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Soil & Contamination Report

Subject = Identification & Extent of Acid Sulphate Soils

Report No. 2007-J28

Project Name: Bevian Road Concept Application

Site Location: Bevian Road, Rosedale

- Lot 2 DP 627034
- Lot 2 DP 623340
- Lot 11,29,32,72,102,118,119,213 DP 755902

Lot Yield: 816 Residential Lots

Land Area: 187.62ha including road reserves.

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Document No.	Issue	Description	Author	Approved by Director
2007- J28	JULY 2007	DRAFT	JO	JO

1. Executive Summary

The completed process of soil contamination site assessment and soil sample analysis complies with the intent and requirements of Section 12 CL.21.1 of the Director General Requirements. The control document for the environmental assessment is the Acid Sulphate Soil Manual by Assmac. D.G.R Section 12 is specific in its description of the requirement to identify the presence and extent of acid sulphate soils on the site and outline appropriate mitigation measures for control of contamination if contamination of soil with acid sulphate's oxidation potential is recorded. The completed site and soil assessment confirms that in the nominated zone of absolute constraints mapping indicating possible acid sulphate soils no evidence of these acid sulphate soils exist. Note that typical areas associated with risk of contamination by acid sulphate soils included the area bordering the nominated Sep 14 wetland.

2. Report Process Format

The Assmac assessment guideline provides a standard process for identification and extend of acid sulphate soils, this process includes:

Section 2:

The Preliminary Assessment:

2.1 Establish the general parameters of the proposed works.
2.2 Establish whether acid sulphate soils are present on the site.
2.3 Reporting on the Preliminary Assessment.

Appendix 1:

Field pH and the Peroxide Test.

Note that this description process has formed the basis of level of site assessment.

3. Report Outcome:

A series of 6 (six) test sites were established across the interface of proposed subdivision layout and nominated zone of possible acid sulphate soils. Soil cores were extracted at each site at depth varying from 1.5m to 3.0m dependant on characteristics of test site soil profile. As core samples were extracted the site soils were examined for indicators of acid sulphate soils as per Table 2.3 of Assmac, as no indicators were encounted in any test site soil samples were collected in air seal containers and refrigerated prior to lab testing. Collected soil samples were then tested in accordance with Appendix 1 of Assmac, see attached test result sheets from Table A1.1 of Assmac numbering no.1 to no.6. All field pH and peroxide test results were negative with no indication of sulphate oxidation in samples tested. Note that a site control comment is included in the test core results. See attached plan no.2007-J28/H01 indicating location of test site bores and absolute mapping extract.

4. Report Recommendation

Site works are able to be completed with no risk of encountering acid sulphate soils based on report outcome. Attached to this report is standard management guidelines based on advice contained within the Assmac assessment guidelines, these guidelines are to be adopted in the event site soil disturbance demonstrated characteristics described in the test core results site control comments.

If you require any additional information, please do not hesitate to contact the undersigned.

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JAMES. P. OLIVE.

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TABLE A1.1 Field pH and peroxide results

Project/Experiment: 2007/J28 – Bevian Road, Rosedale **Officer**: J. Olive **Field Technician**: L Olive **Date Collected**: 08/05/07

Profile ID: Test Hole 1 **Oven No.** N/A **Date In Oven:** N/A **Date out**: D/A **Date In Freezer:** 08/05/07
Date Tested: 09/05/07

