G GEOTECHNICAL AND SITE CONTAMINATION ASSESSMENT

Steve Connelly CPP Pty Ltd

Proposed Residential Subdivision, Settlers Ridge, South West Rocks

Geotechnical and Preliminary Site Contamination Assessment - Revised Report

Report No. RGS20027.1-AC

22 August 2012

REGIONAL
GEOTECHNICAL SOLUTIONS

REGIONAL
GEOTECHNICAL SOLUTIONS

Manning-Great Lakes

Port Macquarie

Coffs Harbour

RGS20027.1-AC

22 August 2012

S J Connelly CPP Pty Ltd
PO Box 538
LENNOX HEAD NSW 2478

Attention: Mr Steve Connelly

Dear Steve,

RE: Proposed Residential Subdivision, Settlers Ridge, South West Rocks

Geotechnical and Preliminary Site Contamination Assessment - Revised Report

As requested, Regional Geotechnical Solutions Pty Ltd (RGS) had previously undertaken a preliminary assessment of geotechnical and site contamination conditions at the site of the proposed Settlers Ridge residential subdivision in South West Rocks as detailed in Report RGS20027.1-AB. The assessment has now been revised to reflect the proposed changes to the subdivision layout and this report now supersedes the original report.

The purpose of the assessment was to assist with providing Part 3A planning requirements for the proposed development. The assessment found the site to be appropriate for the proposed residential development from a geotechnical and site contamination perspective provided the recommendations and advice of this report are adopted

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

Tim Morris

Senior Engineering Geologist

Regional Geotechnical Solutions Pty Ltd
ABN 51141848820

5C/23 Clarence Street
Port Macquarie NSW 2444
Ph. (02) 6553 5641

Email tim.morris@regionalgeotech.com.au
Web: www.regionalgeotech.com.au

Table of Contents

Figures

Appendices

1 INTRODUCTION

As requested, Regional Geotechnical Solutions Pty Ltd (RGS) has undertaken a preliminary assessment of geotechnical and site contamination conditions at the site of the proposed Settlers Ridge residential subdivision, Steve Eagleton Drive, South West Rocks. The site comprises the following lots;

- Lot 31 DP 754396 (31.8ha)
- Lot 57 DP 1117398 (5.3ha)
- Lot 223 DP 754396 (3.4ha)

The purpose of the assessment was to assist with fulfilling Part 3A planning requirements for the proposed development which comprises a 154 residential allotment subdivision with associated infrastructure including roads and services.

The aim of the work described herein was to provide the following;

- Identification of potentially contaminating activities at the site, delineation of associated Areas of Concern and Chemicals of Concern regarding site contamination from the past activities;
- Conclusions regarding the potential presence of contamination at the site and its possible impacts on the proposed landuse;
- The requirement for remediation, further investigation, or ongoing management of site contamination;
- General geotechnical conditions and geotechnical constraints on development including foundation and road subgrade conditions, slope stability and impact of potential instability on the proposed development;
- Preliminary site classification to the requirements of AS2870-2011;
- Presence of Acid Sulfate Soils (ASS) and the need for an ASS Management Plan.

2 INVESTIGATION METHODOLOGY

2.1 Phase 1 Site Contamination Assessment

In accordance with the relevant sections of the NSW EPA, *Guidelines for Consultants Reporting on Contaminated Sites*, the Phase 1 Site Contamination assessment involved the following process:

- A brief study of site history, with the aim of identifying past activities on or near the site that might have the potential to cause contamination;
- Site walkover to assess visible surface conditions and identify any evidence of contamination, or past activities that may cause contamination;

- Review of available recent and historical aerial photography for the last 50 years to identify visible evidence of potential contamination or potentially contaminating activities;
- Search of government records of groundwater use in the area;
- Land title search of the respective lots available from the Land Titles Office to identify the history of land ownership and potentially contaminating activities that may be associated with past site owners;
- Using the above information, characterise the site into Areas of Environmental Concern, in which the potential for contamination has been identified, and nominate Chemicals of Concern that might be associated with those activities;
- Provide comment on the potential for contamination at the site and the requirement for further investigation or site management with regard to contamination.

The results of the site history study are presented in Appendix A.

2.2 Geotechnical Assessment

The geotechnical investigation of the site included a walkover observation of visible surface features such as slope angles, soil and rock types, the presence of fill, potentially wet or unsuitable areas and drainage features.

The subsurface profile was investigated at approximately fifteen locations by excavating mini-excavator test pits in representative areas of the site. Test pit profiles were logged by an Engineering Geologist and representative samples taken for subsequent laboratory testing by NATA accredited laboratories and incorporated:

- Shrink-swell testing – for preliminary site classification purposes;
- Soil erodibility;
- Soil aggresivity;
- ASS screening and detailed ASS analysis.

In addition assessment of sand density profiles at critical locations of the site was undertaken by dynamic penetrometer testing at selected locations.

Engineering logs of the boreholes are presented in Appendix B, together with the results of dynamic penetrometer testing. The test pit locations are shown on Figures 1 and 2.

Laboratory test results are presented in Appendix C.

3 SITE CONDITIONS AND SITE USAGE

3.1 Setting and Surface Conditions

The site is situated in moderately undulating topography to the north east of Spencers Creek, a tributary of the Macleay River. It comprises three separate lots (Lot 223, Lot 57 and Lot 31) that total 40.5ha in area. It is bounded by Keith Andrews Drive to the north, an unformed Crown Road to the west, Spencers Creek road to the south and residential subdivisions to the east adjacent to Steve Eagleton Drive, Trevor Judd Avenue and Gregory Street.

The proposed residential subdivision will occupy Lot 223, Lot 57 and the north eastern corner of Lot 31 and will comprise 154 residential allotments, access roads and areas of open space as shown in Figure 2.

The dominant landforms within the site comprise the following;

- North-north-west trending ridge in the east of the site in Lots 223 and 57. The ridge has a broad crest with slopes of 1° to 3°, while the sides of the ridge slope moderately to the north-east and south-west with slope angles ranging from 7° to 15°. A spur extends from the ridge in the north to form an isolated knoll located in the north east corner of Lot 31. Surface elevations across the ridge range from 12m AHD on the lower slopes to 40m AHD on the crest;
- North-west trending ridge located in the south west of the site in Lot 31. The upper slopes face north-east and south-west and slope angles range from 3° to 7°. Surface elevations range from 10m AHD to 28m AHD;
- A broad gently sloping saddle orientated north east is located between the two ridges and separates the local water catchments present on the site. The elevation of the saddle at its low point in the centre of Lot 31 is approximately 18mAHD;
- An isolated sandy knoll is present in the south east corner of Lot 31 with slope angles of up to 7° on the upper slopes and less than 2° on the lower slopes. Surface elevations range from 16m AHD on the crest of the knoll to 4m AHD on the lower slopes;
- Intermittent drainage paths and depressions are present on the site and flow either north west or to the south as shown in Figure 1.

A Google Earth image of the site is reproduced below;

Approximate boundary of the Settlers Ridge site is shown in red and the general area proposed for development is outlined in blue.

3.2 Historical Aerial Photography

Aerial photographs of the site were purchased from the NSW Land and Property Management Authority and reviewed, to assist in identifying past land uses that may contribute to site contamination. The results of the review are summarised in Table 1.

Table 1: Aerial Photograph Summary

Year	Site	Surrounding Land
1967	The site is thickly vegetated, apart from an isolated square area, approximately 100m x 100m near the centre of Lot 31 that has been cleared.	The site is surrounded by existing vegetation apart from some clearing to the south west. Gregory Street is present on the eastern boundary of the site in the north east corner. A small clearing is present in the vicinity of Trevor Judd Avenue.

Table 1 continued

Year	Site	Surrounding Land
1997	The site is thickly vegetated and the cleared area in the centre of Lot 31 is re-vegetated.	Keith Andrews Drive and Spencers Creek Road are visible as cleared gravel tracks on the northern and southern boundaries respectively. A house is present near the current location of Trevor Judd Avenue and at the rear of the property there is a stockpile of pale material, possibly rock. A residential subdivision and associated roads and infrastructure have been constructed to the north east of the site at Panorama Close and Crystal Place.
2008 (Dept. Lands Imagery)	The site is thickly vegetated. A track orientated north south is visible in the south east corner of Lot 31.	A residential subdivision and associated roads and infrastructure have been constructed to the north of the site on Bruce Field Street and Rippon Place, and to the east of the site on Steve Eagleton Drive and Trevor Judd Avenue.

