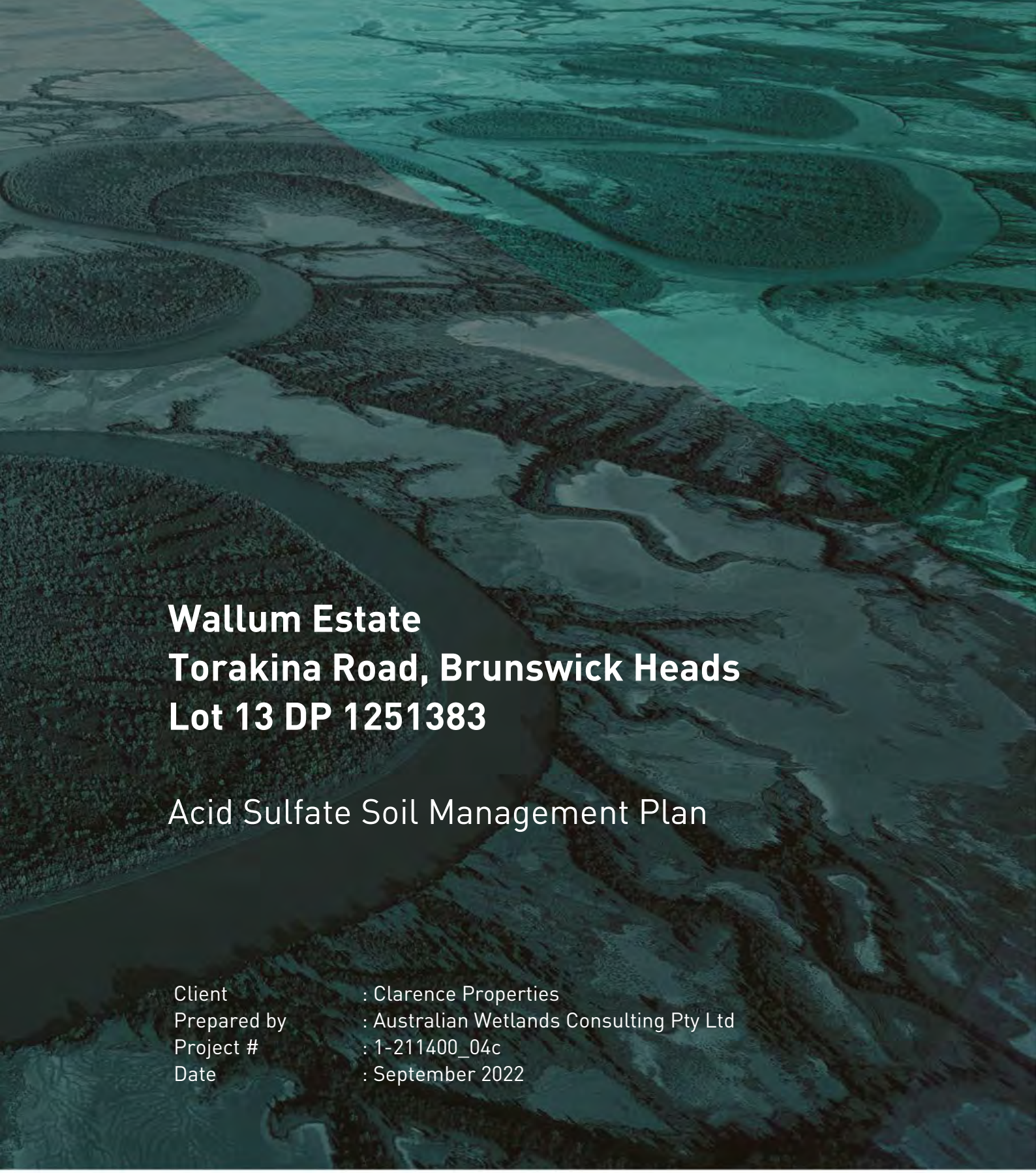

Wallum Estate
Torakina Road, Brunswick Heads
Lot 13 DP 1251383

Acid Sulfate Soil Management Plan

Client	: Clarence Properties
Prepared by	: Australian Wetlands Consulting Pty Ltd
Project #	: 1-211400_04c
Date	: September 2022

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Project control

Project name: **Wallum Estate**
Torakina Road, Brunswick Heads
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Job number: 1-211400_04c
Client: Clarence Properties
Contact: James Fletcher