Description: A1-B1 Light Clay
B2- Medium Clay
C – Medium/Heavy Clay

												Laboratory Analysis required
Lab No.	**SAMPLE NO**	**Core SAMPLE DEPTH**	**SAMPLED**	**Depth pH**	**pH$_F$**	**pH$_{FOX}$ Duplicate**	**Eff. Reaction**	**EC$_F$**	**Segr/Frag** SS – shell G- Gravels J – Jarosite R – Roots	**COMMENTS**	**POCAS**	**S TOS**
A	1	0.5	√	0.5	6.0	4.4	Low	0.25	G	Sulphide has not been oxidized at any time. Low PH can be attributed to other causes. I.e. reaction to H_20_2 by organic materials.	No	-
B	2	1.0	√	1.0	5.6	3.9	Low	0.49	G		No	
C	3	1.5	√	1.5	6.0	4.7	Low	0.53			No	-
D	4	2.0	√	2.0	6.6	4.7	Low	0.59			No	-
E	5	2.5	√	2.5	6.9	4.6	Low	0.55			No	-
F	6	3.0	√	3.0	7.0	6.1	Low	0.75			No	

Site Control Comments: The site soil characteristics shows minimal risk of sulphate oxidation. During the works process soil samples are to be continually monitored for sulfurous odour as excavation is completed and evidence of jarosite, pale yellow mineral deposits are to be recorded.
Note: If evidence of the potential for sulphate oxidation is encounted this is to be reported to site superintendent.

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TABLE A1.1 Field pH and peroxide results

Project/Experiment: 2007/J28 – Bevian Road, Rosedale **Officer**: J. Olive **Field Technician**: L Olive **Date Collected**: 09/05/07

Profile ID: Test Hole 2 **Oven No.** N/A **Date In Oven:** N/A **Date out**: D/A **Date In Freezer:** 09/05/07
Date Tested: 09/05/07

Description: A1-B1 Light Clay
B2- Medium Clay
C – Medium/Heavy Clay

												Laboratory Analysis required
Lab No.	**SAMPLE NO**	**Core SAMPLE DEPTH**	**SAMPLED**	**Depth pH**	**pH_F**	**pH_{FOX} Duplicate**	**Eff. Reaction**	**EC_F**	**Segr/Frag** SS – shell G- Gravels J – Jarosite R – Roots	**COMMENTS**	**POCAS**	**S TOS**
A	1	0.5	√	0.5	6.4	5.1	Low	0.20	G	Sulphide has not been oxidized at any time. Low PH can be attributed to other causes. I.e. reaction to H_20_2 by organic materials.	No	-
B	2	1.0	√	1.0	6.3	5.0	Low	0.36	G		No	
C	3	1.5	√	1.5	6.0	4.9	Low	0.49			No	-
D	4	2.0	√	2.0	6.4	5.2	Low	0.54			No	-

<u>Site Control Comments</u>: The site soil characteristics shows minimal risk of sulphate oxidation. During the works process soil samples are to be continually monitored for sulfurous odour as excavation is completed and evidence of jarosite, pale yellow mineral deposits are to be recorded.
Note: If evidence of the potential for sulphate oxidation is encounted this is to be reported to site superintendent.

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TABLE A1.1 Field pH and peroxide results

Project/Experiment: 2007/J28 – Bevian Road, Rosedale **Officer**: J. Olive **Field Technician**: L Olive **Date Collected**: 09/05/07

Profile ID: Test Hole 3 **Oven No.** N/A **Date In Oven:** N/A **Date out**: D/A **Date In Freezer:** 09/05/07
Date Tested: 09/05/07

Description: A1-B1 Light Clay
B2- Medium Clay
C – Medium/Heavy Clay

												Laboratory Analysis required
Lab No.	**SAMPLE NO**	**Core SAMPLE DEPTH**	**SAMPLED**	**Depth pH**	**pH$_F$**	**pH$_{FOX}$ Duplicate**	**Eff. Reaction**	**EC$_F$**	**Segr/Frag** SS – shell G- Gravels J – Jarosite R – Roots	**COMMENTS**	**POCAS**	**S TOS**
A	1	0.5	√	0.5	6.1	5.0	Low	0.14	G	Sulphide has not been oxidized at any time. Low PH can be attributed to other causes. I.e. reaction to H_20_2 by organic materials.	No	-
B	2	1.0	√	1.0	5.9	5.1	Low	0.24	G		No	
C	3	1.5	√	1.5	6.2	4.9	Low	0.33	G		No	-
D	4	2.0	√	2.0	6.5	4.8	Low	0.41			No	-
E	5	2.5	√	2.5	7.0	5.3	Low	0.44				