3.3 Site Observations

The site is thickly vegetated with mature eucalypts and a thick understory of shrubs and native grasses. Paperbark trees were observed in the drainage depressions in the north and south of the site.

Residual sandy clay soils were exposed in a road cutting on Gregory Street and exhibited rilling erosion. Granite boulders were present on the surface across the upper slopes and crest of the eastern ridge. Surface soils in the east of the site were generally of a sandy nature. Surface soils on the western ridge comprised sands, silts and clays. Surface soils comprised pale grey sands on the sandy knoll and associated foot slopes in the south east corner of Lot 31.

The site is drained by a combination of surface runoff and infiltration in areas of sandy soils. Water flow was observed at the time of investigation in minor drainage lines in the higher elevation areas while water was pooling in the drainage depressions in the lower elevation areas of the site, particularly in the north west corner and adjacent to Spencers Creek Road in the south. Surface soils in the depressions comprised organic silts and were saturated at the time of fieldwork.

Vehicle access to the site was restricted by thick vegetation and loose surface sands although several 4WD tracks were present and allowed access to the west of the site. There were also numerous motorbike bush tracks across the site.

Garden clippings and plant waste were observed dumped within the boundary of the site adjacent to Keith Andrews Drive. Fragments of tiles, drainage pipe and other isolated items of building waste and debris were also observed within the boundary of the site at the rear of the residential subdivision on Steve Eagleton Drive however there was no visible associated contamination.

Selected site photographs are presented below. The photographs also illustrate the four different geotechnical terrains observed on site as discussed further in Section 4.

Surface water pooling on north west boundary of site in drainage depression – Geotechnical Terrain A

Exposed sandy soils in the south east corner of Lot 3 - Geotechnical Terrain B

Exposed soils in road cutting on Gregory Street exhibiting rilling erosion – Geotechnical Terrain C

Granite boulders on the surface of a residential subdivsion to east of site on Steve Eagleton Drive- Geotechnical Terrain D

3.4 NSW EPA Records

A check with the NSW EPA website (www.environment.nsw.gov.au) revealed that no notices have been issued on the site under the Contaminated Land Management Act (1997).

3.5 Land Title Search

A list of past registered proprietors and lessors of the site was obtained from the Land Titles Office. A summary of the title details is included in Appendix A.

The title history search for Lot 57 DP 1117398 revealed the following:

- Prior to 1943, Crown Land
- From 1943 to 2000 it was owned by a number of individuals, including a grantee and a farmer.
- In 2000 it was purchased by Eric Norman Developments Pty Ltd who are the current owners.

The title history search for Lot 223 DP 754396 revealed the following:

- Prior to 1947, Crown Land
- From 1947 to 2000 it was owned by a number of individuals, including a farm labourer/ grantee and a married woman.
- In 2003 it was purchased by Machro Pty Limited who are the current owners.

The title history search for Lot 31 DP 754396 revealed the following:

- From 1886to 2003 it was owned by a number of individuals, including a grantee, bank manager and farmers.
- In 2003 it was purchased by Jaclesta Pty Ltd who are the current owners.

4 SUBSURFACE CONDITIONS

4.1 Geology

The 1:25,000 Kempsey Quaternary Geology Map indicates the site is underlain by greywacke, siltstone and conglomerate of the Kempsey Beds in the elevated areas in the west of the site, residual soils overlying the Smoky Cape Adamellite (granite) in the east of the site and Pleistocene aeolian sand deposits overlying the lower slopes in the centre of the site.

The South West Rocks 1:25,000 Acid Sulfate Soils (ASS) Risk Map indicates that the aeolian sand deposits are preset in the north of the site and have a low risk of ASS at a depth of greater than 3m from surface.

Our previous experience in the South West Rocks area has found that perched water tables within the aeolian sand deposits and isolated granite boulder corestones within deeply weathered residual granite soils can pose construction difficulties.

Site observations and test pitting indicated four distinctly different geological profiles on the site that were associated with topographical features. On the basis of the surface conditions and subsurface profiles encountered, the site has been divided into four geotechnical terrains as summarised in the following sections. The approximate distribution of the terrain units on the site is

delineated on Figures 1 and 2. It is noted that the aeolian sand deposits noted in the north of the site on the ASS risk map were not encountered in the investigation.

4.2 Terrain A: Alluvial Drainage Depressions

The soil profile in this terrain typically consisted of wet organic silts and clays overlying alluvial sandy clays and clayey sands and was present in TP3 and TP14. The observed profiles comprised:

TOPSOIL	Sandy Organic SILT, wet, black, some Clay, low plasticity, from 0.4 to 1.0m thick; overlying
ALLUVIAL CLAY	Sandy CLAY, low plasticity, pale grey / pale brown, stiff to very stiff with an increasing sand content in TP14;

High water inflow was encountered at 0.4m in TP11.

4.3 Terrain B: Aeolian Sands

The soil profile in this terrain typically consisted of thin sandy topsoil overlying aeolian sands and was present in TP7. The observed profile comprised:

TOPSOIL	SAND, fine to medium grained, dark grey, some roots, loose. Typically 0.1m thick; overlying
AEOLIAN SAND	SAND, fine to medium grained, pale grey, medium dense to dense;

Test pit walls collapsed during excavation resulting in refusal. No groundwater was observed.

4.4 Terrain C: Ridge Slopes

Encountered in test pits TP1, TP2, TP4, TP5, TP6, TP8, TP9, TP10 and TP12 this soil profile typically consisted of colluvial clayey sands overlying deep red residual clay soils that graded into Extremely Weathered Granite clays. It is noted that the regional geological mapping indicates the west of the site is underlain by sedimentary rather than granitic rocks, however the deeply weathered profile encountered in the west of the site had similar properties to the profiles observed in the east of the site and for the purposes of this assessment is considered to have equivalent geotechnical properties. The profile encountered comprised:

TOPSOIL	Silty SAND, fine to coarse grained, grey/brown, some Clay low plasticity, and fine to large roots. Typically 0.1 to 0.2m thick; overlying
SLOPEWASH	Sandy CLAY, medium to high plasticity, brown, friable, high Sand content occasionally logged as Clayey SAND; overlying
RESIDUAL SAND	Clayey SAND, fine to coarse grained quartz, pale brown, Clay low plasticity, trace angular Gravel fine to medium grained, some roots, derived from deeply weathered granite where clays have leached out. Typically <1m thick and grading into residual clay;
RESIDUAL CLAY	Sandy CLAY, low to medium plasticity, pale brown / pale orange, Sand fine to coarse, very stiff and friable, becoming more gravelly with depth and grading into extremely weathered granite;

EW GRANITE Sandy CLAY, low plasticity, pale orange / brown, with orange/red mottling increasing with depth, Sand fine to coarse, very stiff and friable, increasing gravel with depth, massive rock fabric and scattered granite corestone boulders, slightly weathered, medium to high strength.

Minor water inflow was encountered at 1.2m in TP2 and TP9 which were located adjacent to drainage depressions. No other groundwater inflows were encountered.

4.5 Terrain D: Ridge crest and upper slopes

This soil profile was encountered in TP6 and TP13 on the elevated eastern ridge line and was typified by shallow slopewash and colluvial soils overlying an extremely weathered granite clay profile that includes large granite corestone boulders that resulted in mini-excavator refusal. The profile typically consisted of:

TOPSOIL Silty SAND, fine to coarse grained, grey/brown, some Clay low plasticity, and fine to large roots. Typically 0.1 to 0.2m thick; overlying

SLOPEWASH Sandy CLAY, medium to high plasticity, brown, friable, high Sand content occasionally logged as Clayey SAND, some Gravel, fine to coarse and granite boulders, slightly weathered, varying from low to high strength; overlying

EW GRANITE Sandy CLAY, low plasticity, pale orange / brown, with orange/red mottling increasing with depth, Sand fine to coarse, very stiff and friable, massive rock fabric with granite corestone boulders, slightly weathered, medium to high strength.