Prepared by: Australian Wetlands Consulting Pty Ltd

8 George Street
Bangalow, NSW, 2479

P | (02) 6687 1550
E | admin@awconsult.com.au

Date:	Revision:	Prepared by:	Reviewed by:	Distributed to:
04/08/2021	A	Jesse Munro	Katrina Curran	Wade Fletcher (Civil Tech) James Fletcher (Clarence Properties)
09/08/2021	B	Jesse Munro	Minor amendment only	Wade Fletcher (Civil Tech) James Fletcher (Clarence Properties)
12/09/2022	C	Jesse Munro	Minor amendment only	Wade Fletcher (Civil Tech) James Fletcher (Clarence Properties)

Table of Contents

1 Introduction and Background

AWC has been engaged to prepare an Acid Sulfate Soil Management Plan (ASSMP) for the proposed Wallum Estate development (formerly known as the Bayside Brunswick Estate) to accompany the Development Application. Development consent is sought to undertake a staged subdivision to create 131 lots upon land described as 15 Torakina Road, Brunswick Heads, being Lot 13 in Deposited Plan 1251383.

1.1 Scope

This document has been prepared to guide management of Acid Sulfate Soils (ASS) during the construction phase of the Wallum Estate development. It is informed by several acid sulfate soil assessments that adequately cover the site and include detailed assessments of soil profiles, soil sample collection and laboratory analysis. These assessments are summarised in Section 1.4; the assessments are submitted to Byron Shire Council as the Amended Wallum Estate, Brunswick Heads - Acid Sulfate Soil Assessment – Drainage Line Works (AWC, 2021).

1.2 Site Overview

The proposed Wallum Estate is located on the southern outskirts of Brunswick Heads. The site is generally flat and vegetated by slashed open heath community with dense remnant vegetation comprising of closed wet and dry sclerophyll forests in the eastern portion of the site. Undeveloped bushland exists to the south and west with earlier stages of the Wallum Estate development to the north.

1.2.1 Soil Types

The New South Wales Department of Planning, Industry and Environment's *eSPADE 2.1* (https://www.environment.nsw.gov.au/eSpade2WebApp) shows the site to be located on the Black Rock (br) Landscape in which sediments are of aeolian origin. The following is a summary of the soil landscape description found in *Soil Landscapes of the Lismore Ballina 1:100,000 Sheet* (Morand 1994):

Soils:	Deep (>300cm), well drained Podzols on dunes; Deep (>300cm), imperfectly drained Humus Podzols and Peaty Podzols in depressions and deep (>200cm), waterlogged Acid Peats in swales; Deep (>300cm), rapidly drained Siliceous Sands on newer, seaward dunes.
Colour:	brownish black to black (topsoil-A_1 horizon); light grey to brownish grey (A_2 horizon; brownish black to reddish black with depth
Texture:	organic loamy sand (often fibric) or coarse sand in topsoils grading to fibric spongy loam to light clay with depth
Structure:	single grained in topsoil, massive at depth
pH:	4.0 to 6.0
Geology:	Quaternary (Pleistocene) beach and dune sands.
Limitations:	Non-cohesive, highly permeable, **highly acid soils** of low fertility. Organic soils in swales with permanently high watertables

1.2.2 ASS Risk Mapping

The work site subject to this assessment is located on soils classified as Class 3 on the ASS risk mapping as detailed in the Byron Local Environmental Plan 2014 (LEP 2014) and shown in Figure 1.1.

Table 1.1 which is sourced from Part 6.1 of Byron Shire Council's (BSC) Byron Local Environmental Plan 2014 (LEP 2014), shows types of works and the required assessment based on ASS risk mapping classification.