Site Control Comments: The site soil characteristics shows minimal risk of sulphate oxidation. During the works process soil samples are to be continually monitored for sulfurous odour as excavation is completed and evidence of jarosite, pale yellow mineral deposits are to be recorded.
Note: If evidence of the potential for sulphate oxidation is encounted this is to be reported to site superintendent.

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TABLE A1.1 Field pH and peroxide results

Project/Experiment: 2007/J28 – Bevian Road, Rosedale **Officer**: J. Olive **Field Technician**: L Olive **Date Collected**: 09/05/07

Profile ID: Test Hole 4 **Oven No.** N/A **Date In Oven:** N/A **Date out**: D/A **Date In Freezer:** 09/05/07
Date Tested: 10/05/07

Description: A1-B1 Light Clay
B2- Medium Clay
C – Medium/Heavy Clay

												Laboratory Analysis required
Lab No.	**SAMPLE NO**	**Core SAMPLE DEPTH**	**SAMPLED**	**Depth pH**	**pH$_F$**	**pH$_{FOX}$ Duplicate**	**Eff. Reaction**	**EC$_F$**	**Segr/Frag** SS – shell G- Gravels J – Jarosite R – Roots	**COMMENTS**	**POCAS**	**S TOS**
A	1	0.5	√	0.5	6.3	5.5	Low	0.11	G	Sulphide has not been oxidized at any time. Low PH can be attributed to other causes. I.e. reaction to H_20_2 by organic materials.	No	-
B	2	1.0	√	1.0	5.8	5.9	Low	0.21	G		No	
C	3	1.5	√	1.5	6.1	5.7	Low	0.26			No	-

Site Control Comments: The site soil characteristics shows minimal risk of sulphate oxidation. During the works process soil samples are to be continually monitored for sulfurous odour as excavation is completed and evidence of jarosite, pale yellow mineral deposits are to be recorded.
Note: If evidence of the potential for sulphate oxidation is encounted this is to be reported to site superintendent.

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TABLE A1.1 Field pH and peroxide results

Project/Experiment: 2007/J28 – Bevian Road, Rosedale **Officer**: J. Olive **Field Technician**: L Olive **Date Collected**: 09/05/07

Profile ID: Test Hole 5 **Oven No.** N/A **Date In Oven:** N/A **Date out**: D/A **Date In Freezer:** 09/05/07
Date Tested: 10/05/07

Description: A1-B1 Light Clay
B2- Medium Clay
C – Medium/Heavy Clay

												Laboratory Analysis required
Lab No.	**SAMPLE NO**	**Core SAMPLE DEPTH**	**SAMPLED**	**Depth pH**	**pH$_F$**	**pH$_{FOX}$ Duplicate**	**Eff. Reaction**	**EC$_F$**	**Segr/Frag** SS – shell G- Gravels J – Jarosite R – Roots	**COMMENTS**	**POCAS**	**S TOS**
A	1	0.5	√	0.5	6.6	4.8	Low	0.26	G	Sulphide has not been oxidized at any time. Low PH can be attributed to other causes. I.e. reaction to H_20_2 by organic materials.	No	-
B	2	1.0	√	1.0	7.4	5.7	Low	0.20	G		No	
C	3	1.5	√	1.5	6.7	5.1	Low	0.23			No	-
D	4	2.0	√	2.0	7.0	5.3	Low	0.25			No	-

Site Control Comments: The site soil characteristics shows minimal risk of sulphate oxidation. During the works process soil samples are to be continually monitored for sulfurous odour as excavation is completed and evidence of jarosite, pale yellow mineral deposits are to be recorded.
Note: If evidence of the potential for sulphate oxidation is encounted this is to be reported to site superintendent.

