



Proposed Residential Development

Woodlands North Development, Lot 33 DP754405, Ocean Drive, Kew

Acid Sulfate Soil Management Plan

Hopkins Consulting Pty Ltd

RGS21691.1-AD

Revision 0

22 June 2026



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1 INTRODUCTION

Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a geotechnical assessment for the proposed Woodlands North residential development at Lot 33 DP754405, Ocean Drive, Kew.

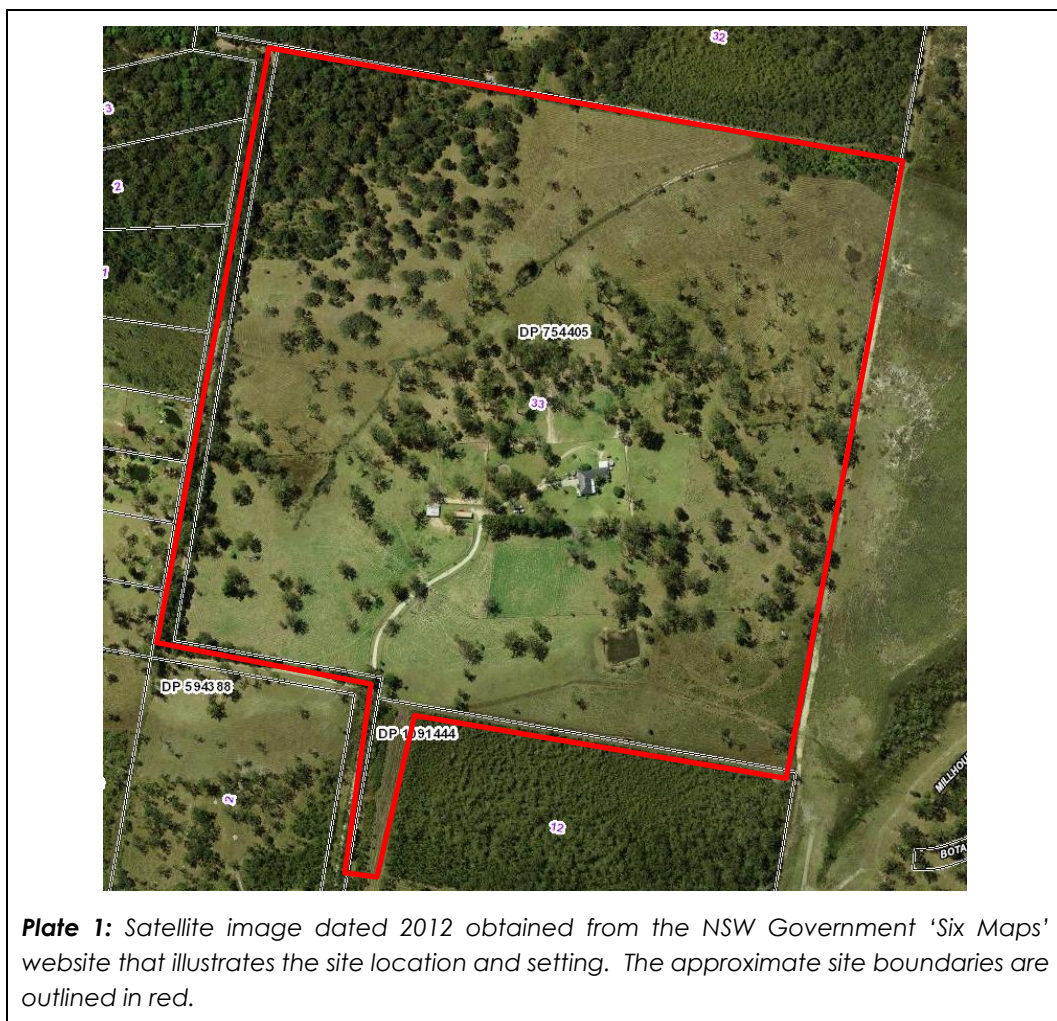
RGS has previously undertaken geotechnical assessments at the site, as documented in Report RGS21457.1-AB dated 1 December 2023 and Report RGS21457.1-AC dated 9 October 2025. Report RGS21457.1-AB included Acid Sulfate Soil (ASS) screening and detailed laboratory testing. The results of that investigation have been adopted for use in this Management Plan.

2 SITE CONDITIONS

The site is located to the north of Ocean Drive in an area of gently to moderately undulating topography where it is situated on the slopes of an alluvial terrace and a low hill in the north western corner that is up to RL 38m in elevation. A broad drainage depression up to approximately 100m width is located in the north of the site between the alluvial terrace and residual slope. A larger alluvial depression is located along the southern boundary of the site. Both alluvial depressions flow to the north east.