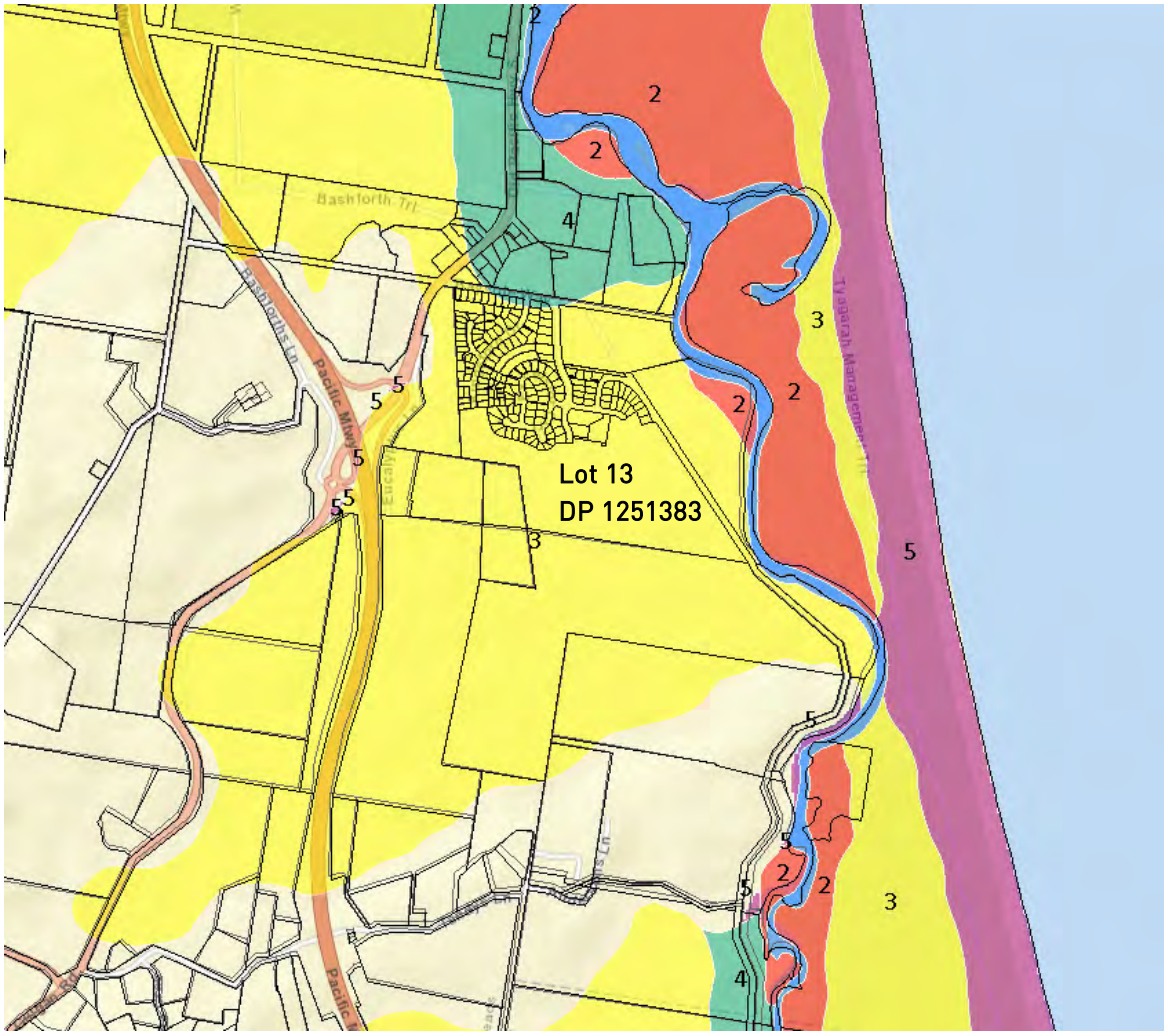


Figure 1.1 ASS risk mapping of the property Lot 13 DP 1251383. Yellow shading refers to Class 3 ASS (Source: Byron Shire Council online ASS LEP 2014; https://maps.byron.nsw.gov.au/Html5Viewer/index.html?viewer=ByronMaps)

Table 1.1 ASS classification and corresponding work requiring assessment

Class of Land	Works
1	Any works
2	Works below natural ground surface Works by which the water table is likely to be lowered
3	Works beyond 1m below natural ground surface Works by which the water table is likely to be lowered beyond 1m below natural ground surface
4	Works beyond 2m below natural ground surface Works by which the water table is likely to be lowered beyond 2m below natural ground surface
5	Works within 500m of adjacent Class 1, 2, 3 or 4 land which are likely to lower the water table below 1m AHD on adjacent Class 1, 2, 3 or 4 land