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TABLE A1.1 Field pH and peroxide results

Project/Experiment: 2007/J28 – Bevian Road, Rosedale **Officer**: J. Olive **Field Technician**: L Olive **Date Collected**: 09/05/07

Profile ID: Test Hole 6 **Oven No.** N/A **Date In Oven:** N/A **Date out**: D/A **Date In Freezer:** 09/05/07
Date Tested: 10/05/07

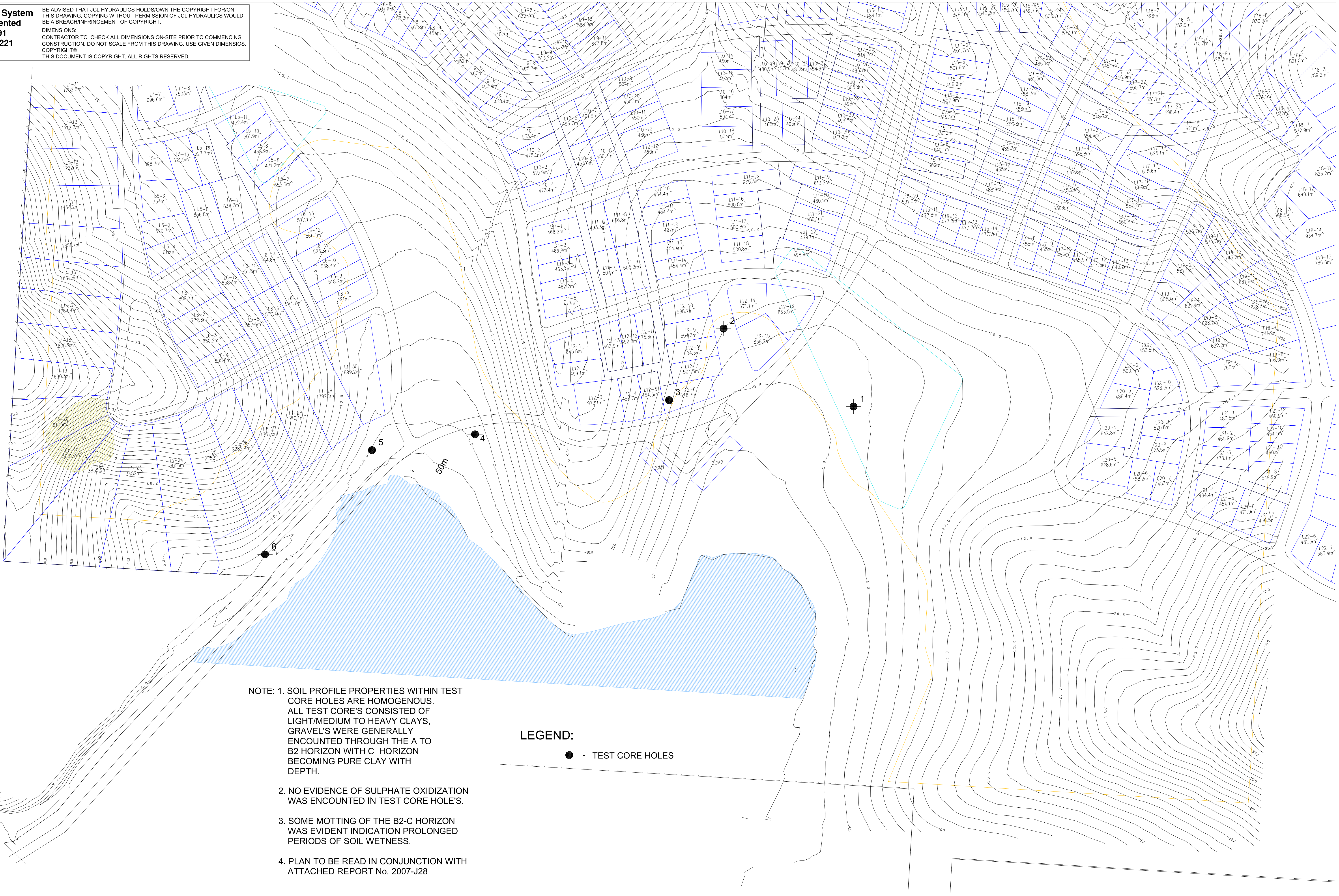
Description: A1-B1 Light Clay
B2- Medium Clay
C – Medium/Heavy Clay