Surface elevations across the site range from approximately RL 28m in the north western corner to approximately RL 3m within the broad drainage depression. Surface slopes across the site are approximately 3 - 8° on the alluvial slopes to approximately 8 - 12° on the residual slopes.

A satellite image that shows the location of the site and the site setting is reproduced in Plate 1.



Two existing dwellings and a small metal shed are located near the centre of the site.

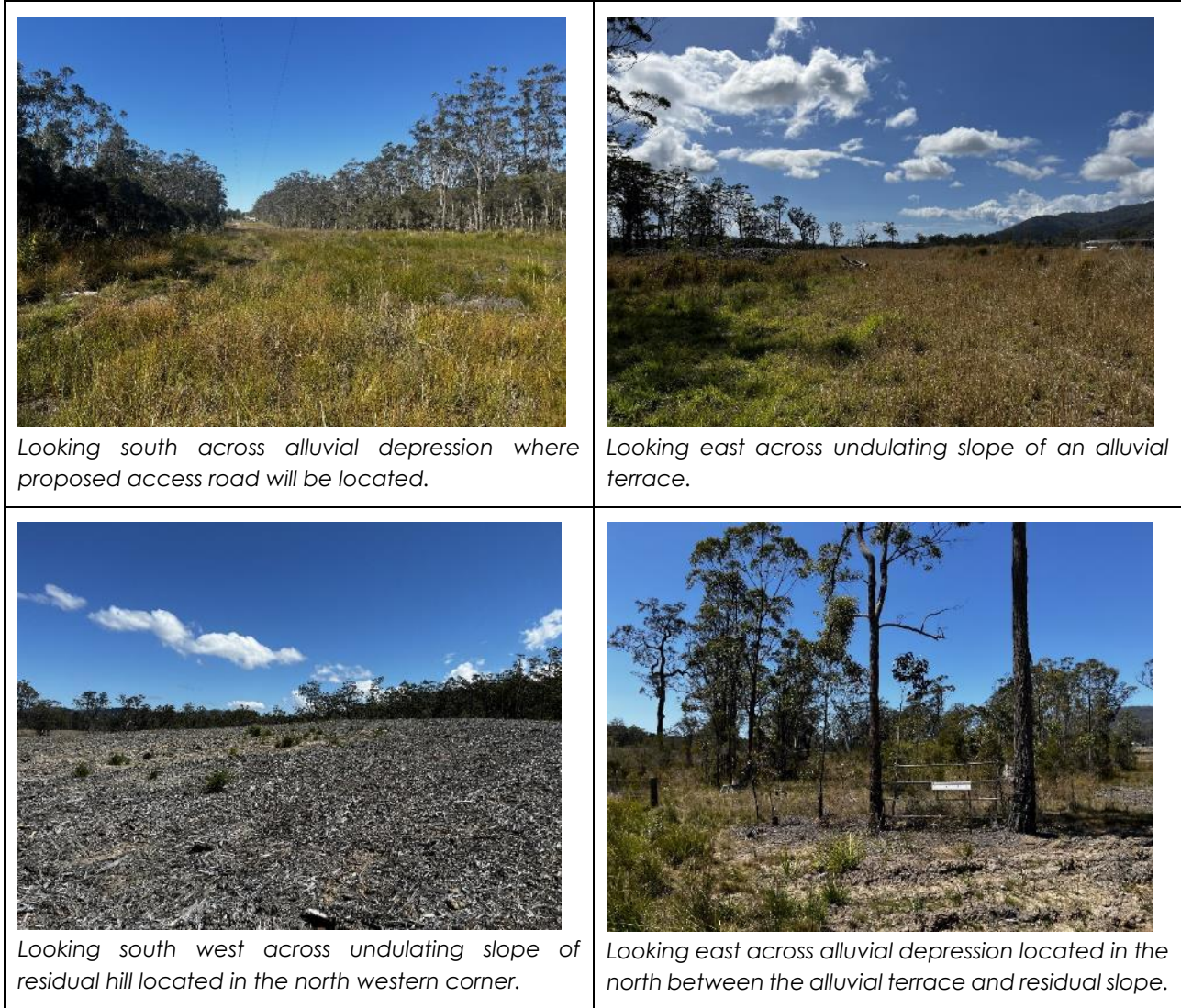
Site trafficability in 4WD was restricted in the low lying areas of the site.