Groundwater or seepage was not encountered.

4.6 Groundwater

A groundwater bore search on the NSW Water Information website, http://waterinfo.nsw.gov.au/gw/ indicated that there are no licensed groundwater bores within the property boundary. A licensed groundwater bore is located approximately 100m to the north east of the site. The bore details indicated the following:

- 0 – 0.5m Soil
- 0.5m – 9m Clay
- 9m – 13.7m Weathered granite - water bearing zone
- The bore was intended for domestic purposes.

Regional groundwater flow in the vicinity of the site would be expected to flow in the general direction of the surface slopes, which is towards the north and south.

5 SITE CONTAMINATION ASSESSMENT

5.1 Areas of Environmental Concern and Chemicals of Concern

Based on the site observations and knowledge obtained about site activities as outlined above, the areas of environmental concern and chemicals of concern outlined in Table 2 were identified for the assessment.

Table 2: Areas of Concern and Chemicals of Concern

Area of Environmental Concern	Mode of potential contamination	Chemicals of Concern
Site boundaries and adjacent to access tracks	Dumping of domestic/garden/ building waste. No contamination was observed during fieldwork	Heavy Metals, Asbestos, TPH, BTEX, PAH, OC/OPP
Heavy Metals - Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel and Zinc *BTEX - Benzene, Toluene, Ethylbenzene and Xylene* *TPH - Total Petroleum Hydrocarbons* *PAH – Polycyclic Aromatic Hydrocarbons* *OC/OPP – Organochlorine and Organophophorus Pesticides*		

5.2 Assessment and Conclusions Regarding Site Contamination

The site history study found that the site has not previously been developed and there is no evidence of historically contaminating activities being undertaken on the site. The geotechnical investigations revealed no evidence of imported fill. Isolated dumping of domestic, garden and building waste was observed within the site boundaries although no visible evidence of associated contamination was observed at the time of fieldwork. Existing dumped waste should be collected and removed off site and access to the site should be restricted to prevent further dumping of waste materials.

Based on the assessment presented above, no evidence of contamination or potentially contaminating activities were encountered at the site, and as such the site is considered suitable for residential land use with accessible soils and gardens, with regard to the presence of soil contamination.

6 GEOTECHNICAL ASSESSMENT

6.1 Foundation Conditions

Laboratory shrink-swell testing was undertaken on samples of clay considered representative of foundation conditions likely to be encountered on the residential lots. Test results are presented in Appendix C and revealed I_{ss} values ranging from 0.69 to 2.17 for the clay soils present in Geotechnical Terrain C where the majority of the development will occur.

On the basis of the profiles encountered in the test pits and the results of laboratory testing, the lots to be constructed on this site are expected to classify in accordance with AS2870-2011 "*Residential Slabs and Footings*" based on the geotechnical terrains they are located in as summarised below*;*

Geotechnical Terrain A	Alluvial drainage depressions, which are not proposed for residential development.
Geotechnical Terrain B	Aeolian sands. Site classifications would typically be Class A or Class S, however disturbance of the upper sand profile during site preparation works will require re-compaction of the upper profile to ensure suitable founding conditions.
Geotechnical Terrain C	Ridge slopes with residual sands overlying residual clay soils. Site classifications would typically be Class M (Moderately Reactive).
Geotechnical Terrain D	Shallow sandy clay soils with potentially large granite corestones. Following site preparation works the resultant foundation conditions may comprise thin remaining natural clay soils or weathered rock where the sites would be expected to classify as Class S (Slightly Reactive) or Class A respectively. However should footings encounter rock outcrop or partial rock foundations, reference should be made to AS2870 as design may be required to incorporate site specific engineering principals in these circumstances.

Site soils likely to be obtained from cuts on site would generally be considered suitable for use as Controlled Fill for the support of residential footings within the development, providing sorting of oversize material is undertaken, and filling complies with the requirements of AS2870-2011 and AS3798-2007 for Controlled Fill under Level One supervision and testing.

The site classifications outlined above are preliminary in nature and would require confirmation following site regrade works when final site levels and natural/fill soil profiles are known.

6.2 Road Subgrade Conditions

The proposed locations of the road formations for the development are illustrated in Figure 2. Details of potential cut and filling requirements are not currently known. The proposed roads will encounter a range of conditions associated with the specific geotechnical terrains that are also shown in Figure 2.

Where roads are to be constructed in Terrain D areas they are likely to encounter residual soil profiles grading into weathered rock. Some excavation difficulty may be experienced in the weathered rock and therefore it is recommended that the road elevations be kept as high as possible through these areas. Bulk excavation for roads in rock masses can often expose preferential drainage or seepage paths within the rock that can result in concentrated water flows within and beneath the pavement.

Where roads are to be constructed in cut they should be excavated to bulk excavation level and then inspected by a geotechnical engineer to identify the presence of potential seepage paths within the exposed rock. If such areas are identified during construction consideration should be given to the use of additional localised drainage measures such as drainage blankets, herringbone drains tying into the roadside subsoil drains, or deeper subsoil and table drains. In general an

allowance should be made to over-rip the rock by 300mm, followed by re-compaction of the ripped material.

In Terrain C and D areas special attention should be paid to cut-fill transition zones that have the potential for concentrations of moisture, and lower strength subgrades than the adjacent cut and fill zones. It would be prudent to allow for the use of a select layer through cut-fill transition zones and across Geotechnical Terrain boundaries.

Thicker working platforms may also be required through the wet areas of Geotechnical Terrain A to facilitate construction and compaction. Subgrade preparation in the aeolian sands of Geotechnical Terrain B will require vibratory compaction with a smooth drum roller to achieve required density within the sands.

Subsoil drains that extend at least 300mm below base of pavement level should be provided along the high side of all roads oriented across slope, and on both sides of all roads oriented parallel to the slope

6.3 Slope Stability

6.3.1 Risk assessment

The risk of slope instability has been assessed using the principles and protocols of the Australian Geomechanics Society publication *Practice Note Guidelines for Landslide Risk Management, 2007*. This methodology represents the currently accepted state of practice for landslide risk assessment.

The slope risk assessment process involves identification of a potential slope failure event, or hazard, followed by an estimation of the likelihood of the event occurring, and the potential consequences should the event occur.

The terms used in the risk assessment process are defined below:

Hazard: A condition with the potential for causing an undesirable consequence.

Likelihood: The probability, expressed qualitatively, that the hazardous event will occur.

Consequence: Loss or damage resulting from a hazard event.

Risk: A term combining the likelihood and consequence of an event in terms of adverse effects to property or the environment.

6.3.2 Hazard Identification

The gently sloping nature of Terrain A and B is such that no potential landslide hazard was identified within these areas. Risks associated with the stability of cuts and fills within these terrains can be controlled by adopting the recommendations of this report.

Within Terrains C and D the ground is gently to moderately undulating. Soils encountered across the site were typically well drained granular soils which included aeolian sands, residual sands and clays that graded into extremely weathered granite. Within Terrain D large granite corestone boulders were present at or near the surface.

Groundwater was encountered adjacent to or within natural drainage depressions.

No evidence of ground instability was observed at the time of the site visit. The occurrence of landslides such as deep seated rotational or translational slope failures within Terrain C and D would require significant deterioration of current slope conditions combined with extreme climatic events, and is estimated to have an indicative recurrence interval of less than 1 in 100,000 years. This would deem the natural occurrence of landslides within these areas as rare, under the terminology and classification system incorporated in the AGS2007 Guidelines.

Without knowing specific details of the proposed development it is difficult to undertake a landslide risk assessment on the site in its developed state. For the purposes of this assessment, it has been assumed that good hillside construction practices will be incorporated in the approval process for the development. A guide to hillside construction practices within the proposed development is presented in Section 6.3.5.

Based on the terrains present and assuming the recommendations of this report are adopted, the following potential hazards were assessed in relation to the site and the proposed development:

Hazard 1 – Small scale rotational slide and associated debris flow (<100m^3) due to destabilisation of slope by unretained excavations. Such a failure could cause moderate damage to structures and impact the ongoing utility of the site until repairs are undertaken;

Hazard 2 – Toppling failure of granite boulders exposed within road cuts;

Hazard 3 – Soil creep. Creep is an imperceptibly slow movement that takes place on sloping soil sites. It is an ongoing, natural slope process involving the progressive downslope migration of soils over the underlying rock profile. Creep can be managed by undertaking good hillside construction practice as recommended in this report.