												Laboratory Analysis required
Lab No.	**SAMPLE NO**	**Core SAMPLE DEPTH**	**SAMPLED**	**Depth pH**	**pH$_F$**	**pH$_{FOX}$ Duplicate**	**Eff. Reaction**	**EC$_F$**	**Segr/Frag** SS – shell G- Gravels J – Jarosite R – Roots	**COMMENTS**	**POCAS**	**S TOS**
A	1	0.5	√	0.5	5.5	4.1	Low	0.11	G	Sulphide has not been oxidized at any time. Low PH can be attributed to other causes. I.e. reaction to H_20_2 by organic materials.	No	-
B	2	1.0	√	1.0	5.0	3.8	Low	0.34	G		No	
C	3	1.5	√	1.5	4.9	3.2	Low	0.47			No	-
D	4	2.0	√	2.0	4.8	3.2	Low	0.55			No	-
E	5	2.5	√	2.5	4.6	3.1	Low	0.57			No	-

Site Control Comments: The site soil characteristics shows minimal risk of sulphate oxidation. During the works process soil samples are to be continually monitored for sulfurous odour as excavation is completed and evidence of jarosite, pale yellow mineral deposits are to be recorded.
Note: If evidence of the potential for sulphate oxidation is encounted this is to be reported to site superintendent.

Quality System Implemented ISO. 9091 Lic No. 221

DIMENSIONS:
CONTRACTOR TO CHECK ALL DIMENSIONS ON-SITE PRIOR TO COMMENCING CONSTRUCTION. DO NOT SCALE FROM THIS DRAWING. USE GIVEN DIMENSIONS.



NOTE: 1. SOIL PROFILE PROPERTIES WITHIN TEST CORE HOLES ARE HOMOGENOUS. ALL TEST CORE'S CONSISTED OF LIGHT/MEDIUM TO HEAVY CLAYS, GRAVEL'S WERE GENERALLY ENCOUNTED THROUGH THE A TO B2 HORIZON WITH C HORIZON BECOMING PURE CLAY WITH DEPTH.

2. NO EVIDENCE OF SULPHATE OXIDIZATION WAS ENCOUNTED IN TEST CORE HOLE'S.

3. SOME MOTTING OF THE B2-C HORIZON WAS EVIDENT INDICATION PROLONGED PERIODS OF SOIL WETNESS.

4. PLAN TO BE READ IN CONJUNCTION WITH ATTACHED REPORT No. 2007-J28

LEGEND:

● - TEST CORE HOLES

Issue:	Description:	Date:
B	REVISED SITE LAYOUT	03/08/07
A	PRELIMINARY	11/05/07

Project:
PROPOSED SUBDIVISON LOTS 11, 29, 32, 72, 102, 118, 119, & 213
DP 755902 LOT.2 DP 623340 & LOT.2 DP 627034 BEVIAN ROAD ROSEDALE.

Drawing Title:
ACID SULPHATE ASSESSMENT CORE HOLE LOCATION PLAN.