Surrounding developments include rural properties in all directions. Vegetation comprised pasture grasses with scattered trees near the alluvial depressions.

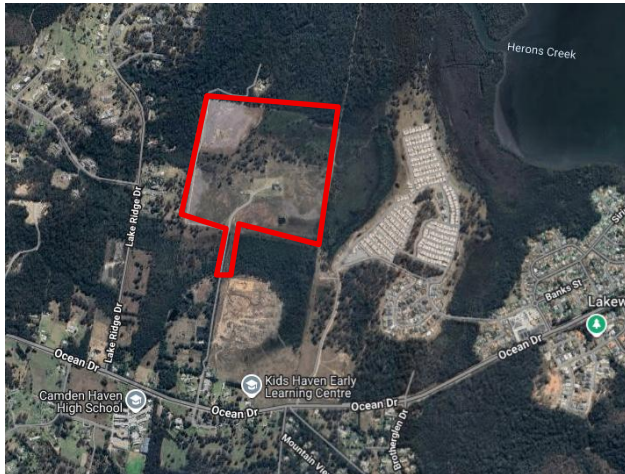
Drainage of the site would be via a combination of overland flow and surface infiltration. A small dam with water is located near the southern boundary.

Selected images from the investigation are presented below.

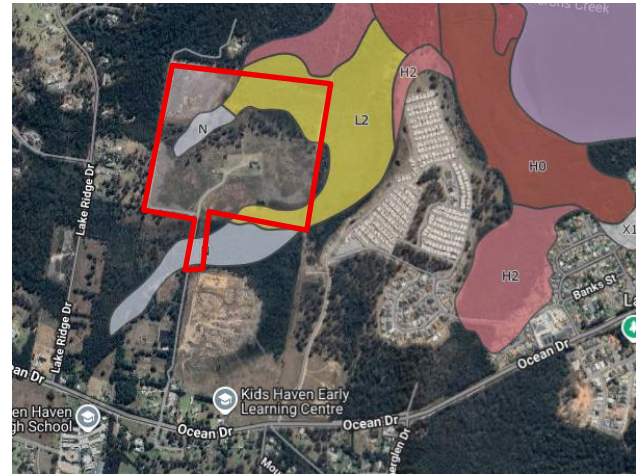


3 ACID SULFATE SOILS

Reference to the NSW Government eSPADE online mapping (reproduced below) indicates that portions of the site are located within areas of no known occurrence of Acid Sulfate Soils (ASS), while other portions are mapped as having a low probability occurrence of ASS at depths between 1m and 3m below ground surface.



Approximate location of the proposed residential development shown in red as indicated by eSPADE image.



Extract from the NSW Government eSPADE Acid Sulfate Soil Risk Map indicates that the site is located within areas of no known occurrence of Acid Sulfate Soils (ASS) and low probability of ASS occurrence. The location of the site is shown in red.

ASS produce sulphuric acid when exposed to oxygen due to the presence of iron sulphides in the form of pyrite within the soil matrix. These soils form when iron-rich sediments are deposited in saltwater or brackish water environments. Prior to oxidation, these pyritic soils are referred to as Potential ASS. ASS that has produced acid because of oxidation are referred to as Actual ASS. They typically occur in natural, low-lying coastal depositional environments below approximately 5m AHD. In the field, ASS is generally identified as saline sediments such as alluvial or estuarine soils or bottom sediments in creeks and estuaries.

In environments such as that which exists at the site, the pyrite and resultant acidity (if any) may exist within alluvial clays.

3.1 Laboratory Testing

Samples obtained from the investigation were submitted to the NATA accredited Environmental Analysis Laboratory (EAL) and screened for the presence of ASS. The results are presented in Appendix A and indicate the following:

- The pH of the samples in distilled water ranged from 4.15 to 5.06. A pH value of less than 4 in this test is considered indicative of Actual ASS;
- A low to medium reaction was noted in the samples after addition of hydrogen peroxide; and
- The pH of the samples after oxidation in hydrogen peroxide ranged from 2.9 to 4.43. A pH value of less than 3 in this test is considered indicative of Potential ASS (PASS) and a pH value between 3 and 4.5 as being possible PASS.

Based on the screening results, eight samples were submitted for detailed chromium reducible sulphur (CrS) and KCl extractable sulfur analysis. The results are presented in Appendix B and are summarised in Table 1.