1.2.3 Acidophilic Ecosystem

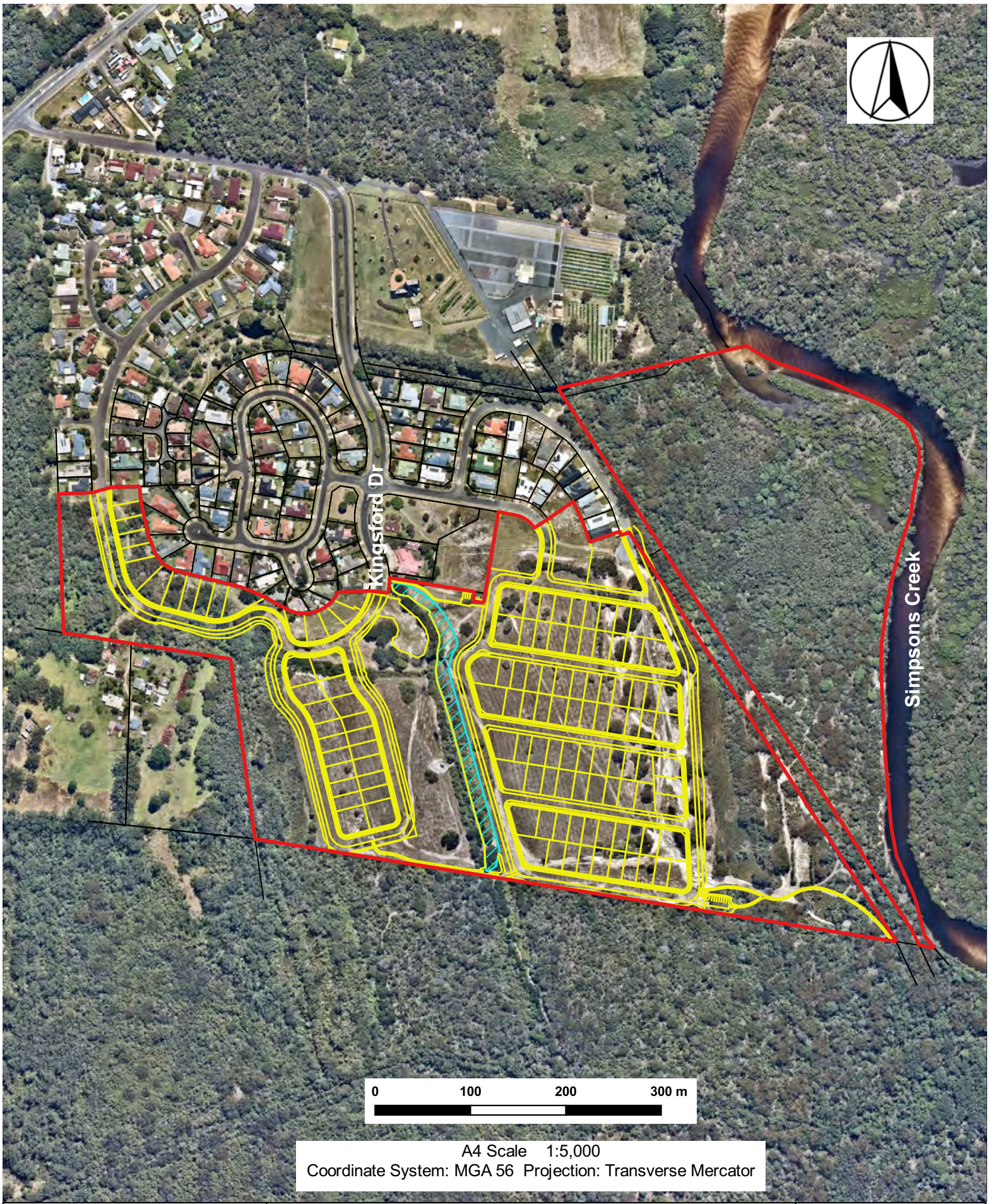
The subject site has a naturally occurring acidity formed through organic acids (humic acid). Flora and fauna have evolved to accept this acidity which includes the Wallum Froglet (*Crinia tinnula*) which is a 'Vulnerable Species' under the NSW Biodiversity Conservation Act 2016 and is known to occur on the site. The creation and retention of Wallum Froglet habitat is a primary concern with the design of the subdivision works and preservation of the low pH water on site is a high priority. As such, no attempts should be made to 'neutralise' surface and groundwaters at the site. Further detail on the site design response and Wallum Froglet can be found in the Wallum Froglet Management Plan (AWC, 2021).

1.3 Proposed Development Description

Development consent is sought to undertake a staged subdivision to create 131 lots upon land described as 15 Torakina Road, Brunswick Heads (Lot 13 in DP 1251383). The application proposes the subdivision of the land in 3 stages comprising, 123 residential lots, three (3) medium density lots, one (1) residue lot and three (3) public reserves together with associated public roads and infrastructure services (water, sewer, drainage and stormwater management works), bulk earthworks, tree removal and vegetation management works (refer Figure 1.2).

The development occupies approximately 13.33 ha (43.7 %) of the site. Residual land outside of the development footprint (~17.2 ha) will be managed for biodiversity and comprises public reserves (P1, P2 and P3) and land to be retained in private ownership (Lot B128). Public reserves will be dedicated to Council once required works are completed. The portion of the site east of the road reserve flanking Simpsons Creek (10.24 ha) will also be dedicated to Council.

There will be some excavation works along the primary drainage line and formation of habitat areas. Soil disturbance will be due to all proposed works on site, however much of the disturbance area is limited to the surface. The main area of excavation will be along the drainage line, acid frog habitat development (ponds) and for trenching of services. Refer civil design plans by Civil Tech.



A4 Scale 1:5,000
Coordinate System: MGA 56 Projection: Transverse Mercator

AWC

Disclaimer:
Care was taken in the creation of this map. AWC should be consulted as to the suitability of the information shown herein prior to the commencement of any works based on the information provided. AWC cannot accept any responsibility for errors, omissions or positional accuracy. There are no warranties expressed or implied as to the suitability of this map for a particular purpose. However, notification of any errors will be appreciated.

