Preliminary Acid Sulfate Soil Investigation

Location:

Proposed Additional Flow Path for
Byron Sewage Treatment Plant

Byron Bay NSW

Prepared for:

Byron Shire Council

Report:

HMC 2019.053

March 2019

HMC environmental consulting pty ltd

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Document Control Summary

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Title:	Preliminary Acid Sulfate Soil Investigation
Job No:	HMC2019.053
Client:	Byron Shire Council

Version	Date	Prepared by	Checked by	Approved for issue by
Draft	27.03.2019	MT	KL	MT
				MT

Issue Register

Distribution List	Date Issued	Method of Transmission	Number of Copies
Planit Consulting	27.03.2019	Email	1 x pdf

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Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary.
Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time, natural processes and the activities of man.

EXECUTIVE SUMMARY

To improve the operation of the Byron Sewage Treatment Plant (STP), a new pipeline would be installed within the western part of an additional flow path. This flow path would provide an alternate discharge for the STP and includes both pipeline and open channels.

The pipeline would extend through both Council controlled land and public road reserve. The site is mapped as Class 3 Acid Sulfate Soil (ASS) and an acid sulfate soil investigation was completed with soil samples collected throughout the soil profile in six boreholes to a maximum 2.5m depth below the ground surface.

The collected samples were subjected to qualitative laboratory testing with selected samples subjected to quantitative laboratory testing to assess potential and actual acidity.

The chromium reducible sulfur results did not record reduced inorganic sulfur (RIS) and, although the total actual acidity results for several samples did exceed action criteria, it appears the source of the acidity was not likely related to the oxidation of RIS. The field pH (pHF) results were all greater than 4.0 and the pHKCl results adjusted to reflect pHF were also all > 4.

The geological setting is also not indicative of ASS. The lowest elevation for the pipe invert is RL 1.78m AHD. In fact, only 20m length of the pipeline is below RL 2.0m AHD. As stated in White et al (1995) and Wilson (2005), the upper level of ASS is not expected to be higher than RL 1.0m AHD. The risk mapping shows the area is within a Pleistocene age geology not a Holocene age and the mapping confirms the area as "*low probability*" ASS.

Acid sulfate soils have not been identified as being a constraint to the installation of the proposed pipeline within the proposed excavation zone. An Acid Sulfate Soil Management Plan or further investigation would not be required.

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1 INTRODUCTION

To improve the operation of the Byron Sewage Treatment Plant (STP), a new pipeline would be installed within the western part of an additional flow path. This flow path would provide an alternate discharge for the STP and includes both pipeline and open channels.

The pipeline would extend through both Council controlled land and public road reserve. The site is mapped as Class 3 Acid Sulfate Soil (ASS) and an acid sulfate soil investigation was completed with soil samples collected throughout the soil profile in six boreholes to a maximum 2.5m depth below the ground surface.

This report addresses an investigation to determine the presence of, and, any measures to be implemented to ameliorate any existing acid or acid generation due to the possible disturbance of acid sulfate soils during the proposed development.

2 SITE INFORMATION

Site Address	399 Ewingsdale Road, Byron Bay
Property description	Lot 1 DP 620682
Report commissioned by	Planit Consulting
Proposed development	Pipeline
Byron LEP 2014 Zone	SP3 Tourist
Maximum depth of excavation	<Approx 1-2-1.5m
ASS interception depth	NA
Investigator	Mark Tunks
Local Government Authority	Byron Shire Council
Soil investigation date	19 March 2019

Figure 1 Locality Map

3 PROJECT DESCRIPTION

The project comprises the installation of a pipeline within the western part of the additional flow path for the Byron Sewage Treatment Plant (STP). This flow path would provide an alternate discharge for the STP and includes both pipeline and open channels.