Date: 03/08/07
Scale: 1:2000
Plan No. 1/1
Drawn By: L.RICE
Design By: J.OLIVE
Checked By: ....
Drawing No. 2007-J28/H01
Issued For: PRELIMINARY B

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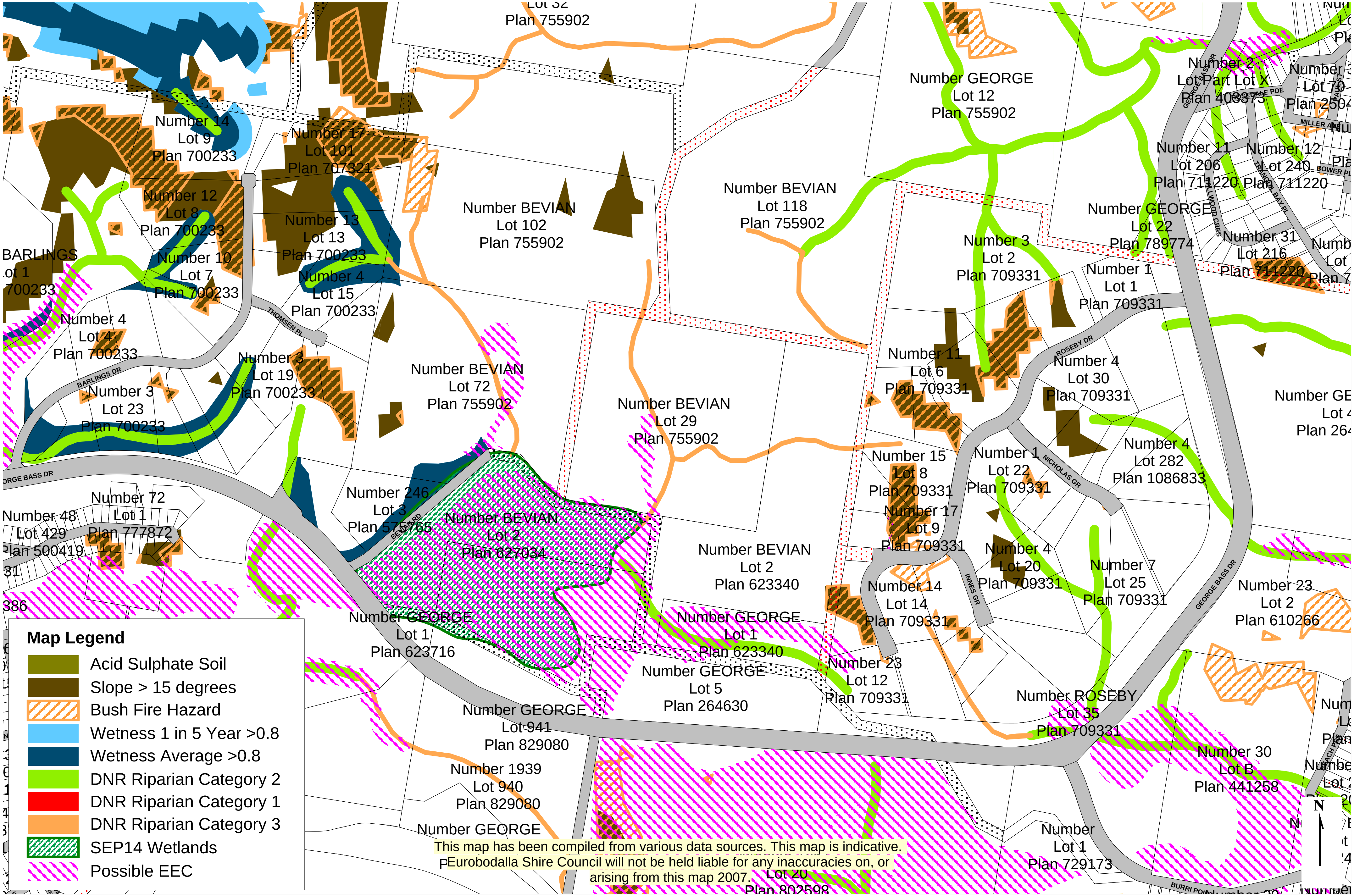
North Point.