Table 1 - Summary of Detailed ASS Analysis Results

Sample Location	Sample Depth (m)	Material	Texture	Titrateable Actual Acidity, TAA (mol H ⁺ /t)	Chromium Reducible Sulfur, S _{cr} (mol H ⁺ /t)	KCl Extractable Sulfur (mol H ⁺ /t)	Net Acidity (mol H ⁺ /t)	Lime kg CaCO ₃ /tonne
TP308	0.3 – 0.8	Alluvial Clay	Fine	50	11	--	61	5
TP308	0.8 – 1.3	Alluvial Clay	Fine	101	5	39	137	10
TP308	1.3 – 1.8	Alluvial Clay	Fine	96	7	38	128	10
TP308	1.8 – 2.0	Alluvial Clay	Fine	94	6	39	138	10
TP319	0.3 – 0.8	Alluvial Clay	Fine	91	5	20	95	7
TP319	0.8 – 0.9	Alluvial Clay	Fine	88	0	18	88	7
TP319	0.9 – 1.4	Alluvial Clay	Fine	98	0	14	98	7
TP319	1.4 – 1.9	Alluvial Clay	Fine	95	0	--	95	7
Criteria for ASS (Table 4.4 - ASS Manual)								
Fine-textured soils (>1,000 tonnes disturbed): Net Acidity >18 mol H ⁺ /t								

3.2 ASS Assessment Summary

A review of the above results indicates the following:

- All samples recorded Titrateable Actual Acidity (TAA) that exceeded the adopted action criteria indicating the presence of actual acidity;
- Oxidisable sulfur concentrations were below the adopted action criteria, indicating that PASS is not present at concentrations exceeding the adopted action criteria;
- Net acidity exceeded the adopted action criteria in all samples as outlined above indicating the presence of Actual (ASS);
- KCl-extractable sulfur testing was undertaken to assess the contribution of sulfur-derived acidity to the measured net acidity. KCl-extractable sulfur concentrations ranged from 14 to 39 mol H⁺/t, with several samples exceeding the adopted action criterion for fine-textured soils. This indicates that part of the measured acidity may be sulfur-derived. However, Chromium Reducible Sulfur (SCR) concentrations were below the adopted action criterion in all samples, indicating limited remaining oxidisable sulfides and a low potential for further acid generation.

Based on the TAA, Net Acidity and SCR test results, the alluvial soils encountered within the proposed development are classified as Actual Acid Sulfate Soil (AASS). The low SCR concentrations indicate that little oxidisable sulfide remains within the soils and that the measured acidity is largely associated with existing acidity rather than future sulfide oxidation.

An Acid Sulfate Soil Management Plan (ASSMP) is therefore required for any excavation, disturbance, handling or reuse of these soils.

An ASSMP has been prepared and is presented in Section 4. The ASSMP is based on lime treatment of the soils excavated from below existing ground level and assumes a liming rate calculated on the basis of more than 1,000 tonnes of excavated soil, adopting the following:

- Ag lime for neutralisation is to have a neutralising value (NV) of at least 90%; and



- A Factor of Safety of 1.5 for incomplete mixing

4 ACID SULFATE SOIL MANAGEMENT PLAN

4.1 Introduction

The Acid Sulfate Soil Management Plan (ASSMP) outlined below shall be adopted for works associated with the excavation of soils up to 3m of depth for the proposed residential development at Woodlands North, Lot 33 DP754405, Ocean Drive, Kew.

This ASSMP is aimed at remediating or controlling the generation of sulphuric acidity during the excavation of Actual ASS. It is to be applied to alluvial soils excavated within 3m below the existing ground surface level.

Attention is drawn to the fact that verification testing of the treated ASS generally takes between 5 and 10 working days and therefore time should be allowed in the earthworks management plan for the site for this process to occur.

The soil sampling program should be undertaken in accordance with NSW Acid Sulfate Soils Management Advisory Committee (1998) 'Acid Sulfate Soils Assessment Guidelines' (ASSMAC).

The ASSMP has been prepared in accordance with the ASSMAC (1998) guidelines.

4.2 Responsibilities

The project superintendent is responsible for implementing the ASS management protocols detailed within this ASSMP. Only a suitably experienced ASS consultant may vary the procedures detailed herein.

The superintendent shall:

- Obtain a survey of existing ground levels and develop a model of the site that allows identification of areas where excavations will exceed 1m depth below the existing levels;
- Ensure that the procedures outlined in this management plan shall be applied to all soils excavated below existing ground level;
- Record a daily log showing the volume of material that has been excavated and treated;
- Ensure that verification testing is undertaken by an independent monitoring consultant on a regular basis prior to removal or re-use of treated soils.