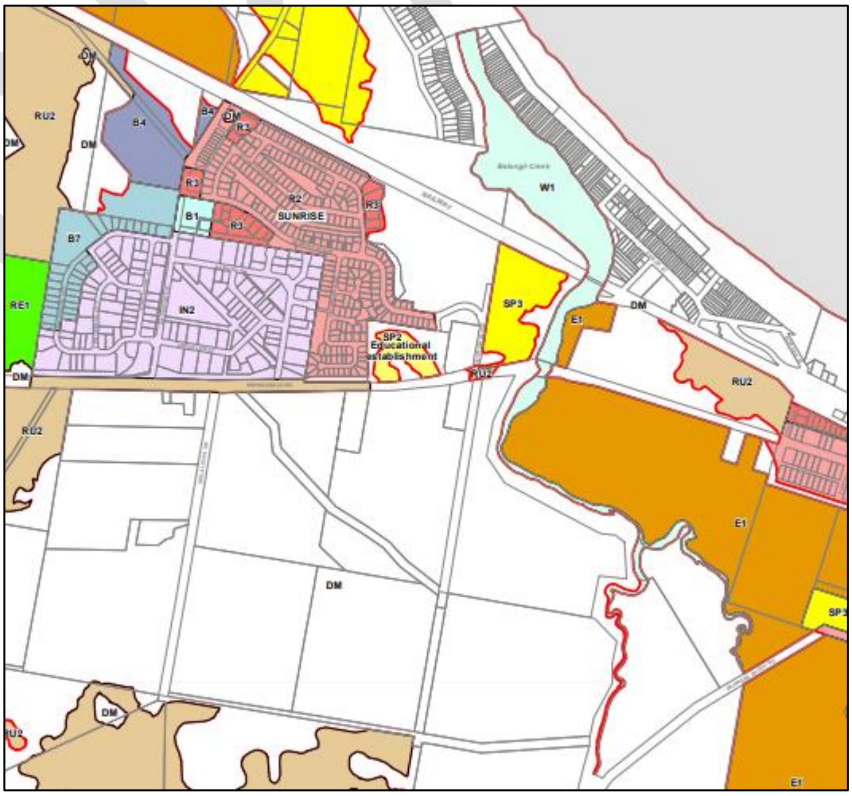
4 PROPOSED EARTHWORKS

A linear excavation approximately 640m long and up to 2.0m depth below the natural ground level (mBGL) would be required to install the proposed pipeline. The pipeline invert ranges from RL 1.78m AHD to RL 4.1m AHD. The minimum elevation of the pipeline invert would be RL 1.78m AHD with only 20m length of pipeline <RL 2.0m AHD. It is expected the operation would be continuous with approximately 20m length of excavation being open at any one time. This rapid process would help minimise any oxidation of reduced inorganic sulfur (RIS).

5 BYRON LOCAL ENVIRONMENT PLAN 2014

A review of the Byron LEP 2014 maps shows the site is located within a Class 3 ASS area. Clause 61 of the Byron LEP 2014, requires that works beyond 1m depth below the ground surface proposed in Class 3 areas require a preliminary acid sulfate soil assessment prior to consent. An Acid Sulfate Soil Management Plan (ASSMP) is required unless Byron Shire Council after reviewing the preliminary assessment provides written confirmation that an ASSMP is not required for the proposed works. If a management plan is required, Clause 61 of the Byron LEP states that it must be prepared in accordance with the Acid Sulfate Soil Assessment Guidelines produced by the Acid Sulfate Soil Management Advisory Committee (ASSMAC).

A review of the NSW Department of Land and Water Conservation (now DPI) ASS Risk Maps (Naylor, 1997) shows the site within a (Wa2(p)), aerolian sandplain with an elevation of 2-4m AHD. The (p) designation indicates the site is within a Pleistocene not Holocene geological unit.



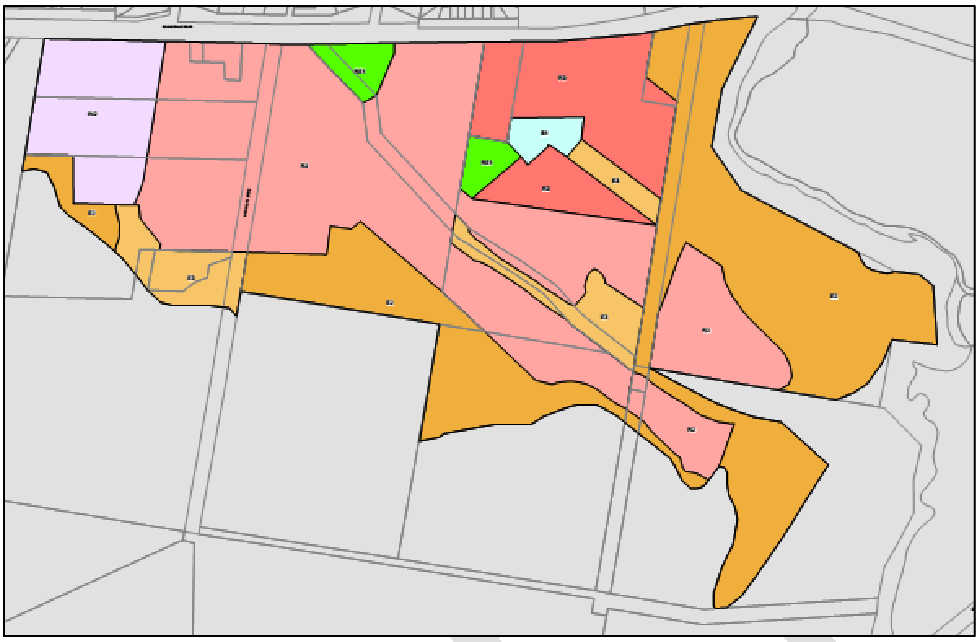


Figure 2 Byron LEP 2014 ASS Mapping (http://www.legislation.nsw.gov.au/)