6.3.3 Risk Evaluation for Existing Site Conditions

The consequences of the failures outlined above on a typical residential development would range from minor to insignificant as defined by AGS2007. Assuming the recommendations of this report are adopted, the likelihood of the above events occurring would be as outlined in Table 2. Based on these estimates, the risk of slope instability for each of the hazards identified is also outlined in Table 3.

Table 3: Slope Risk Assessment Based on AGS2007 method

Hazard	**H1** **Localised failure of unsupported cuts**	**H2** **Toppling failure of granite boulders**	**H3** **Soil Creep**
Likelihood	Rare	Rare	Almost Certain
Consequence	Minor	Minor	Insignificant
Risk	Very Low	Very Low	Low

6.3.4 Evaluation of Risk Level

It is noted that the assessment presented in Table 2 indicates an overall **Low to Very Low** risk of slope instability, assuming the development is undertaken in accordance with good hillside construction practice and the specific recommendations of this report. This risk rating would normally be considered acceptable in Australia for residential construction.

6.3.5 Slope Stability - Recommended Development Practices

Geotechnical constraints at the site from a slope stability perspective are summarised below;

Excavation:

Excavations should preferably not exceed 1.5m in depth and should be supported by properly designed and constructed retaining walls or else battered at 1V: 2H or flatter and protected against erosion. Deeper excavations should be subject to specific geotechnical assessment.

Filling:

The depth of unsupported fill on the site should not exceed 1.5m and should be battered at 1V:2H or flatter and protected against erosion. All fill greater than 1.5m deep should be supported by an engineer designed retaining wall or subject to specific geotechnical assessment.

Where fill is placed on slopes in excess of 1V:8H (7°), a prepared surface should be benched/stepped into the natural slope.

Prior to any filling works on slopes in excess of 10°, a geotechnical investigation and report should be prepared to provide appropriate guidance.

Retaining Walls:

Retaining walls can be founded on Controlled Fill, natural residual soils, or in-situ weathered rock. The walls should be designed by an experienced engineer familiar with the site conditions, and taking into account surcharge loading from slopes, retaining walls, structures and other existing/future improvements in the vicinity of the wall. Adequate subsurface and surface drainage should be provided behind all retaining walls.

Drainage and Sewage Disposal:

All collected stormwater run-off should be piped into a street drainage system or an inter-allotment drainage system or discharged to an existing watercourse in a controlled manner that limits erosion.

Where road fill crosses drainage gullies a culvert of adequate capacity to accommodate flood flows should be provided. Geofabric wrapped gravel drains should also be provided beneath any fill placed across the low point of gullies or drainage depressions.

6.4 Stormwater and Erosion Management

Two samples were submitted for dispersion testing. The nominated samples were selected from TP3 (1.0 - 2.0m) in Terrain A where soils are likely to be exposed in the drainage depression for construction of culverts and service trenches and from TP5 (0.2 – 0.8m) located in Terrain C where soils are likely to be exposed in road cut batters.

The test results which are presented in Appendix C are summarised below;

Geotechnical Terrain A	Alluvial drainage depressions. Sample has a light clay texture (AS1547-2000) and is non-dispersive.
Geotechnical Terrain C	Ridge slopes with residual sands overlying residual clay soils. Sample has a loamy sand texture (AS1547-2000) and is dispersive (Emerson Class 3).

The soils present in the upper profile of Geotechnical Terrains C and D are susceptible to erosion on exposure. This is evidenced by rill erosion observed in the exposed cut in geotechnical Terrain D on Gregory Street where soils have been left without vegetation cover. It is therefore essential that:

- Site earthworks are undertaken in accordance with a site specific erosion and sedimentation control plan;
- Earthworks should be undertaken progressively, minimising the area and length of time that any part of the site is denuded of vegetation at any one time;
- Revegetation or other erosion protection should be undertaken as soon as possible on all cut batters;
- The erodibility of the soils should be taken into account in the long term stormwater management plan for the site (eg. Sizing and ongoing management or maintenance of detention ponds).

6.5 Soil Aggressivity

In accordance with the aggresivity and exposure classifications provided in AS2159-2009 the aggresivity classifications for the site are summarised below;

Geotechnical Terrain A	Alluvial drainage depressions. Clay soils would be considered mildly aggressive to concrete and non-aggressive to steel.
Geotechnical Terrain C	Ridge slopes with residual sands overlying residual clay soils. Residual soils would be considered non-aggressive to concrete and steel.

Design of piles and footings for the development should take into account the recommendations of AS2159-2009 for piles in soils with these aggresivity classifications.

6.6 Acid Sulphate Soils (ASS)

Reference to the South West Rocks 1:25,000 Acid Sulfate Soils (ASS) Risk Map indicates that there are aeolian sand deposits in the north of the site which have a low risk of ASS at a depth of greater than 3m from surface. It is noted that the geotechnical investigation did not identify any aeolian sands in the north of the site.

Samples obtained from TP3 located in Geotechnical Terrain A were screened for the presence of ASS using methods 21Af and 21Bf of the ASSMAC ASS Guidelines. The results are presented in Appendix C and indicate the following:

- The pH of the samples in distilled water ranged from 4.97 to 5.27. A pH value of less than 4 in this test is considered indicative of Actual ASS;

- All samples showed a low reaction and pH values ranged from 3.73 to 3.94 after oxidation in hydrogen peroxide. A pH value of less than 3 in this test is considered indicative of potential ASS;

The soils in Geotechnical Terrain A are considered naturally acidic soils, which are a feature of low lying coastal landscapes in the South West Rocks area. However they are not considered ASS. The addition of agricultural lime to these soils may assist plant growth and reduce acidic impacts on infrastructure if required.

7 LIMITATIONS

The findings presented in the report and used as the basis for 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. 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.