The requirements of the ASSMP are in addition to, but do not override any other standard procedures such as safety considerations. Where conflict results, or may result from, the implementation of the ASS management plan as against other performance criteria, the project superintendent shall obtain directives from the project manager or the ASS consultant as appropriate.

4.3 Neutralizing Materials

Fine Agricultural Lime (aglime) will be used for lining of processing or stockpile areas and for blending within excavated materials. Dolomitic aglime, or magnesium blend aglime, should not be used. The aglime shall have:

- At least 85% by weight passing 1mm, and 100% passing 2.5mm. In general a finer grind is better; and
- Aglime shall have a Neutralising Value (NV) of 90% or better (i.e. NV>90).



4.4 Management and Processing of ASS

4.4.1 Treatment Area

All alluvial soils excavated within 3m of existing ground level shall be placed in a prepared treatment area or filling area on site at an approved location. To prevent runoff to other areas of the site the treatment area shall be ringed by a bund wall that has a height of at least 0.5m that comprises soils that are not ASS or are treated ASS. The treatment area should be of sufficient size to treat the excavated materials at the proposed excavation rate and to store material for the period required to undertake the verification testing.

For materials excavated within 3m of the ground surface, the base of the treatment area and bund wall batter shall be limed at a rate of 10kg_{lime}/tonne_{soil}.

4.4.2 Treatment

The ASS shall be placed in the treatment area and spread in layers of not more than 300mm thick with lime being applied across the treatment area at a rate of 10kg_{lime}/tonne_{soil}.

4.4.3 Verification Testing

Verification testing shall be undertaken by an independent ASS consultant. The number of samples to be tested shall be based on the volume of the stockpile or treated soil within the treatment area as outlined in Table 2.

Table 2. Number of verification samples required based on treated soil/stockpile volume

Volume (m ³)	Number of samples
<250	2
251 - 500	3
501 – 1,000	4
>1,000	4 plus one per additional 500m ³

The samples shall be submitted for testing by the Chromium Reducible Sulfur suite and the Verification Net Acidity compared to ASSMAC Action Criteria. The Verification Net Acidity shall be determined from the test results as outlined below:

$$\text{Verification net acidity} = \text{Potential Sulfidic Acidity} + \text{Actual Acidity} + \text{Retained Acidity} - (\text{Post treatment Acid Neutralising Capacity} - \text{Initial Acid Neutralising Capacity})$$

If testing indicates verification net acidity values that exceed ASSMAC Action Criteria in the processed sand, reprocess (potentially requiring variation in the processing methodology) and re-sample to verify that acceptable values have been obtained.

All records applicable to acid sulfate testing and treatment shall be collated to substantiate treatment.

4.4.4 Water Quality Monitoring

Surface waters and groundwater collected in the treatment area or excavations shall be tested for pH on a daily basis during the works. If the recorded pH of any sample is less than 6, it shall be immediately retested. If the pH is again below 6, the pH shall be adjusted by the application of hydrated lime until it is in the range 6 to 8.

Where the pH is less than 4.0, the ASS Consultant shall be engaged within 6 hours to review the site practices and monitoring results and to recommend remedial measures.



Complete records of all monitoring results shall be maintained by the Contractor.

4.4.5 Post Treatment

Once the ASS materials have been treated in accordance with this ASSMP, the materials may be reused on-site, or disposed of at a licensed waste landfill. In accordance with a directive from the EPA, unless a specific order, exemption, or approval is granted from the EPA the treated material may not be reused on another site

5 IMPORTANT INFORMATION

This report comprises the results of an investigation carried out for a specific purpose and client as defined in the document. The report should not be used by other parties or for purposes or projects other than those assumed and stated within the report, as it may not contain adequate or appropriate information for applications other than those assumed or advised at the time of its preparation. The contents of the report are for the sole use of the client and no responsibility or liability will be accepted to any third party. The report should not be reproduced either in part or in full, without the express permission of Regional Geotechnical Solutions Pty Ltd.

Geotechnical site investigation is based on data collection, judgment, experience, and opinion. By its nature, it is less exact than other engineering disciplines. The findings presented in this report and used as the basis for the recommendations presented herein were obtained using normal, industry accepted geotechnical design practises and standards. To our knowledge, they represent a reasonable interpretation of the general condition of the site. Under no circumstances, however, can it be considered that these findings represent the actual state of the site at all points.

The recommended depth and properties of any soil, rock, groundwater, or other material referred to in this report is an engineering estimate based on the information available at the time of its writing. The estimate is influenced and limited by the fieldwork method and testing carried out in the site investigation, and other relevant information as has been made available. In cases where information has been provided to Regional Geotechnical Solutions for the purposes of preparing this report it has been assumed that the information is accurate and appropriate for such use. No responsibility is accepted by Regional Geotechnical Solutions for inaccuracies within any data supplied by others.