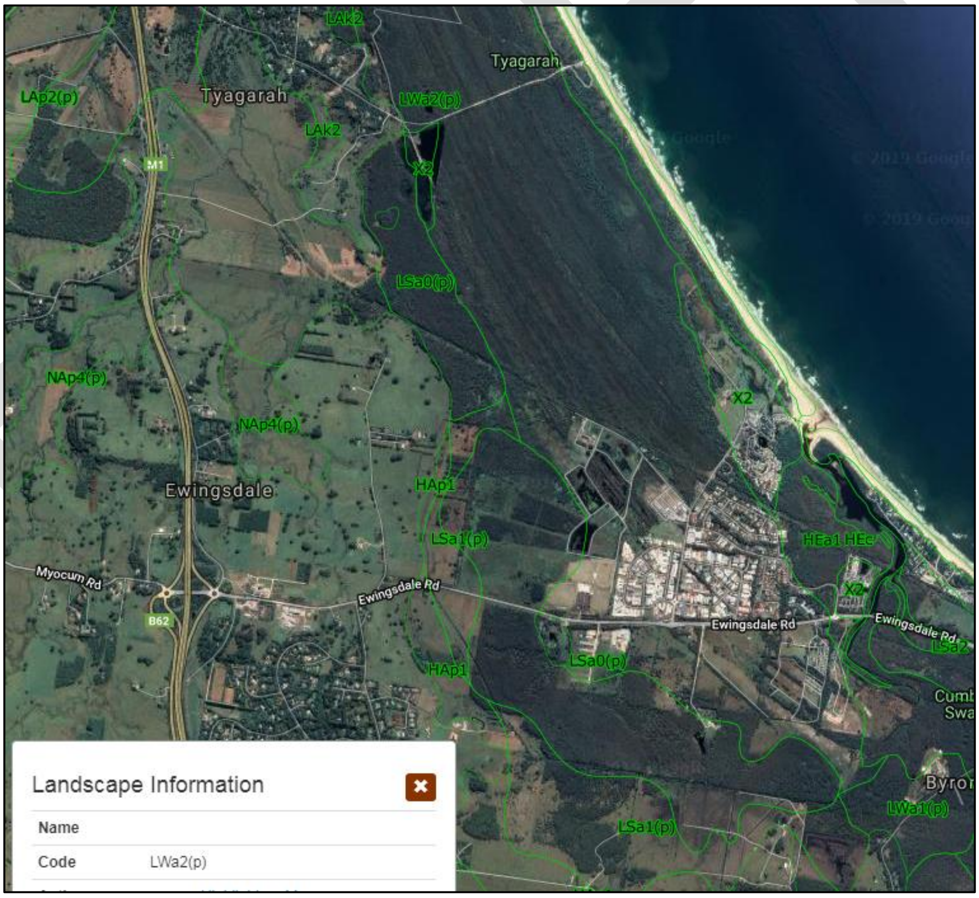


Figure 3 DLWC Byron Bay ASS Risk map (Naylor, 1997)

6 GEOLOGY & SOIL LANDSCAPE

Geology (Hashimoto et al (2008) shows the site in an coastal barrier system, pleistocene ridge and associated strandplain characterised by marine sand, indurated sand, gravel *(Qpbr)*.

The NSW Department of Conservation and Land Management "Soil Landscape of the Lismore-Ballina 1:100 000 Sheet" (Morand, 1994) shows the subject site lies within a "Tyagarah" (ty) soil landscape which is found within sediment basins of mixed estuarine and aeolian origin within the inland margins of the Tweed-Byron Coast. Soil relationships are varied in this soil landscape due to the complex origin of the landform.

White et al (1997) note that "*the top of the sulfidic horizon should be close to where it was last formed, at about mean high tide sea level (about **1m AHD** in eastern Australia).* Naylor et al (1998) also conclude following the extensive ASS mapping project across NSW that an "*analysis of the relationships between elevation levels (AHD) and soil data established the critical level at which the upper limit of ASS occurs. This is at or less than about **1m AHD***". The 1m AHD benchmark can also be confirmed via the wording of provisions relating to class 5 land and watertable elevation.

Wilson (2005) also reports a maximum elevation of ASS of 1m AHD after reviewing soil investigation results for the NSW ASS mapping program (see appendix 5).

Figure 4 - Soil landscape map (Source: http://www.environment.nsw.gov.au/eSpadeWebApp/)