Legend

- Site
- Layout
- Side Swale

Figure 1.2 Proposed Development

Data source:
Aerial - Nearmaps
Layout - Cilviltech

Date:7-09-22
Job No:211400
Drawn:ED
Checked:DM

1.4 Acid Sulfate Soil Assessments

Previous ASS assessments have not detected any ASS on the site with recommendations including no further action required. Notwithstanding this, there needs to be some precautions taken to ensure ASS is identified if it is uncovered and management responses. The site is mapped as a Class 3 which suggests there is a moderate risk of ASS on the site; although a robust sampling regime has been undertaken there is always the chance that undetected ASS remains on the site.

Previous ASS assessments are discussed below:

1. ASS Assessment (Border Tech, 2010)

Border-Tech conducted an ASS Assessment at Lot 1 DP871039 that formed part of a Part 3A Major Project Development Application to the NSW Department of Planning. The Assessment combined results of preliminary ASS testing completed in 2003 by Jim Glazebrook and Associates Pty Ltd, dated August 2006, which involved 23 boreholes (approx. 1 borehole/ha) to a depth of 2.0m below surface level. Border-Tech drilled an additional seven boreholes to 2.0m below surface level in 2009.

Border-Tech concluded that the results suggest acid sulfate soils were not present within the proposed building footprint to a depth of 2.0m below the existing surface level and proposed no further action.

2. Geotechnical and Acid Sulfate Soils Investigation (Geotech, 2018)

Geotech Investigations Pty Ltd completed a geotechnical and acid sulfate soils investigation for the proposed 12-lot residential subdivision, being Stage 1A of "Bayside Brunswick" (north east corner). The investigation comprised the drilling and sampling of 12 boreholes to 3 m and 3.5 m depth, followed by laboratory testing, engineering analysis and reporting.

Geotech concluded that the laboratory results indicate that the action criterion for disturbance of ASS has not been exceeded on any samples collected, and therefore these disturbances will not require any treatment or management of ASS.

3. Bayside Estate, Brunswick Heads – Acid Sulfate Soil Assessment – Drainage Line Works (amended) (AWC, 2021)

AWC were engaged to undertake an ASS Assessment of the then proposed works on the primary drainage line through the site. These works are similar in nature to the amended subdivision design with excavations and widening of the drainage line proposed. The previous assessment is considered satisfactory for the current arrangement.

Three boreholes to a depth of 2.0m were made with four samples collected for laboratory analysis from each borehole. Net Acidity values above the trigger level were detected, however this was attributed to the naturally acidic environment and organic acids. The Retained Acidity and Potential Sulfidic Acidity values were low suggesting the Net Acidity of the system is not a function of ASS.

Organic acids (e.g., humic acid) are common in coastal ecosystems and can produce acid water and sediments with pH around 4.5 - -5.5 and can lead to Net Acidities exceeding the action criteria. These naturally occurring acidic soils form part of acidophilic ecosystems whose health depends on maintaining an acidic environment - they are not considered an environmental hazard that require management to change their acidity. The liming of naturally acidic ecosystems can lead to unnaturally alkaline environments and result in the ecological damage to the acidophilic organisms (e.g., acid frogs) that rely on the acidic nature of these ecosystems.

AWC concluded no amelioration or management of ASS is required for the proposed works in the main drain.

2 Acid Sulfate Soil Management

Although the ASS assessments on the site have not detected any ASS and have all generally concluded there is no action to be taken, some due diligence is required to ensure that if ASS is detected appropriate amelioration is conducted.

2.1 Induction

As part of the site induction provided to all staff and contractors on the construction site, details of the potential presence of ASS must be included. Staff are to be made aware of what to look for and who to inform (Environment Manager and/or Site Superintendent) should indicators be detected.

2.2 Monitoring to Detect Change

Likely indicators of potential ASS disturbance and acid production, and their monitoring are discussed below. Groundwater and surface water quality and groundwater levels are expected to be measured as a component of general construction phase environmental monitoring. This data is to be made available under the CEMP to the site superintendent and environmental manager to assess and act if required. Inspection of exposed soils during earthworks shall be undertaken to assess for visual indicators of ASS.

2.2.1 Groundwater Level

Decrease in groundwater levels caused by construction activities may instigate oxidation of Potential Acid Sulfate Soils (PASS) and subsequent acid production. Groundwater levels are to be monitored over the construction phase of the development, particularly during works such as dewatering or channel works. If substantial reductions in groundwater level are evident, further assessment of surface and groundwater quality will be required to confirm ASS indicators are not present.