Constraints Map for Various Lots Bevian Rd Rosedale



This map has been compiled from various data sources. This map is indicative. Eurobodalla Shire Council will not be held liable for any inaccuracies on, or arising from this map 2007.

Approximate Map Scale 1: 10,000

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MANAGEMENT GUIDELINES FOR INCIDENCE OF SULPHATE OXIDATION.

1. Techniques to be adopted in the management of extracted acid sulphate materials.

Where acid sulphate material is extracted as part of the excavation, the short and long term management of the material should be considered. Ideally, the extracted acid sulphate material should immediately be managed so that:

- The sulfidic material is not able to be oxidised (eg. placed back in an anaerobic environment preferably below the watertable) or
- The reduced volume of more concentrated sulfidic material is encouraged to oxidise quickly under a controlled situation with neutralisation of all leachate produced during treatment or
- The sulfidic material is allowed to oxidise slowly under a controlled situation with neutralisation of all leachate produced during treatment or
- The sulfidic material is separated out and managed by one of the above methods. Usually a precautionary low rate lime application is made to the existing soil surface prior to placement of the sluiced sand.

If it is necessary to stockpile the soils to treatment or disposal, provision should be made to safely store the material. Stockpiles of acid sulphate soils should be located in settings that ensure minimal environmental impact from any acidic leachate produced. The design of stockpile(s) should:

- Establish leachate collection and treatment systems including an impervious pad on which to place the stockpile.
- Minimise the surface area exposed to oxidation – consider using some form of artificial capping if storage is for longer than a few weeks.
- Minimise the amount of infiltration of water – consider using some form of artificial capping.
- Establish diversion banks upslope to prevent run-on water.
- Establish sediment control structure to ensure sulfidic material is not eroded – consider using some form of capping.

All stockpiles should be bunded and leachate collection and treatment systems should be installed. If an impervious pad has not been established under the stockpile, as a precautionary measure, an apron of fine lime should be applied when stockpiling materials for any length of time. In addition, to ensure acid groundwater movements off sites are contained or neutralised, an apron of limestone should be buried at least 0.5m below the current watertable level. The infiltration and movement of surface acid water out of the bund area is likely to be intercepted by the apron of limestone. Over the longer term, iron, aluminium and gypsum are likely to coat the limestone, reducing its effectiveness. If material is to be moved to another site, eg, landfill, then it must be fully treated with lime using at least a safety factor of 1.5 and tested to show success. Relevant approval from authorities will also be required. In general, direct return of concentrates to below the water table and covering with a layer of non-sulfidic material is the safest method. Most of the other methods have a greater risk component.

2. Techniques to Remediate Degraded Areas

The remediation of acid scalds or other degraded areas are receiving increasing attention. Techniques under consideration involve one or more of the following:

- Incorporating neutralising materials in surface layers
- Increasing the organic matter content in surface layers
- Planting acid and salt-tolerant species
- Raising groundwater levels by re-engineering drains, levees and floodgates.
- Removing floodgates, barrages and levees to allow flooding and inundation of the area.

Raising groundwater levels, altering existing drainage and particularly altering and removing floodgates, barrages and levees can modify the existing ecology of an area. A fresh water swamp, for example, may become a salt-water swamp dominated by mangroves and salt-water couch. In addition, salt-water inundation can lead to soil salinity rendering the land unproductive for most agriculture uses and have a drastic effect on the existing vegetation ecosystem.

The flooding of exposed actual acid sulphate or degraded areas as a remediation method should still be considered to be experimental requiring a high level of supervision and monitoring. Care should be taken as flooding of actual acid sulphate soils without appropriate neutralising material may lead to the export of significant volumes of acid water high in aluminium and iron content in the short and long term.