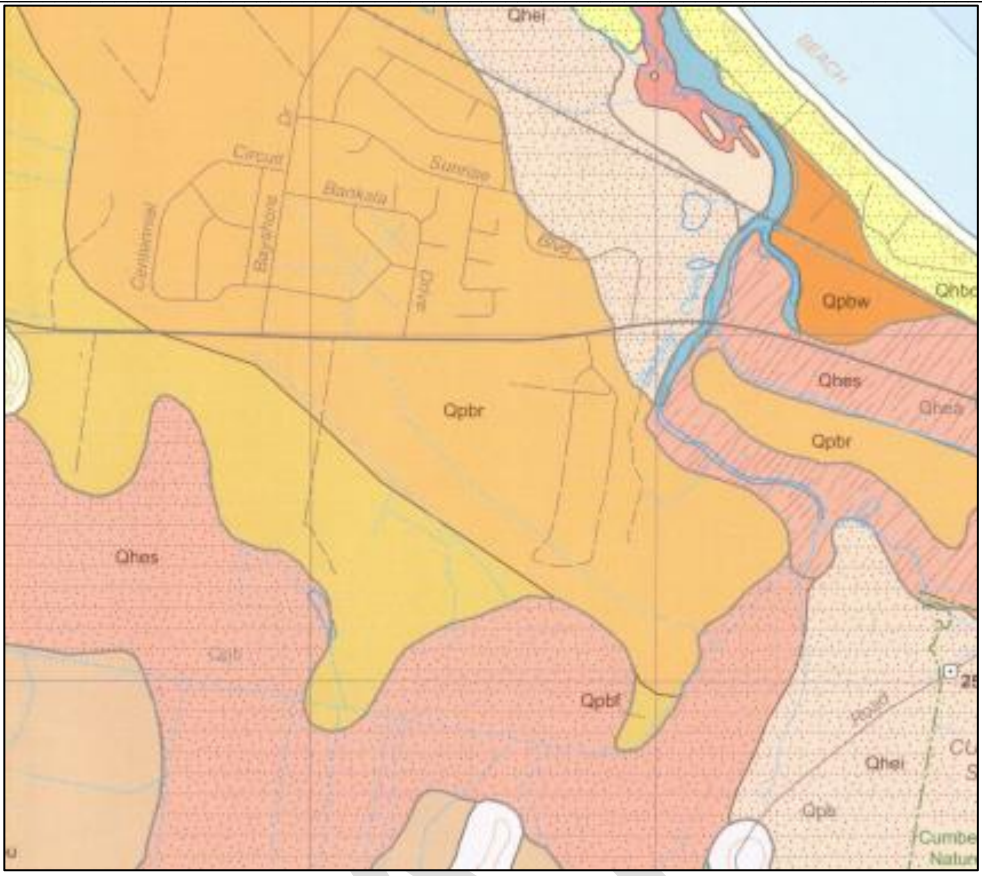


Figure 5 Geology (Hashimoto et al, 2008)

7 SOIL INVESTIGATION

Six (6) boreholes (BH1 – BH6) were drilled by Mazlab drilling contractor on site by HMC on 19 March 2019 ranging from 1.5m up to 2.5m depth in the locations shown in Appendix 1. The soil profile was generally sand/silty sand throughout the depth of investigation. This would be classed as a coarse texture soil.

Soil samples were generally collected from the boreholes at 0.5m depth intervals. Where a soil profile transition was recorded, a sample was collected. A total of 28 soil samples were collected. The samples were subjected to preliminary screening using the field pH (pH_F), oxidised field pH (pH_{FOX}), and reaction to both acid and hydrogen peroxide tests. (see Appendix 4).

Appendix 1 of the ASSMAC (1998) Assessment Guidelines states that pH_F readings of pH<=4 indicate that actual acid sulfate soil (AASS) may be present. pH_{FOX} readings of pH<3, with a level at least one unit below pH_F, and a strong reaction to the hydrogen peroxide indicate a high level of certainty of a potential acid sulfate soil (PASS). The greater the drop in pH_{FOX} below 3, the more positive the presence of oxidisable sulfur. To confirm the initial screening results, 15 of the soil samples were also subjected to Chromium Reducible Sulfur (S_{CR}) and Total Actual Acidity (TAA) tests.

The S_{CR} test measures the RIS in the soil and is particularly suited to coarse sediments (sand) with low RIS concentrations. The TAA test measures the existing acidity in the soil. It is noted that sources other than the oxidation of sulfidic sediments eg organic acids and metal oxyhydroxides may account for elevated TAA levels.

Action criteria thresholds are shown in Table 1

Table 1 Texture based ASS action criteria (Table 4 ASSMAC, 1998)

Type of Material		Action Criteria 1-1000 tonnes disturbed Existing + Potential Acidity		Action Criteria if more than 1000 tonnes disturbed Existing + Potential Acidity	
Texture Range	**Approx. clay Content (%<0.002 mm)**	**Equivalent sulfur (%S) (oven-dry basis)**	**Equivalent acidity (mol H^+/tonne) (oven dry basis)**	**Equivalent sulfur (%S) (oven-dry basis)**	**Equivalent acidity (mol H^+/tonne) (oven dry basis)**
Coarse Texture Sands to loamy sands	≤0 5	0.03	18	0.03	18
Medium Texture Sandy loams to light clays	5 – 40	0.06	36	0.03	18
Fine Texture Medium to heavy clays and silty clays	≥ 40	0.1	62	0.03	18

8 RESULTS

The results of the preliminary screening tests are summarised in Tables 2 and 3. No samples recorded field pH (pHF) were indicative of actual acid sulfate soil (AASS) (min. pHF 4.9). Four samples recorded pHFOX results (min pHFOX 2.6) that were slightly indicative of potential acid sulfate soil (PASS).

Reaction to hydrogen peroxide generally ranged from nil to low. A single sample recorded a medium reaction although the pHFOX was >3.0 (BH1 -1.0 pHFOX 3.2). No high or very high reactions were recorded. A nil reaction to hydrochloric acid was recorded, indicating buffering capacity eg shell was not present in the soil.

To confirm the screening results,15 selected samples were subjected to the Chromium Reducible Sulfur (SCR) and Total Actual Acidity (TAA) tests to confirm RIS and actual acidity levels.