If site conditions encountered during construction vary significantly from those discussed in this report, Regional Geotechnical Solutions Pty Ltd should be contacted for further advice.

This report alone should not be used by contractors as the basis for preparation of tender documents or project estimates. Contractors using this report as a basis for preparation of tender documents should avail themselves of all relevant background information regarding the site before deciding on selection of construction materials and equipment.

If you have any questions regarding this project, or require any additional consultations, please contact the undersigned.

For and on behalf of **Regional Geotechnical Solutions Pty Ltd**

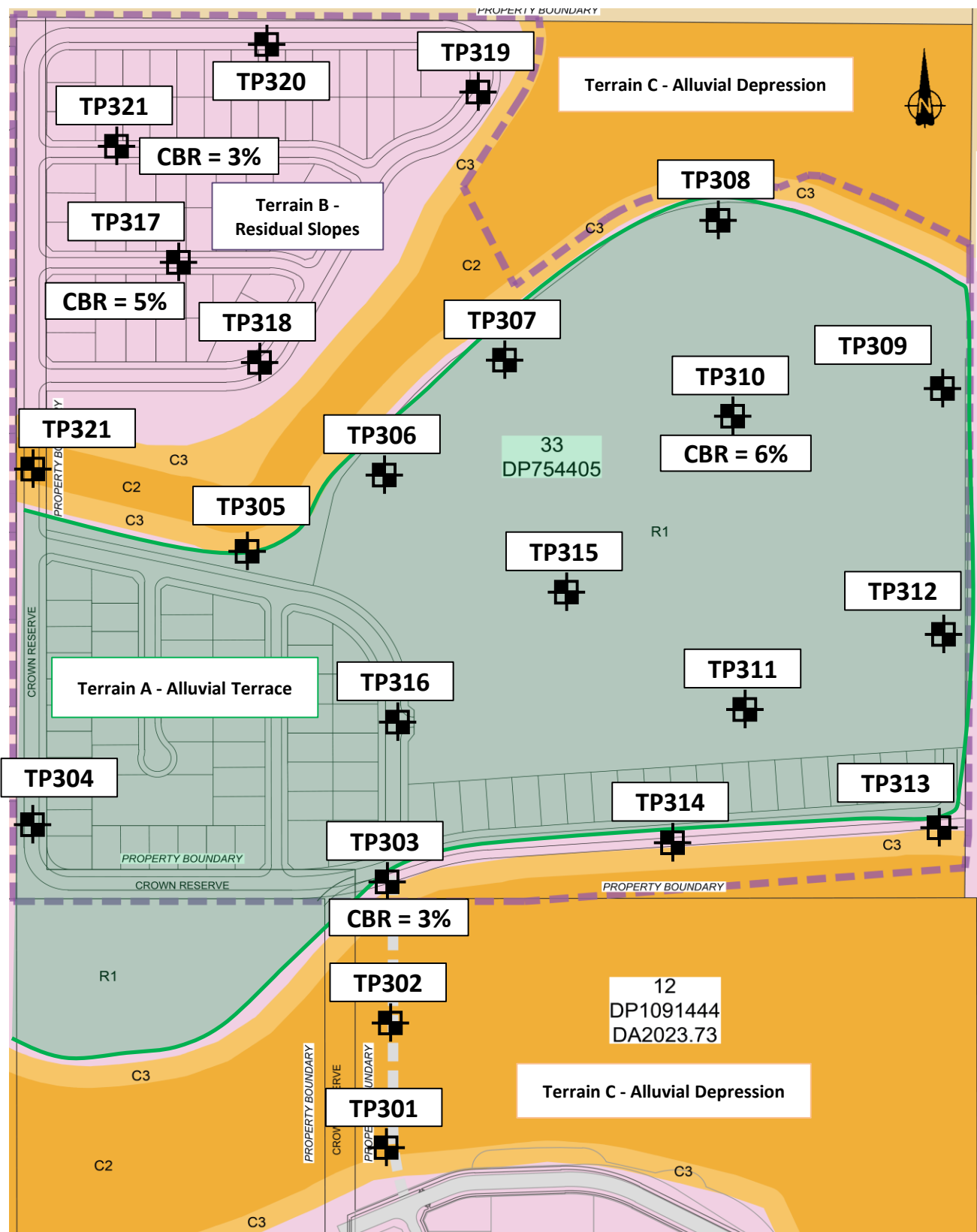
Prepared by

Grant Colliar

Senior Engineering Geologist



Figures



Legend
 Test Pit Location

Based on supplied drawing titled "WOODLANDS SUBDIVISION ZONING PLAN & LOT LAYOUT"