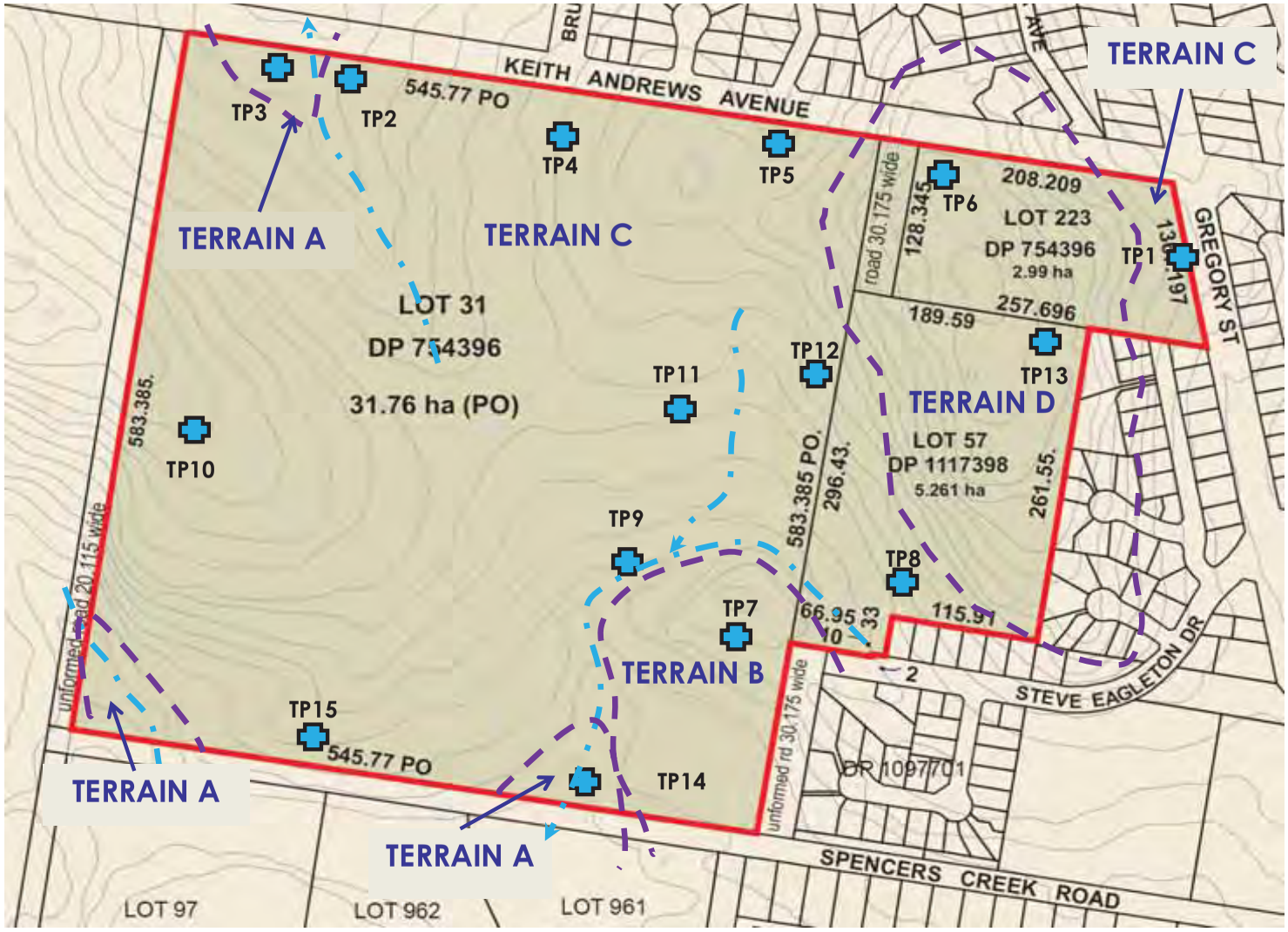
For and on behalf of

Regional Geotechnical Solutions Pty Ltd

Tim Morris

Senior Engineering Geologist

Figures

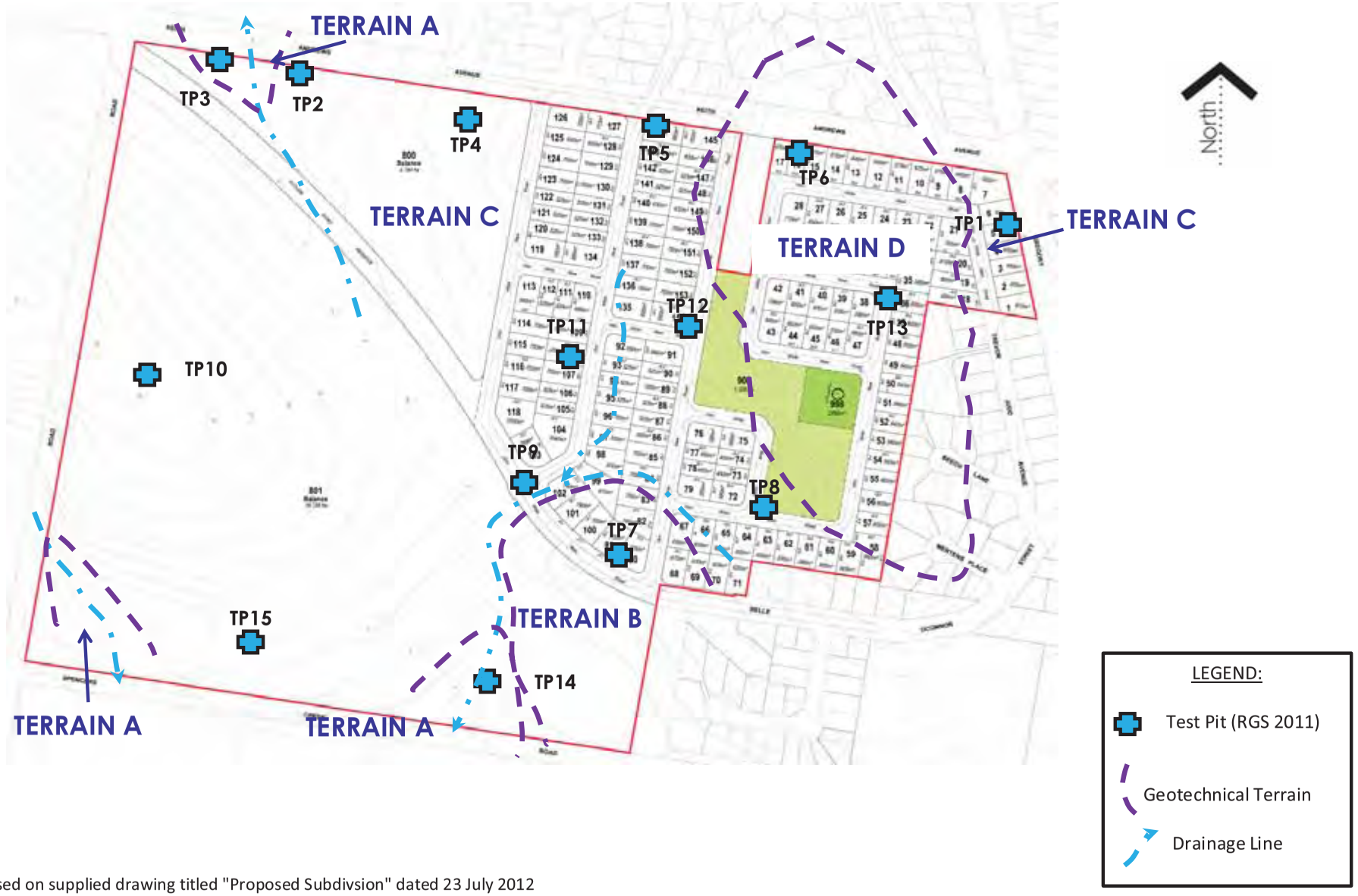


LEGEND:

- Test Pit (RGS 2011)
- Geotechnical Terrain
- Drainage Line

Based on supplied drawing from Brief

REGIONAL GEOTECHNICAL SOLUTIONS	Client	S J CONNELLY PTY LTD	Job No. RGS20027.1-AC
	Project:	SETTLERS RIDGE SUBDIVISION SOUTH WEST ROCKS	Drawn By: TLM Date: 22-Aug-12
	Title:	TEST PIT LOCATION PLAN	Drawing No. **FIGURE 1**



Based on supplied drawing titled "Proposed Subdivsion" dated 23 July 2012

REGIONAL GEOTECHNICAL SOLUTIONS	Client	S J CONNELLY PTY LTD	Job No.	RGS20027.1-AC
	Project:	SETTLERS RIDGE SUBDIVISION	Drawn By:	TLM
		SOUTH WEST ROCKS	Date:	22-Aug-12
	Title:	PROPOSED SITE LAYOUT	Drawing No.	**FIGURE 2**

Appendix A

Results of Site History Assessment

ADVANCE LEGAL SEARCH PTY LIMITED

(ACN 077 067 068)
ABN 49 077 067 068

P.O. Box 149
Yagoona NSW 2199

Telephone: +612 9754 1590
Mobile: 0412 169 809
Facsimile: +612 9754 1364
Email: alsearch@optusnet.com.au

14th December, 2010

REGIONAL GEOTECHNICAL SOLUTIONS PTY LTD
Suite 5C/23 Clarence Street,
PORT MACQUARIE, NSW **2444**

Attention: Tim Morris

RE: **Keith Andrews Avenue,**
South West Rocks

Note 1: **Lot 57 DP 1117398**
Note 2: **Lot 223 DP 754396**
Note 3: **Lot 31 DP 754396**

Note 1:

Current Search

Folio Identifier 57/1117398 (title attached)
DP 1117398 (plan attached)
Dated 10th December, 2010
Registered Proprietor:
ERIC NORMAN DEVELOPMENT PTY LIMITED