The SCR results were all <0.01% confirming no RIS was present. Seven samples recorded TAA results (max 82 mol H+/T) that exceeded the action criteria for sandy soil (18 mol H+/T). None of the samples recorded a pHF result <4.0. The pHKCl for these samples was not indicative of AASS when adjusted to pHH20 results (add approximately 0.8 pH units).

Table 2 – Soil Analysis Summary

Test	Range	Action Criteria
pHF	4.9-6.8	<4.0
pHFOX	2.6-5.2	<3.0 & min 1 unit < pH_F
Reaction to HCl	Nil	Indicative of shell, carbonate
Reaction to H_2O_2	Nil – Medium	Strong
%SCR	<0.01	0.03 (coarse texture)
TAA mol H^+/t	3-82	18 (coarse texture)
ANC mol H^+/t	0	Indicative of shell, carbonate

Table 3 Soil Laboratory Analysis Results

Depth (m)	Borehole ID											
	(BH1)				(BH2)				(BH3)			
	pH_F	pH_{FOX}	$\%S_{CR}$	TAA mol H^+/T	pH_F	pH_{FOX}	$\%S_{CR}$	TAA mol H^+/T	pH_F	pH_{FOX}	$\%S_{CR}$	TAA mol H^+/T
0.20-0.30									5.7	3.1	<0.01	**36**
0.40-0.50	6.8	5.2			6.8	4.9			5.6	3.7	<0.01	10
0.60-0.70									5.0	**2.6**	<0.01	**50**
0.70-0.80												
0.90-1.00	6.6	3.2	<0.01	3	6.6	4.2			4.9	3.4	<0.01	**25**
1.40-1.50	6.5	**2.7**	<0.01	5	6.5	4.3	<0.01	5	5.9	3.3		
1.90-2.00					6.0	3.7	<0.01	3	6.1	3.3		
2.40-2.50									5.9	3.3		

Depth (m)	Borehole ID											
	(BH4)				(BH5)				(BH6)			
	pH_F	pH_{FOX}	$\%S_{CR}$	TAA mol H^+/T	pH_F	pH_{FOX}	$\%S_{CR}$	TAA mol H^+/T	pH_F	pH_{FOX}	$\%S_{CR}$	TAA mol H^+/T
0.20-0.30												
0.40-0.50	6.8	5.2			6.5	4.3	<0.01	17	5.0	**2.6**	<0.01	**78**
0.60-0.70	6.6	3.2										
0.70-0.80									4.9	3.4	<0.01	**82**
0.90-1.00	6.5	**2.7**	<0.01	**78**	6.0	3.7	<0.01	-	5.9	3.3	<0.01	**42**
1.40-1.50	6.8	4.9			5.7	3.1	<0.01	-	6.1	3.3		
1.90-2.00	6.6	4.2			5.6	3.7			5.9	3.3		

Bold/shading - pH_F/pH_{FOX} indicative of ASS/PASS or S_{CR}/TAA Exceeds action criteria

9 DISCUSSION

The SCR results did not record RIS and although TAA results for several samples did exceed action criteria it appears the source of the acidity was not likely related to the oxidation of RIS. The pHF results were all >4.0 and the pHKCl results adjusted to reflect pHF were also all > 4.

The results show that although there is existing acidity in some of the collected samples, the results are generally below action criteria. Where action criteria has been exceeded, the acidity does not appear to be from the oxidation of RIS. As noted in the recent, *National Acid Sulfate Soils guidance: National acid sulfate soils sampling and identification methods manual, (Sullivan et al, 2018):*

"….it is important to note the acidity hazard of soil materials that are strongly acidic due to processes other than RIS oxidation, are not considered an ASS acidity hazard. Actual ASS are acid soil materials, but not all acid soil materials are Actual ASS. Naturally-occurring acidic soils are not uncommon and are not considered an environmental hazard that require management to change their acidity."

As stated in Sullivan et al (2018) *"Actual ASS materials are severely acidic (that is pH less than 4) as a result of RIS oxidation".*

The geological setting is also not indicative of ASS. The lowest elevation for the pipe invert is RL 1.78m AHD. In fact, only 20m length of the pipeline is below RL 2.0m AHD. As stated in White et al (1995) and Wilson (2005), the upper level of ASS is not expected to be higher than RL 1.0m AHD. The risk mapping shows the area is within a Pleistocene age geology not a Holocene age and the mapping confirms the area as "*low probability*" ASS.

10 ASS CONCLUSION

Acid sulfate soils have not been identified as being a constraint to the installation of the proposed pipeline within the proposed excavation zone. An Acid Sulfate Soil Management Plan or further investigation would not be required.