	Client:	HOPKINS CONSULTANTS	Job No.	RGS21457.1
	Project:	PROPOSED WOODLANDS NORTH	Drawn By:	GC
		OCEAN DRIVE, KEW	Scale:	NTS
	Title:	INVESTIGATION LOCATION PLAN	Date:	29-Nov-23
			Figure No.	1



Appendix A

Laboratory Test Results

RESULTS OF ACID SULFATE SOIL ANALYSIS

18 samples supplied by Regional Geotechnical Solutions Pty Ltd on 13/10/2023. Lab Job No. P6345.

Analysis requested by Grant Collilar. Your Job: RGS21457.1.

44 Bent Street WINGHAM NSW 2429

44 Bent Street WINGHAM NSW 2429

															Non-treated soil				Non-treated soil	
Sample Identification	EAL Lab Code	Texture	Moisture Content		pH _f and pH _{FOX}				KCl-extractable sulfur		Potential Sulfidic Acidity		pH _{KCl}	Actual Acidity (Titratable Actual Acidity - TAA) (mol H ⁺ /t)	Retained Acidity		Acid Neutralising Capacity		Net Acidity (mol H ⁺ /t)	Lime Calculation (kg CaCO ₃ /t DW)
			(% moisture of total wet weight)	(g moisture / g of oven dry soil)	pH _f	pH _{FOX}	pH change	Reaction	(S _{KCl})		(Chromium Reducible Sulfur - CRS)				(ANC _{NT})					
									(% S _{KCl})	(equiv. mol H ⁺ /t)	(% S _w)	(mol H ⁺ /t)			(% CaCO ₃)	(mol H ⁺ /t)				
Method Info.		**	(In-house method S21)						(In-house method S20)		(In-house method 16b)				(In-house method S14)					
TP308 0.3-0.8	P6345/1	Fine	20.2	0.25	4.32	3.21	-1.11	Low	..	..	0.017	11	4.71	50	..	..	..	..	61	5
TP308 0.8-1.3	P6345/2	Fine	30.2	0.43	4.38	3.17	-1.21	Medium	0.063	39	0.009	5	4.41	101	0.067	31	..	..	137	10
TP308 1.3-1.8	P6345/3	Fine	30.6	0.44	4.15	2.91	-1.24	Medium	0.061	38	0.011	7	4.34	96	0.053	25	..	..	128	10
TP308 1.8-2.0	P6345/4	Fine	29.2	0.41	4.16	2.90	-1.26	Medium	0.063	39	0.010	6	4.31	94	0.081	38	..	..	138	10
TP313 0.3-0.8	P6345/5	Fine	26.9	0.37	4.24	3.13	-1.11	Low	..	..	..	..	..	..	..	..	..	..	..	..
TP313 0.8-1.3	P6345/6	Fine	17.4	0.21	4.89	3.75	-1.14	Medium	..	..	..	..	..	..	..	..	..	..	..	..
TP313 1.3-1.8	P6345/7	Fine	18.0	0.22	4.98	3.84	-1.14	Medium	..	..	..	..	..	..	..	..	..	..	..	..
TP313 1.8-2.0	P6345/8	Fine	17.6	0.21	4.86	3.70	-1.16	Low	..	..	..	..	..	..	..	..	..	..	..	..
TP314 0.25-0.5	P6345/9	Fine	20.8	0.26	4.69	3.44	-1.26	Low	..	..	..	..	..	..	..	..	..	..	..	..
TP314 0.5-0.8	P6345/10	Fine	23.5	0.31	4.55	3.36	-1.19	Medium	..	..	..	..	..	..	..	..	..	..	..	..
TP314 0.8-1.3	P6345/11	Fine	17.3	0.21	5.06	3.86	-1.20	Medium	..	..	..	..	..	..	..	..	..	..	..	..
TP314 1.3-1.8	P6345/12	Fine	17.7	0.22	4.92	3.74	-1.18	Low	..	..	..	..	..	..	..	..	..	..	..	..
TP314 1.8-2.0	P6345/13	Fine	17.9	0.22	4.77	3.56	-1.21	Low	..	..	..	..	..	..	..	..	..	..	..	..
TP319 0.3-0.8	P6345/14	Fine	20.3	0.26	4.55	3.39	-1.16	Medium	0.032	20	0.008	5	4.45	91	<0.001	0	..	..	95	7
TP319 0.8-0.9	P6345/15	Fine	20.1	0.25	4.48	3.38	-1.10	Low	0.029	18	<0.005	0	4.46	88	<0.001	0	..	..	88	7
TP319 0.9-1.4	P6345/16	Fine	18.2	0.22	4.48	4.43	-0.05	Low	0.023	14	<0.005	0	4.39	98	<0.001	0	..	..	98	7
TP319 1.4-1.9	P6345/17	Fine	18.5	0.23	4.75	3.70	-1.05	Low	..	..	<0.005	0	4.50	95	..	..	..	..	95	7
TP319 1.9-2.0	P6345/18	Fine	18.1	0.22	4.52	3.46	-1.06	Low	..	..	..	..	..	..	..	..	..	..	..	..