2.2.2 Water Quality Monitoring

Water quality monitoring is to be undertaken on a routine basis during construction. Both groundwater (monitoring wells) and surface water will be monitored in accordance with the schedule in Table 2.1. Sample locations are shown on Figure 2.1. Surface waters will also be monitored for visual indicators.

Surface water will be collected from three internal sites, located in the primary drainage channel and tributaries. Groundwater samples will be collected from four groundwater monitoring wells, adjacent the primary drain works, groundwater will move laterally towards the drain expressing to surface waters.

Indicators of ASS disturbance and impact to the water on the site are discussed in Table 2.2, with trigger values provided. As the site can have naturally occurring low pH in water and soils, pH values alone are not sufficient to detect ASS impact. Previous data collected at the site provides an indication of the existing baseline pH levels allowing a trigger level to be determined (refer Table 2.2).

2.2.3 Soils

During excavation works ASS may be uncovered and exposed. Visual identification of ASS may be difficult however the following are potential indicators:

- Sulfur odour (rotten egg gas)
- Different soil types, particularly clays on this site
- Yellow mottles in the soil (jarosite)

If any of these are detected, excavations should cease and water testing immediately surrounding the works should be undertaken (as per Table 2.2). Additionally, soil pH can be tested in the field to provide an indication.

Table 2.1 Water quality monitoring schedule (ASS parameters)

Monitoring	Monitoring frequency	
	Routine #	Works based *
Routine visual and field parameters (soil and water)	Weekly	Daily
Routine surface water sample collection and laboratory analysis	Monthly	Weekly
Routine groundwater sample collection and laboratory analysis	Monthly	Weekly
Note: this schedule is in relation to the ASS Management Plan only, other water quality monitoring may be required for other environmental management. Frequency can be modified to align with other monitoring schedules to the satisfaction of the Site Superintendent, Environmental Manager and Byron Shire Council # Routine monitoring to continue through the construction phase and continuing for 3 months * E.g. dewatering and/or excavations, or other works to the satisfaction of the Environment Manager		

Table 2.2 Water indicators of ASS/PASS

Indicator Type		Parameter	Indicator	Comment	Trigger value
# Field/visual indicators		Actual ASS	• Water of pH <5.5 in adjacent streams, drains, groundwater or ponding on the surface • Unusually clear or milky blue-green drain water flowing from or within the area (aluminium released by the ASS acts as a flocculant) • Red iron colouring sediments deposited on aquatic plants and channels (refer Photo 1 and Photo 2)	Refer below for pH triggers Detection of unusually clear or milky blue-green water in drains is a key indicator; the naturally occurring waters on site are generally tannin stained Iron floc staining on the banks and aquatic plants of water courses ((refer Photo 1 and Photo 2))	Detection of clear and/or milky blue-green water in surface waters and/or groundwater and/or Detection of iron floc staining
		Potential ASS	• Water pH neutral but may be acid		
## Water Quality tests	Field parameters (hand held sensor)	pH	Change +/- 0.5 pH units from natural range (range varies depending on site location)	Baseline data for surface water shows pH range 4.05-5.86	pH <3.5 and/or >6.5 water in surface waters and/or groundwater
		TDS EC	TDS >1500 mg/L	Baseline data shows EC range 91-153 µS/m though close to an estuarine system,	EC values >500 µS/m
	Laboratory analysis	Calculation of $Cl:SO_4$ ratio	0.5 = indicator value	Existing range 1.8-15.96	>16
		Fe (total)	>500 µg/L	Existing range 233-3467 µg/L	>3500 µg/L
		Al (total)	5 µg/L for pH <6.5 100 µg/L for pH >6.5	Existing range 454-1370 µg/L	>1370 µg/L

Based on Table 2.3 of the ASSMAC Guidelines (1998)
ANZECC guidelines as part of commentary in ASSMAC (1998) (Section 5.3 pg 37)
TDS = Total Dissolved Solids; EC = Electrical Conductivity

