014 % S.
- TPA results were identified to be less than the DWER ASS criteria of 18 mol H^+/tonne (equivalent 0.03 %S) for all seven samples analysed, all of which were also less than the LOR of 2 mol H^+/tonne.
- ANC is a measure of the soils natural ability to buffer acidity and resist the lowering of the soil pH. ANC analysis was completed as part of the acid-based accounting for the seven samples. The results for these samples indicated an inherent ANC ranging between 1.5 – 9.67 % $CaCO_3$ (299 – 1,930 mol H^+/tonne equivalent).

3.1.3 Net Acidity calculations

Of the seven primary samples analysed, none were found to have a net acidity (excluding ANC) above the DWER ASS action criteria of 18 mol H^+/tonne (equivalent 0.03 %S). Additionally, all seven samples recorded a net acidity less than the laboratory LOR of <10 mol H^+/tonne (equivalent <0.02 %S) and a significant amount of ANC inherently present.

3.2 Quality Assurance/Quality Control

A review of the field and laboratory QA/QC information revealed the following key findings:

- All field procedures were undertaken in line with appropriate GHD and industry standards.
- ALS Environmental is accredited by the National Association of Testing Authorities (NATA) for the analysis performed with the exception of the pH field testing (pH_F and pH_{FOX}) which is used as a preliminary screen only. The internal laboratory QA/QC results are presented in Attachment 6 and concluded:
  - No duplicate outliers occurred
  - No matrix spike recovery outliers were required to be reported
  - No laboratory control outliers occurred

- No method blank outliers were required to be reported
- No analysis holding time outliers occurred
- No quality control sample frequency outliers occurred
- For all regular sample matrices, no surrogate recovery outliers occur

A comparison of the soil primary and field duplicate samples, for analysis undertaken, indicates that all calculated RPDs were less than 50% suggesting that the analytical procedures are repeatable. A review of the field and laboratory QA/QC information indicates that the data obtained through the investigation is considered to be of an adequate quality upon which to draw meaningful conclusions regarding the presence of ASS across the development area.

4. Conclusions

As a result of the preliminary ASS investigation undertaken along the proposed disturbance corridor, there was found to be no indications of AASS or PASS risk, within the extent of the soil profile assessed, based on the following key findings:

- An average pH_F of 7.9 and an average pH_{FOX} of 6.3 was reported across the dataset
- An average pH_{KCL} of 9.4 and an average pH_{OX} of 7.6 was reported across the dataset
- There were no exceedances of the DWER action criteria for reported concentrations of TAA, TPA or S_{CR} results.
- Significantly high laboratory reported ANC concentrations in the soils ranging between 299 – 1,930 mol H^+/tonne equivalent were noted. The reported ANC concentrations support the visual observations during sampling where a substantial proportion of the soil below 0.1 m bgl comprised gritty shell material and larger shell fractions including fully intact bivalves.

Furthermore, and in support of the conclusion that the ASS risk within the proposed disturbance corridor is low, GHD considers the following information pertinent:

- The sample collected from the surface of an aged stockpile of dredged material derived from an adjacent private pond construction (LS05) was also found to not demonstrate any indications of ASS with a pH_F of 9.0 and a pH_{FOX} of 6.4 and a TAA, TPA and S_{CR} result below the DWER Action Criteria. GHD considers that this stockpiled material would be representative of the proposed disturbance material once dried out and oxidised.
- Insitu water quality measured during an initial site inspection with City staff using a calibrated water quality meter, recorded pH measurements in the active stream and ponded/swale areas along the alignment between 7.3 and 7.5.
- The surface soil profile proposed to be removed along with the sedge root zone (i.e. <0.25 m bgl), would experience seasonal wetting and drying cycles naturally and to date the area does not reflect any symptoms of an ASS impacted area.

5. Recommendation

As a result of the ASS investigation undertaken, GHD considers that there are no indications of actual (existing) ASS at the site and there are also no indications that the disturbed soil (either the material to be removed offsite or remaining insitu post the clearing works) represents a potential ASS risk. As such, and on the basis that the City does not change the proposed construction methodology to include dewatering, GHD does not recommend that any form of ASS management is required to be implemented by the City during the proposed minor clearing works.

6. References

AS (2005) AS4482.1 *Guide to the sampling and investigation of potentially contaminated soil Part 1: Non-volatile and semi-volatile compounds*.

Department of Environment Regulation (DWER) (2015a) *Acid Sulfate Soil Guideline Series: Identification and investigation of acid sulfate soils and acidic landscapes* (2015).

Department of Environmental Regulation (DWER) (2015b) *Acid Sulfate Soil Guideline Series: Treatment and management of soils and water in acid sulfate soil landscapes* (2015).

Regards

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