NOTES:

- All analysis is reported on a dry weight (DW) basis, unless wet weight (WW) is specified.
- Samples are dried and ground immediately upon arrival (unless supplied dried and ground).
- Analytical procedures are sourced from Sullivan L, Ward N, Toppler N and Lancaster G. 2018. National acid sulfate soils guidance: national acid sulfate soils identification and laboratory methods manual, Department of Agriculture and Water Resources, Canberra, ACT. CC BY 4.0.
- The Acid Base Accounting Equation, where Acid Neutralising Capacity has not been corroborated by other data, is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity (Eq. 3.2; Sullivan et al. 2018 - full reference above).
- The Acid Base Accounting Equation for post-limed soil materials is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - (post treatment Acid Neutralising Capacity - initial Acid Neutralising Capacity) (Eq. 3.3; Sullivan et al. 2018 - full reference above).
While the Acid Neutralising Capacity of a soil material may not be included in the Net Acidity calculation (Note 4), it must be measured to give an Initial Acid Neutralising Capacity if verification testing is planned post-liming.
The Initial Acid Neutralising Capacity must be provided by the client to enable EAL to produce Verification Net Acidity and Liming calculations for post-limed soil materials.
- The Acid Base Accounting Equation, where Acid Neutralising Capacity has been corroborated by other data, is Net Acidity = Potential Acidity + Actual Acidity + Retained Acidity - Acid Neutralising Capacity (Eq. 3.1; Sullivan et al. 2018 - full reference above).
- The lime calculation includes a Safety Factor of 1.5 as a safety margin for acid neutralisation (Sullivan et al. 2018). This is only applied to positive values. An increased Safety Factor may be required in some cases.
- Retained Acidity is required when the pH_{KCl} < 4.5 or where jarosite has been visually observed.
- A negative Net Acidity result indicates an excess acid neutralising capacity.
- If insufficient mixing occurs during initial sampling, or during post-liming, or both: the Potential Sulfidic Acidity may be greater in the post-limed sample than in the initial sample; the post-liming Acid Neutralising Capacity may be lower in the post-limed sample than in the initial sample.
- An acid sulfate soil management plan is triggered by Net Acidity results greater than the texture dependent criterion: coarse texture ≥ 0.03% S or 18 mol H⁺/t; medium texture ≥ 0.06% S or 36 mol H⁺/t; fine texture ≥ 0.1% S or 62 mol H⁺/t (Table 1.1; Sullivan et al. 2018 - full ref**
- For projects that disturb > 1000 t of soil material, the coarse trigger of ≥ 0.03% S or ≥ 18 mol H⁺/t must be applied in accordance with Sullivan et al. (2018) (full reference above).
- Acid sulfate soil texture triggers can be related to NCST (2009) textures: coarse and peats = sands to loamy sands; medium = clayey sand to light clays; fine = light medium to heavy clays (Sullivan et al. 2018 - full reference above).
- Bulk density is required to convert liming rates to soil volume based results. Field bulk density rings can be submitted to EAL for bulk density determination.
- A negative Net Acidity result indicates an excess acid neutralising capacity.
- '..' is reported where a test is either not requested or not required. Where pH_{KCl} is < 4.5 or > 6.5, zero is reported for SNAS and ANC in Net Acidity calculations, respectively.
- Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.
- ** NATA accreditation does not cover the performance of this service.
- Analysis conducted between sample arrival date and reporting date.
- All services undertaken by EAL are covered by the EAL Laboratory Services Terms and Conditions (refer SCU.edu.au/eal/t&cs or on request).
- Results relate to the samples tested.
- This report was issued on 29/11/2023 and replaces the report issued on 19/10/2023. Net Acidity data is now included for selected samples.