Photo 1 Example iron floc staining

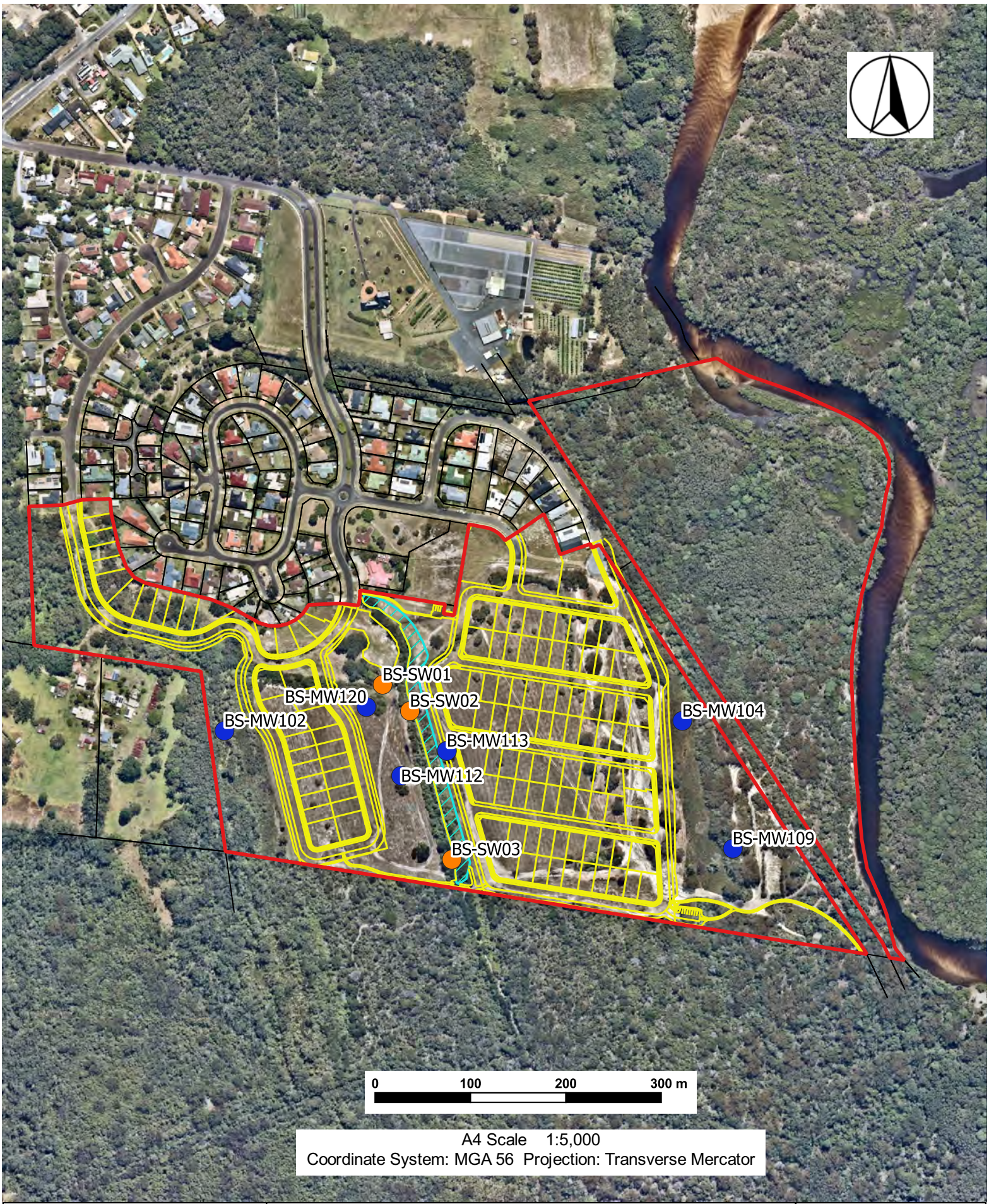
Photo 2 Example iron floc staining (2)

2.3 Trigger Response Plan

Table 2.3 provides a framework for the response required where monitoring reveals exceedance of assigned trigger values.

2.4 CEMP

A site-specific Construction Environmental Management Plan will be prepared by the primary contractor which will include all monitoring and trigger response plan detailed in this report. The monitoring will be informed by the proposed works plan, works methods and relevant staging.



A4 Scale 1:5,000
Coordinate System: MGA 56 Projection: Transverse Mercator

AWC

Legend

- Site
- 22.08.18_Wallum_Base_Layout entities
- Side Swale Edit 3
- Groundwater monitoring bores (amended Jan2022)
- Surface water monitoring locations

Figure 2.1 Routine groundwater and surface water sampling locations (for ASS management only)

Data source:
Aerial - Nearmaps 2022
Layout - Cilviltech
Monitoring Locations - AWC

Date:14-09-22
Job No:211495
Drawn:ED
Checked:JM

Table 2.3 Trigger Response Plan (ASS Management)