At this stage, the preferred re-flooding method appears to involve the following steps:

- Incorporate lime some months before re-flooding
- Increase the organic matter content by incorporating composted green waste, sugar cane waste, treated sewerage sludge (providing it does not contain heavy metals or excessive salt) or other composted materials into the surface of the soil.
- Modifying the drains and bunding the site so that the water movement onto and off the site can be controlled thereby providing a permanent cover of water. This option is only practical when an appropriate water balance can be maintained indefinitely. This will need to be established through an appropriate hydrological assessment.
- Manage water so that all water leaving the bunded area is treated to an acceptable standard.
- Encourage the growth of water couch and other water and acid tolerant species that will assist in building up an organic peat layer.
- Consult with DLWC or relevant authority in other states to establish a monitoring program to track the changes in the soil and water.

3. Factors when selecting neutralising materials

A variety of neutralising agents are available to add to soil or water to increase the pH to acceptable levels or to allow for future neutralisation of any acid produced from oxidation of sulphides. Depending on the circumstances, factors such as those listed below should be considered in selecting neutralising agents.

- Neutralising value (NV) and effective neutralising value (ENV)
- Solubility
- pH, chemical constituents, moisture content and contaminants or impurities
- Grades of lime, fineness rating or particle size
- Purchase price per tonne, delivery costs and size of a full load
- Spreading costs

From an environmental point of view, the most critical factors in managing outcomes are the pH of the neutralising agent, effective neutralising value (ENV) and solubility.

Generally the slightly alkaline, very low solubility products such as agricultural lime can be safely used on soil without the risk of leaching and contaminating the ground water or local waterways. The main issues associated with using these products involve limiting wind or water erosion of stockpiles and the practical difficulties in effectively incorporating or mixing the lime with often wet or lumpy acid sulphate soil material.

Commonly available agricultural limes are very stable chemically and take years to influence soil pH beyond the depth of mixing. Its controlled use should not normally present environmental risks. Results from a 79 year old trial indicate that lime moves down the profile at around 0.005m (5 mm) per year (Ridley *et al*. 1990.) Because of the difficulty in mixing lime with acid sulphate soil and the low reactivity of even fine lime, safety factors of 1.5-2 are usually required. Such a safety factor in addition to any correction factors for purity or particle size discussed later. It is important that product specifications be sought from the supplier and are confirmed prior to purchase or application.

Acid sulphate soil management plans usually require acid sulphate affected water to be treated to a pH of 6.5, if it is to be discharged from a site. However, low solubility safe products such as agriculture lime are inefficient at treating water. While the solubility is usually substantially increased in extremely low pH water, it becomes less soluble as the pH rises. As a result, it can be difficult to reach pH 6.5 in a reasonable time scale. Temperature is another important factor influencing the solubility of these products in water. Most solubility data refers to a temperature of 20-25°C only.

The more soluble neutralising materials, such as hydrated lime, provide a quicker response in treating acid water but carry a potential risk due to their solubility and more alkaline pH. The acid sulphate soil management plan needs to address any potential risk from higher pH products to the environment as well as to workers.

Provided due care and a responsible management plan is developed, there are circumstances where it may be more efficient to use a soluble alkaline product on soil, for example, to neutralise acidity at depth where excavation and mechanical mixing are not feasible. Rehabilitation of an existing acid affected area may be an example. A mixed lime or a hydrated lime may be used with an injection or slotting technique provided there is no leakage to groundwater, vegetation or other environmental considerations.

Agricultural lime with a pH of about 8.2, is the most widely used and the safest material. Other more caustic neutralising agents such as magnesium hydroxide (pH 12) or slaked lime (pH 12) impose environmental risks from overdosing with the potential damage estuarine ecosystems (Bowman, 1993).

Currently, there is interest in using industrial by-products or wastes from the cement, lime and smelting industries as acid neutralising agents. Prior to the use of industrial by-products as acid neutralising agents, trials should be run to determine their effectiveness in the field and analysis undertaken to check for the presence of containments such as heavy metals. Workplace, health and safety issues need to be considered when dealing with neutralising agents that are strongly alkaline.