11 REFERENCES

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- Sullivan, L, Ward, N, Toppler, N and Lancaster, G 2018, *National Acid Sulfate Soils Guidance: National acid sulfate soils identification and laboratory methods manual,* Department of Agriculture and Water Resources, Canberra, ACT

12 APPENDICES

Appendix 1 Borehole Location

SEE NEXT PAGE

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Preliminary Acid Sulfate Soil Investigation

Byron Bay STP Flow Path

Base Drawing Source: NSW LPI

HMC Ref: HMCDWG2019.053

Job No: 2019.053
Date: March 2019
Revision Date:

Appendix 2 Site Photo

Photo 1 – View west along proposed pipeline alignment

Photo 2 – Drilling rig located at BH6

Appendix 3 Soil Laboratory Report

SEE NEXT PAGES

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EMAIL: mazlab@bigpond.com

Client: HMC Environmental **Project:** Byron Bay STP

Mazlab Job No: HMC3033 **Date:** 20/03/2019

LABORATORY TEST RESULTS
Certificate of Test Results – ASS Screenings

Sample No.	Client I.D	Soil Description (truncated)	Reaction to H_2O_2	Reaction to HCL	pHf	pHfox
44733	BH1-0.50	Sandy GRAVEL(GP) pale orange brown	Nil	Nil	6.8	5.2
44734	BH1-1.00	Silty SAND(SM) dark grey	Medium	Nil	6.6	3.2
44735	BH1-1.50	Silty SAND(SM) dark grey	Low	Nil	6.5	2.7
44736	BH2-.050	SAND(SP) pale brown	Nil	Nil	6.8	4.9
44737	BH2-1.00	Silty SAND(SM) dark brown	V/Low	Nil	6.6	4.2
44738	BH2-1.50	Silty SAND(SM) dark brown	V/Low	Nil	6.5	4.3
44739	BH2-2.00	Silty SAND(SM) dark brown	V/Low	Nil	6.0	3.7
44740	BH3-0.30	Silty SAND(SM) dark brown	V/Low	Nil	5.7	3.1
44741	BH3-0.50	Silty SAND(SM) dark brown	V/Low	Nil	5.6	3.7
44742	BH3-0.70	Silty SAND(SM) dark brown	Low	Nil	5.0	2.6
44743	BH3-1.00	Clayey SAND(SC) pale yellow & pale orange brown	Nil	Nil	4.9	3.4
44744	BH3-1.50	SAND(SP) pale brown	V/Low	Nil	5.9	3.3
44745	BH3-2.00	Silty SAND(SM) brown	V/Low	Nil	6.1	3.3
77446	BH3-2.50	Silty SAND(SM) dark brown	V/Low	Nil	5.9	3.3

Checked By: ______________________

Laboratory Test Methods follow procedures described in : QASSIT – Acid Sulphate Soils Laboratory Methods Guidelines – Version 2.1 June 2004

Environmental Testing, Sampling and Drilling (Vibracore)

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Client: HMC Environmental **Project:** Byron Bay STP

Mazlab Job No: HMC3033 **Date:** 20/03/2019

LABORATORY TEST RESULTS
Certificate of Test Results – ASS Screenings

Sample No.	Client I.D	Soil Description (truncated)	Reaction to H_2O_2	Reaction to HCL	pHf	pHfox
44747	BH4-0.50	Sandy CLAY(CL) pale yellow & pale orange brown	Low	Nil	6.8	5.2
44748	BH4-0.70	Sandy CLAY(CL) pale yellow & pale orange brown	Low	Nil	6.6	3.2
44749	BH4-1.00	Silty SAND(SM) pale yellow, pale orange & pale grey	Low	Nil	6.5	2.7
44750	BH4-1.50	Silty SAND(SM) grey/dark grey	V/Low	Nil	6.8	4.9
44751	BH4-2.00	Silty SAND(SM) dark brown	V/Low	Nil	6.6	4.2
44752	BH5-0.50	SAND(SP) pale grey brown	Low	Nil	6.5	4.3
44753	BH5-1.00	SAND(SP) pale grey brown	Low	Nil	6.0	3.7
44754	BH5-1.50	Silty SAND(SM) dark brown	Low	Nil	5.7	3.1
44755	BH5-2.00	Silty SAND(SM) dark brown	Low	Nil	5.6	3.7
44756	BH6-0.50	Silty SAND(SM) dark brown	Low	Nil	5.0	2.6
44757	BH6-0.80	Topsoil - Silty SAND(SM) dark grey with organics	V/Low	Nil	4.9	3.4
44758	BH6-1.00	Silty SAND(SM) dark brown	Low	Nil	5.9	3.3
44759	BH6-1.50	Silty SAND(SM) brown	Low	Nil	6.1	3.3
44760	BH6-2.00	Silty SAND(SM) brown	Low	Nil	5.9	3.3

Checked By: ______________________

Laboratory Test Methods follow procedures described in : QASSIT – Acid Sulphate Soils Laboratory Methods Guidelines – Version 2.1 June 2004

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Mazlab Job No: HMC3033 **Date:** 22/03/2019