Indicator Type	Trigger	Management Response/Action
Groundwater Level	Reduction of groundwater level caused by construction works (i.e. dewatering)	1. Review data and validate 2. Notify Environmental Manager and/or Site Superintendent 3. Undertake investigation to confirm construction activities were the cause of groundwater level decrease/increase a. Engage suitably qualified consultant if necessary b. Consider recent relevant conditions (weather, works, other) c. Review other relevant monitoring data d. If investigation confirms trigger level exceedance is not a result of construction works, record data and cease investigation 4. If trigger exceedance is found to be caused by the construction works, determine if the activities have caused, or have the potential to cause substantial environmental harm a. Notify Environmental Manager, Site Superintendent, Byron Shire Council and other relevant authority b. Implement remedial measures c. Complete an Investigation Report detailing the incident and distribute to above 5. Review and revise Monitoring plan if necessary
Surface Water Quality – Field/visual indicators	Refer Table 2-2 and Photo 1 and Photo 2	1. Confirm data is correct (ie instrument calibration, review other relevant data) a. If trigger values are exceeded, undertake additional surface water laboratory analysis and investigation as below 2. Notify Environmental Manager and/or Site Superintendent

Indicator Type	Trigger	Management Response/Action
Surface water Quality – Water quality tests	Refer Table 2-2	1. Review data and validate 2. Notify Environmental Manager and/or Site Superintendent 3. Undertake investigation to confirm construction activities were the cause of surface water quality exceedance a. Engage suitably qualified consultant if necessary b. Consider recent relevant conditions (weather, works, other) c. Review other relevant monitoring data d. If investigation confirms trigger groundwater quality exceedance is not a result of construction works, record data and cease investigation 4. If trigger exceedance is found to be caused by the construction works, determine if the activities have caused, or have the potential to cause substantial environmental harm a. Notify Environmental Manager, Site Superintendent, Byron Shire Council and other relevant authority b. Engage suitably qualified and experienced consultant and determine and implement remedial actions c. Complete an Investigation Report detailing the incident and distribute to above d. Review and revise Monitoring plan if necessary
Groundwater Quality - Water quality tests	Refer Table 2-2	1. Review data and validate 2. Notify Environmental Manager and/or Site Superintendent 3. Undertake investigation to confirm construction activities were the cause of groundwater quality exceedance a. Engage suitably qualified consultant if necessary b. Consider recent relevant conditions (weather, works, other) c. Review other relevant monitoring data d. If investigation confirms groundwater quality trigger exceedance is not a result of construction works, record data and cease investigation 4. If trigger exceedance is found to be caused by the construction works, determine if the activities have caused, or have the potential to cause substantial environmental harm a. Notify Environmental Manager, Site Superintendent, Byron Shire Council and other relevant authority b. Engage suitably qualified and experienced consultant and determine and implement remedial actions c. Complete an Investigation Report detailing the incident and distribute to above d. Review and revise Monitoring plan if necessary

Indicator Type	Trigger	Management Response/Action
Soils	Evidence of ASS exposed during excavations including sulfidic dour (rotten egg gas), jarosite (yellow mottling), different soil types (i.e. grey clay)	1. Cease excavations a. Test soil for pH value and check for surrounding water quality indicators (field/visual indicators) b. If indicators suggest ASS has been exposed initiate further investigation (as below), if not document incident (provide to Environmental Manager) and continue excavation works 2. Notify Environment Manager and/or Site Superintendent 3. Engage suitably qualified consultant to undertake investigation to confirm extents and strength of ASS a. Consider recent relevant conditions (weather, works, other) b. Review other relevant monitoring data c. Undertake assessment and management as required 4. Complete an Investigation Report detailing the incident and distribute to Environment Manager, Site Superintendent and Byron Shire Council Implement remedial measures as required

3 Conclusion

There have been several ASS Assessments undertaken on the Wallum Estate (formerly Bayside Brunswick Estate) site over the years by different consultants. None of the assessments, which involved soils sampling and laboratory analysis in accordance with relevant guidelines, detected any Actual or Potential Acid Sulfate Soil. Nonetheless, as the site is mapped as Class 3 probability by Byron Local Environmental Plan 2014, there is the potential to expose undetected ASS, or impact ASS through dewatering works or reduction in groundwater levels during the construction phase. As such, monitoring of a range of indicators, including visual and water quality is recommended to detect impacts resulting from ASS.

4 References

AWC (2021) *Amended Bayside Estate, Brunswick Heads – Acid Sulfate Soil Assessment – Drainage Line Works*. A report prepared for Codlea Pty Ltd

AWC (2021a) *Bayside Brunswick, Bayside Way, Brunswick Heads Lot 13 DP 1251383 – Wallum Froglet Management Plan*. A report prepared for Clarence properties

BorderTech (2010) *Geotechnical Engineering Assessment.* A report prepared for Codlea Pty Ltd

GeoTech (2018) *Geotechnical and Acid Sulfate Soils Investigation for Proposed Residential Subdivision Stage 1A "Bayside Brunswick"* a report prepared for Codlea Pty Ltd

Bangalow

8 George Street
Bangalow NSW 2479
P 02 6687 1550
info@awconsult.com.au

www.awconsult.com.au