Title Tree
Lot 57 DP 1117398

Folio Identifier 57/1117398

Folio Identifier 511/1048157

Folio Identifier 51/1025337

Folio Identifier 224/754396

Certificate of Title Volume 6387 Folio 142

CROWN LAND

*****

Summary of proprietor(s)
Lot 57 DP 1117398

Year	Proprietor
	(Lot 57 DP 1117398)
2008 – todate	Eric Norman Development Pty Limited
2007 – 2008	Eric Norman Developments Pty Limited
	(Lot 511 DP 1048157)
2002 – 2007	Eric Norman Developments Pty Limited
	(Lot 51 DP 1025337)
2001 – 2002	Eric Norman Developments Pty Limited
	(Lot 224 DP 754396)
2000 – 2001	Eric Norman Developments Pty Limited
1989 – 2000	John George Marriott
	(Portion 224 Parish of Arakoon – Area 15 Acres 2 Roods 15 Perches – CTVol 6387 Fol 142)
1951 – 1989	John George Marriott, farmer
1943 – 1951	Albert Henry Marriott, grantee
	(Portion 224 Parish Arakoon – Area 15 Acres 2 Roods 15 Perches)
Prior – 1943	CROWN LAND
(1942 – 1943)	*(conditional purchase 1942/7, Kenpsey)*

*****

Note 2:

Current Search

Folio Identifier 223/754396 (title attached)
Crown Plan 3541-666 (plan attached)
Dated 10th December, 2010
Registered Proprietor:
MACHRO PTY LIMITED

Title Tree
Lot 223 DP 754396

Folio Identifier 223/754396

Certificate of Title Volume 5728 Folio 113

CROWN LAND

*****

Summary of proprietor(s)
Lot 223 DP 754396

Year	Proprietor
	(Lot 223 DP 754396)
2003 – todate	Machro Pty Limited
1989 – 2003	Marjorie Lucille Saville, married woman Maureen Joan Huckstepp, married woman Jacelyn Mary Cronan, married woman
	(Portion 223 Parish Arakoon – Area 7 Acres 1 Rood 22 Perches – CTVol 5728 Fol 113)
1977 – 1989	Marjorie Lucille Saville, married woman Maureen Joan Huckstepp, married woman Jacelyn Mary Cronan, married woman
1947 – 1977	Christopher Vincent White, farm labourer / grantee
	(Portion 223 Parish Arakoon – Area 7 Acres 1 Rood 22 Perches)
Prior – 1947	CROWN LAND
(1911 – 1947)	*(Conditional purchase 1947/1079, Kempsey, held by Christopher Vincent White)*

*****

Note 3:

Current Search

Folio Identifier 31/754396 (title attached)
Crown Plan 359-666 (plan attached)
Dated 10th December, 2010
Registered Proprietor:
JACLESTA PTY LIMITED
SHANNON PACIFIC PTY LIMITED

Title Tree
Lot 31 DP 754396

Folio Identifier 31/754396

Certificate of Title Volume 821 Folio 180

*****

-5-

Summary of proprietor(s)
Lot 31 DP 754396

Year	Proprietor
	(Lot 31 DP 754396)
2009 – todate	Jaclesta Pty Limited Shannon Pacific Pty Limited
2003 – 2009	Jaclesta Pty Limited
1996 – 2003	John George Marriott Jean Marriott
1991 – 1996	John George Marriott, farmer
	(Portion 31 Parish of Arakoon – Area 78 Acres 2 Roods – CTVol 821 Fol 180)
1957 – 1991	John George Marriott, farmer
1928 – 1957	Albert Henry Marriott, farmer
1922 – 1928	Eric Alexander McKay, farmer
1920 – 1922	Eric Alexander McKay, farmer Marion McKay, widow
1900 – 1920	Annie Maria Cooper
1894 – 1900	Duncan Ernst McKellar, grazier
1889 – 1894	Henry Clement Tingcombe, bank manager
1888 – 1889	Margaret Anne Forsyth, widow
1886 – 1888	George Forsyth, grantee

*****

Appendix B

Results of Field Investigations

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - TEST PIT

Client SJ Connelly CPP Pty Ltd
Project Settlers Ridge Development, Southwest Rocks
Test Pit Location Gregory Street

TEST PIT NUMBER TP1
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Existing Road cutting
Test Pit Length:
Width:
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information					Test Type/ Method	Result	Structure and additional observations
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density			
Existing excavation						ML	TOPSOIL: Sandy SILT, grey/brown, Sand fine to coarse grained, fine to large roots	D	D			TOPSOIL
				0.5		CL	Sandy CLAY, light plasticity, pale orange, sand fine to coarse grained	M	H			RESIDUAL Exposed soils rilling Batter = 2V: 1H
				1.0			From 1.0m some rock fabric present and increase in red/white mottling. Grading to extremely weathered granite. Trace isolated rounded cobble corestones.					1:1 Batter on opposite side of road not as eroded
				1.5								
				2.0			1.7m Base of cutting					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

REGIONAL GEOTECHNICAL SOLUTIONS

Client SJ Connelly CPP Pty Ltd
Project Settlers Ridge Development Southwest Rocks

Test Pit Location See Figure 1

TEST PIT NUMBER TP2
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information					Test Type/ Method	Result	Structure and additional observations
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density			
Excavator				0		SM	TOPSOIL: Silty SAND dark brown.	M	MD			TOPSOIL
						SC	Clayey SAND fine to medium grained, brown, clay low plasticity with fine roots.					SLOPEWASH
				0.5		CL	Sandy CLAY, light plasticity, pale orange with orange mottling, sand fine to coarse grained, trace gravel fine to medium, subangular, almost clayey SAND.	>Wp	Fb/VSt			RESIDUAL
	1.2			1.0								
				1.5			Increasing gravel content with depth some rock fabric, white/pale orange with orange/dark orange mottling.					From 1.5 grading to extremely weathered Granite
				2.0								
				2.5			End of hole 2.2m					
				3								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

REGIONAL GEOTECHNICAL SOLUTIONS

Client SJ Connelly CPP Pty Ltd
Project Settlers Ridge Development, Southwest Rocks
Test Pit Location See Figure 1

TEST PIT NUMBER TP3
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information							
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density	Test Type/ Method	Result	Structure and additional observations
						OH	TOPSOIL: Sandy Organic CLAY low plasticity, black with trace fine roots.	W	Fb			TOPSOIL, some surface water
		ASS		0.5		CL	Sandy CLAY, light plasticity, pale grey, pale brown, sand fine to coarse grained	>Wp	VSt			ALLUVIAL
		ASS		1.0			From 1.0m grading to pale grey					
		ASS		1.5								
				2.0			Trace of mottling					
				2.5								
							2.5m End of hole					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

Client SJ Connelly CPP Pty Ltd
Project Settlers Ridge Development, Southwest Rocks
Test Pit Location See Figure 1

TEST PIT NUMBER TP4
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information					Test Type/ Method	Result	Structure and additional observations
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density			
						SM	TOPSOIL: Silty SAND fine to medium grained dark brown with thin roots, trace clay low plasticity.	D	MD			TOPSOIL
				0.25		SM	Silty SAND fine to coarse orange/brown, trace charcoal and clay low plasticity, fine roots	M	MD			SLOPEWASH
				0.5		SC	Clayey SAND, fine to coarse grained, pale orange/pale brown. Some gravel, fine, subangular, quartz, low plasticity clay	M	MD/D			RESIDUAL (Granite saprolite) too granular for a U50 sample
				0.75								
				1.0								
				1.25		CL	Sandy CLAY, light plasticity, pale orange/pale brown with orange/dark orange/red mottling. Sand fine to coarse grained. Clear quartz, with massive fabric	<Wp	Fb/VSt			Extremely Weathered Granite
				1.5			From 1.5m trace fine to coarse grained Granite gravel, very low strength					
				1.75								
				2.0			End of hole 2.0m					
				2.25								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

ENGINEERING LOG - TEST PIT

REGIONAL GEOTECHNICAL SOLUTIONS

Client SJ Connelly CPP Pty Ltd
Project Settlers Ridge Development, Southwest Rocks

Test Pit Location See Figure 1

TEST PIT NUMBER TP5
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information							
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density	Test Type/ Method	Result	Structure and additional observations
						SM	TOPSOIL: Silty SAND fine to medium grained, black, some clay light plasticity, with fine roots	M	L			TOPSOIL
		E		0.25 0.5 0.75		SC	Clayey SAND; fine to coarse grained, pale brown,with fine roots, Clay low plasticity		MD			RESIDUAL (too granular for U50 sample)
				1.0 1.3 1.5 1.75 2.0		CL	Sandy CLAY, light plasticity, pale orange/orange. Fine to coarse grained sand, clear quartz. Some quartz to fine gravel	<Wp	Fb			RESIDUAL
							End of hole 2.0m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - TEST PIT