LABORATORY TEST RESULTS
Certificate of Test Results – Chromium Reducible Sulphur

Sample No.	Client I.D	Soil Description (truncated)	pH KCL	SCr mol (H+/t) %S	TAA mol (H+/t)	SNAS %S	ANC mol (H+/t) NA= Scr< action limit	Net Acidity mol (H+/t)	Liming Rate (Kg/ dry/ t)
44734	BH1-1.00	Silty SAND(SM) dark grey	6.1	<2 <0.01%	3	-	-	3	Nil
44735	BH1-1.50	Silty SAND(SM) dark grey	5.9	<2 <0.01%	5	-	-	5	Nil
44738	BH2-1.50	Silty SAND(SM) dark brown	5.9	<2 <0.01%	5	-	-	5	Nil
44739	BH2-2.00	Silty SAND(SM) dark brown	5.7	<2 <0.01%	3	-	-	3	Nil
44740	BH3-0.30	Silty SAND(SM) dark brown	4.6	<2 <0.01%	36	-	-	36	2.8
44741	BH3-0.50	Silty SAND(SM) dark brown	5.2	<2 <0.01%	10	-	-	10	Nil
44742	BH3-0.70	Silty SAND(SM) dark brown	4.2	<2 <0.01%	50	<0.02%	-	50	3.9
44743	BH3-1.00	Clayey SAND(SC) pale yellow & pale orange brown	4.5	<2 <0.01%	25	-	-	25	1.9
44749	BH4-1.00	Silty SAND(SM) pale yellow, pale orange & pale grey	3.8	<2 <0.01%	78	<0.02%	-	78	6.0
44752	BH5-0.50	SAND(SP) pale grey brown	5.0	<2 <0.01%	17	-	-	17	Nil
44753	BH5-1.00	SAND(SP) pale grey brown	6.8	<2 <0.01%	-	-	NA	<2	Nil
44754	BH5-1.50	Silty SAND(SM) dark brown	6.6	<2 <0.01%	-	-	NA	<2	Nil
44756	BH6-0.50	Silty SAND(SM) dark brown	4.1	<2 <0.01%	78	<0.02%	-	78	6.0
44757	BH6-0.80	Topsoil - Silty SAND(SM) dark grey with organics	3.8	3 <0.01%	82	<0.02%	-	85	6.6
44758	BH6-1.00	Silty SAND(SM) dark brown	4.2	<2 <0.01%	42	<0.02%	-	42	3.3

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Laboratory Test Methods follow procedures described in : QASSIT – Acid Sulphate Soils Laboratory Methods Guidelines – Version 2.1 June 2004

Appendix 4 Laboratory Method

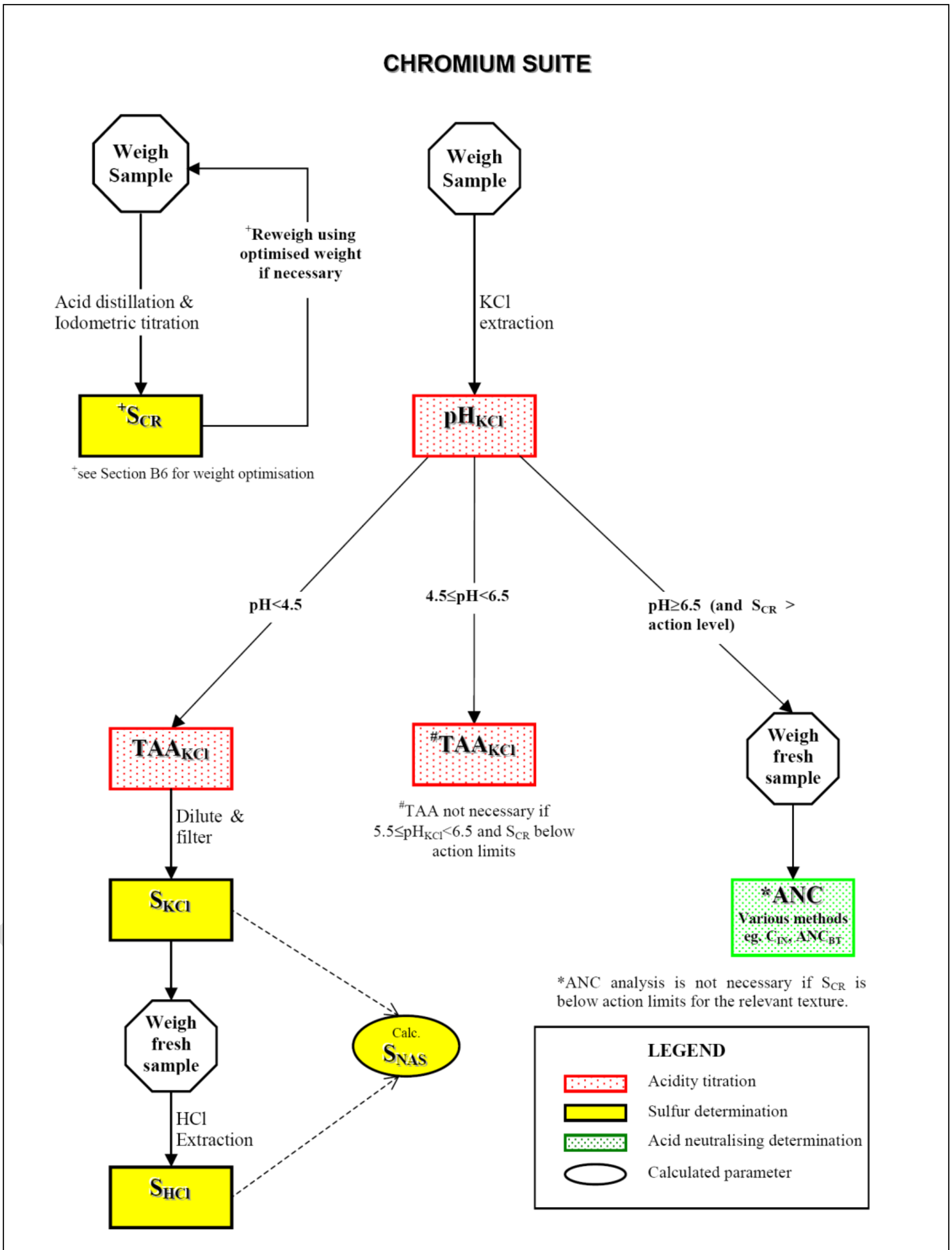

Figure A2.2. Flow diagram for Chromium suite.

Source: Ahern et al (2004)

Appendix 5 NSW ASS Elevation (extract from Wilson, 2005)

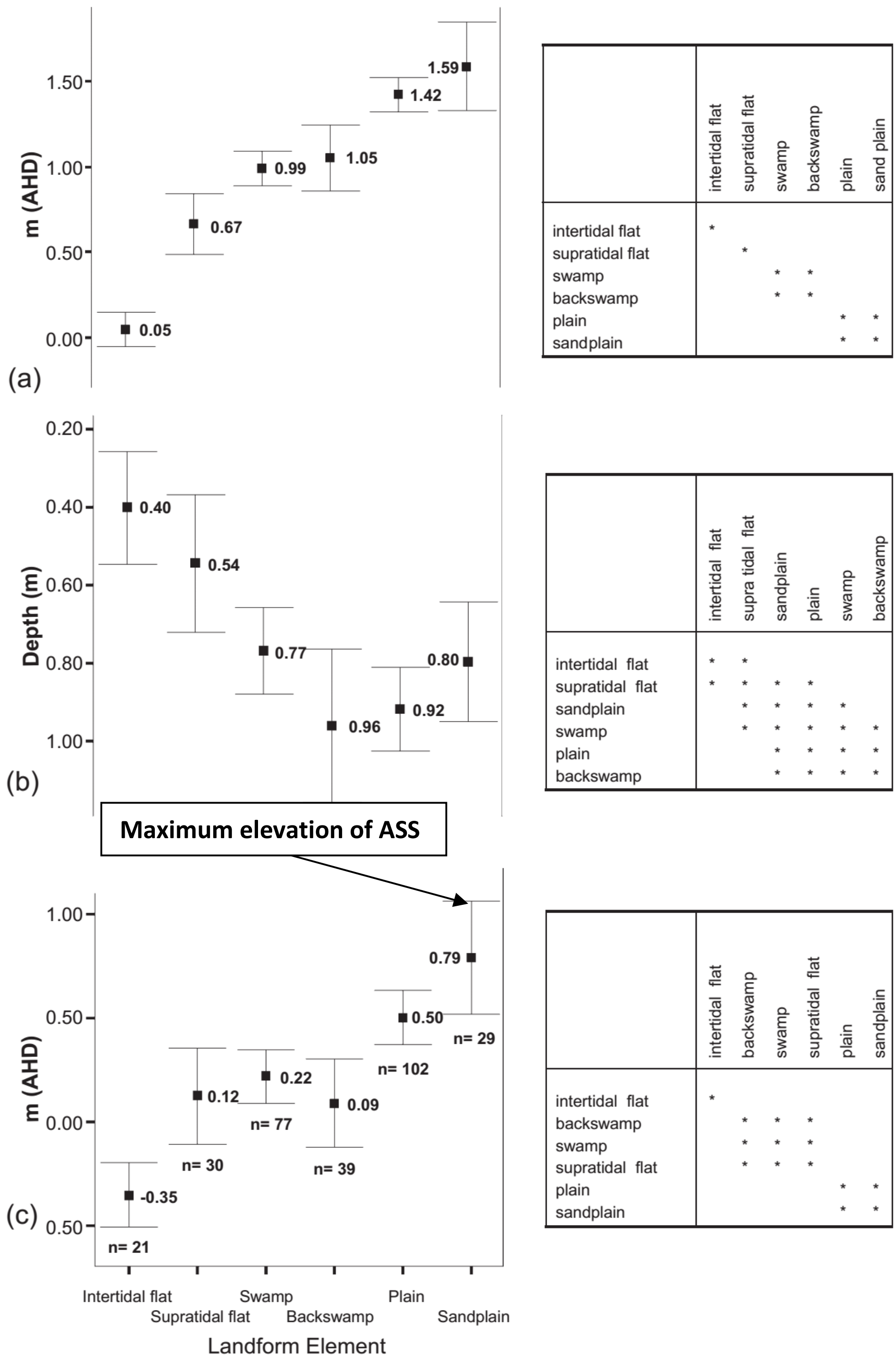

Fig. 2. Stratigraphic characteristics of all ASS profiles. Surface elevation (a), depth to sulfurous materials (b), and elevation of sulfurous materials (c). Error bars are 95% confidence interval of the mean. An asterisk (*) in similarity matrices indicates that mean difference between landforms is not significant (P<0.05).