Client Steve Connelly
Project Settlers Ridge

Test Pit Location See Figure 1

TEST PIT NUMBER TP6
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information							
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density	Test Type/ Method	Result	Structure and additional observations
						MH	TOPSOIL: Sandy clayey SILTSTONE, dark brown fine to coarse sand, low plasticity clay with fine to coarse roots	M	Fb			TOPSOIL
				0.25		CL	Sandy CLAY, low plasticity, brown, sand fine to coarse grained, some roots, trace charcoal.	>Wp	F/Vst			SLOPEWASH
		U50		0.5		CL	Sandy CLAY, low plasticity, pale grey with orange/red mottling	>Wp	Fb/H			RESIDUAL
				0.75						pp	500	Large granite corestone boulder at south end of test pit
				1.0								Grading to extremely weathered Granite
				1.25								
				1.5			END OF HOLE 1.5m					
				1.75								
				2								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - TEST PIT

Client Steve Connelly
Project Settlers Ridge

Test Pit Location See Figure 1

TEST PIT NUMBER TP7
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information					Test Type/ Method	Result	Structure and additional observations
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density			
						SP	TOPSOIL: SAND, fine to medium grained, dark grey, some organic fines, thin roots	D	L			TOPSOIL
				0.25		SP	SAND fine to medium grained, pale grey, trace organic fines, black.	M	MD			AEOLIAN
				0.5								
				0.75								
				1.0								
				1.3								
				1.5								
				1.75			Refusal - hole collapsing					
				2								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

REGIONAL GEOTECHNICAL SOLUTIONS

ENGINEERING LOG - TEST PIT

Client Steve Connelly
Project Settlers Ridge

Test Pit Location See Figure 1

TEST PIT NUMBER TP8
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information					Test Type/ Method	Result	Structure and additional observations
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density			
				0.2		SM	TOPSOIL: Silty SAND fine to coarse grained, dark brown some clay low plasticity with thin roots	D				TOPSOIL
		U50		0.25		CL	Sandy CLAY low plasticity, brown, sand fine to coarse grained, some thin roots, trace charcoal.	>Wp	Fb			SLOPEWASH
				0.5								
				1.75		CL	Sandy CLAY, low plasticity, brown with orange mottling, sand fine to coarse grained	>Wp	Fb/Vst			RESIDUAL
				1.0								
				1.3			Sandy CLAY low plasticity, pale grey with orange/red mottling associated with rock fabric	<Wp	Fb/H	pp	500	Extremely Weathered Granite
				1.5								
				1.75								
				2								
							End of hole 2.0m					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

Client Steve Connelly
Project Settlers Ridge

Test Pit Location See Figure 1

TEST PIT NUMBER TP9
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information							
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density	Test Type/ Method	Result	Structure and additional observations
						SM	TOPSOIL: Organic Silty SAND, fine to medium grained, black with thin roots	M	L			TOPSOIL
				0.5		CL	Sandy CLAY, low plasticity, pale orange/pale brown with dark orange mottling	>Wp	Fb/VSt			RESIDUAL
				1.0						pp	200	
	➡						Becoming paler with depth			pp	400	From 1.0m grading to extremely weathered granite
				1.5			1.3m End of hole					
				2.0								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

REGIONAL GEOTECHNICAL SOLUTIONS

Client Steve Connelly
Project Settlers Ridge

Test Pit Location See Figure 1

TEST PIT NUMBER TP10
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information							
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density	Test Type/ Method	Result	Structure and additional observations
						CL	TOPSOIL: Sandy silty CLAY, low plasticity, brown, sand fine to coarse grained, with thin roots		Fb			TOPSOIL
				0.25		CL	Sandy CLAY, low plasticity, pale brown with orange mottling, sand fine, trace thin roots	>Wp	Fb/Vst	pp	400	RESIDUAL
				0.5								
		U50		0.75								
				1.0		CH	Sandy CLAY, medium plasticity, orange with red mottling, sand fine, some rock fabric, massive	>Wp	H			RESIDUAL
				1.3								Grading to fine grained extremely weathered SANDSTONE
				1.5								
				1.75								
				2			2.0m End of hole.					
				2.25								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

REGIONAL GEOTECHNICAL SOLUTIONS

Client Steve Connelly
Project Settlers Ridge

Test Pit Location See Figure 1

TEST PIT NUMBER TP11
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information						Test Type/ Method	Result	Structure and additional observations
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density				
						SM	TOPSOIL: Silty SAND, fine to coarse grained, grey/black, some low plasticity clay, thin roots	M	L				TOPSOIL
				0.25		SC	Clayey SAND, fine to coarse grained pale brown. Clay low plasticity, some thin roots	M	MD				RESIDUAL
				0.5									
				0.75									
				1.0									
						CL	Sandy CLAY, low plasticity, pale grey with orange/red mottling. Sand fine to coarse grained with massive rock fabric	<Wp	Fb/H		pp	400	Extremely Weathered Granite
				1.3									
				1.5									
				1.75									
				2									
							2.0m end of hole						

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

REGIONAL GEOTECHNICAL SOLUTIONS

Client Steve Connelly
Project Settlers Ridge

Test Pit Location See Figure 1

TEST PIT NUMBER TP12
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information							
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density	Test Type/ Method	Result	Structure and additional observations
						SM	TOPSOIL: Silty SAND, fine to medium, brown, trace low plasticity clay, thin roots	M	L			TOPSOIL
				0.25		SC	Clayey SAND fine to coarse grained, pale brown trace thin roots, trace gravel fine to medium grained, subangular	M	MD			RESIDUAL
				0.5								
				0.75								
				1.0			Sandy CLAY low plasticity, pale orange with orange mottling, sand fine to coarse grained.	>Wp	Fb/H	PP	500	RESIDUAL
				1.3								
				1.5		CL	Sandy CLAY low plasticity pale grey with orange/red mottling associated with massive rock fabric	<u>≤Wp</u>	Fb/H			Extremely Weathered Granite.
				1.75								
				2			1.8m end of hole					
				2.25								

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

REGIONAL GEOTECHNICAL SOLUTIONS

Client Steve Connelly
Project Settlers Ridge

Test Pit Location See Figure 1

TEST PIT NUMBER TP13
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information							
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	**Material Description**: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density	Test Type/ Method	Result	Structure and additional observations
						SM	TOPSOIL: Silty SAND, fine to coarse grained, black, thin roots, some fine to coarse grained gravel	M	L			TOPSOIL, some boulders on surface
			0.25			CL	Gravelly CLAY, low plasticity, orange/brown. Clay as matrix for gravel and boulders to 700mm. Subangular, granite corestones, medium to high strength.	M	Fb			SLOPEWASH Granite boulders in clay matrix
			0.5				0.5m Refusal on rock					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_p	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

REGIONAL GEOTECHNICAL SOLUTIONS

Client Steve Connelly
Project Settlers Ridge

Test Pit Location Spencers Creek road

TEST PIT NUMBER TP14
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information						Test Type/ Method	Result	Structure and additional observations
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	**Material Description**: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density				
	▼	0.1				OL	Sandy clayey organic SILT, black with thin roots	W	Fb/F				TOPSOIL
0.4				0.25									
				0.5									High water inflow at 0.4m
				0.75									
				1.0									
						CL	Sandy CLAY low plasticity, pale grey/white, almost clayey SAND, increasing in stiffness with depth	>Wp	St		PP	100	ALLUVIAL, Boundary unclear, under water
				1.3									
		ASS		1.5					VSt		PP	350	
				1.75									
				2									
							Refusal at 2.0m, water inflow too high						

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

ENGINEERING LOG - TEST PIT

REGIONAL GEOTECHNICAL SOLUTIONS

Client Steve Connelly
Project Settlers Ridge

Test Pit Location Spencer Creek Road

TEST PIT NUMBER TP15
Job No: RGS20027.1
Logged By: TLM
Date: 20/12/2010

Machine type: Mini Excavator
Test Pit Length: 2m **Width:** 0.5m
Surface RL:
Datum:

Drilling and Sampling					Material description and profile information								
Method	Water	Samples	RL (m)	Depth (m)	Graphic Log	Classification Symbol	Material Description: Soil type, plasticity/particle characteristics, colour, minor components	Moisture Condition	Consistency, density	Test Type/ Method	Result	Structure and additional observations
						SM	TOPSOIL: Silty SAND, fine to medium grained, dark brown, some clay, light plasticity and thin roots	M	L			TOPSOIL
				0.2		SP	Fine to medium grained SAND, pale brown, trace clay	M				AEOLIAN
				0.7		CL	Sandy CLAY, low plasticity, pale orange with orange/red mottling. Fine to coarse grained sand.	>Wp	Fb/Vst	p p	400	RESIDUAL at 1.2m
				1.4		CL	Sandy CLAY, light plasticity, pale grey/white with orange/red mottling, sand fine to coarse grained.	>Wp				Extremely Weathered GRANITE
							1.6m End of hole					

LEGEND:

Water
- Water Level (Date and time shown)
- Water Inflow
- Water Outflow

Strata Changes
- Gradational or transitional change
- Definitive or distinct strata change

Notes, Samples and Tests

U_{50}	50mm Diameter tube sample
CBR	Bulk sample for CBR testing
E	Environmental sample (Glass jar, sealed and chilled on site)
ASS	Acid Sulfate Soil Sample (Plastic bag, air expelled, chilled)
B	Bulk Sample
PID	Photoionisation detector reading
DCP (x-y)	Dynamic penetrometer test (test depth interval shown)
VS	Vane Shear test

Consistency

		UCS(kPa)
VS	Very Soft	<25
S	Soft	25 - 50
F	Firm	50 - 100
St	Stiff	100 - 200
VSt	Very Stiff	200 - 400
H	Hard	>400
Fb	Friable	

Moisture Condition

D	Dry
M	Moist
W	Wet
W_P	Plastic Limit
W_L	Liquid Limit

Density

VL	Very Loose	Density Index <15%
L	Loose	Density Index 15 - 35%
MD	Medium Dense	Density Index 35 - 65%
D	Dense	Density Index 65 - 85%
VD	Very Dense	Density Index 85 - 100%

Appendix C

Laboratory Test Results

RESULTS OF ACID SULFATE SOIL ANALYSIS

4 samples supplied by Regional Geotechnical Solutions Pty Ltd on 23rd December, 2010 - Lab. Job No. B2178
Analysis requested by Tim Morris. - **Your Project: RGS 20027.1 Settlers Ridge**

5/97 Isabella Street, Wingham NSW 2429

Sample Site	Depth (m)	EAL lab code	TEXTURE (note 6)	MOISTURE CONTENT (% moisture of total wet weight)	MOISTURE CONTENT (g moisture / g of oven dry soil)	FIELD/ LAB PEROXIDE SCREENING TECHNIQUE: Initial pH_F water	pH_{FOX} peroxide	pH change	Reaction
Method No.									
TP3	**0.40-1.0**	*B2178/1*	Fine	14.2	0.17	5.17	3.73	-1.44	Low
TP3	**1.0-2.0**	*B2178/2*	Fine	12.8	0.15	5.27	3.94	-1.33	Low
TP3	**2.0-2.5**	*B2178/3*	Fine	13.6	0.16	5.20	3.90	-1.30	Low
TP14	**1.0-2.0**	*B2178/4*	Fine	17.7	0.21	4.97	3.93	-1.04	Low

NOTE:

1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)
2 - Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & sulfate) and 'Chromium Reducible Sulfur' technique (Scr - Method 22B)
3 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). ***Acid Sulfate Soils Laboratory Methods Guidelines*** . QLD DNRME.
4 - Bulk Density is required for liming rate calculations per soil volume. Lab. Bulk Density is no longer applicable - field bulk density rings can be used and dried/ weighed in the laboratory.
5 - **ABA Equation**: **Net Acidity = Potential Sulfidic Acidity (ie. Scrs or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF (with FF currently de**
6 - The neutralising requirement, lime calculation, includes a 1.5 safety margin for acid neutralisation (an increased safety factor may be required in some cases)
7 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays
8 - .. denotes not requested or required. '0' is used for ANC and Snag calcs if TAA pH <6.5 or >4.5
9 - SCREENING, CRS, TAA and ANC are NATA accredited but other SPOCAS segments are currently not NATA accredited
10- Results at or below detection limits are replaced with '0' for calculation purposes.
11 - Projects that disturb >1000 tonnes of soil, the ≥0.03% S classification guideline would apply (refer to acid sulfate management guidelines).
12 - Results refer to samples as received at the laboratory. This report is not to be reproduced except in full.

(Classification of potential acid sulfate material if: coarse Scr≥0.03%S or 19mole H^+/t; medium Scr≥0.06%S or 37mole H^+/t; fine Scr≥0.1%S or 62mole H^+/t) - as per QUASSIT Guidelines

checked: .....
Graham Lancaster
Laboratory Manager

Chandler Morrison Geotechnical Pty Ltd

Unit 3, 18 Jambali Road, Port Macquarie NSW 2444 **ABN 55 139 985 050**

CMG

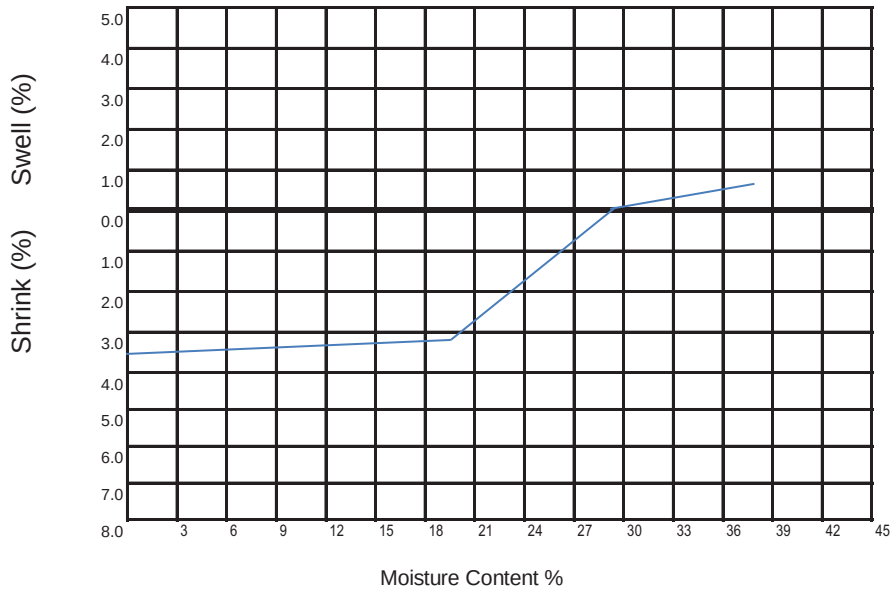
Client:	Regional Geotechnical Soln's	Project No.	P10003	Report No:	P10003-73
Address:	5/97 Isabella Street				
	Wingham NSW	Test Date:	12/01/11	By:	SC
Project:	Settlers Ridge	Sample No.	S-1310	Page:	1 of 3

SOIL REACTIVITY REPORT
SHRINK-SWELL INDEX - AS 1289 7.1.1

Material Description: Sandy CLAY, red/grey mottled. Test Pit 6, 0.4 - 0.7 metres.

CORE SHRINKAGE TEST		SWELL TEST	
Moisture Content - Air Dried	19.6%	Pocket Penetrometer - Initial	440kPa
Shrinkage - Air Dried	3.3%	Pocket penetrometer - Final	340kPa
Field Moisture Content - Oven Dried	29.2%	Moisture Content - Final	37.9%
Shrinkage - Oven Dried	3.6%	Swell under load	0.60%

Iss = 2.17 % per ΔpF



21/1/11

Approved Signatory: **S Chandler** Date

NATA Accredited Laboratory No. 17255

Chandler Morrison Geotechnical Pty Ltd

Unit 3, 18 Jambali Road, Port Macquarie NSW 2444 **ABN 55 139 985 050**

CMG

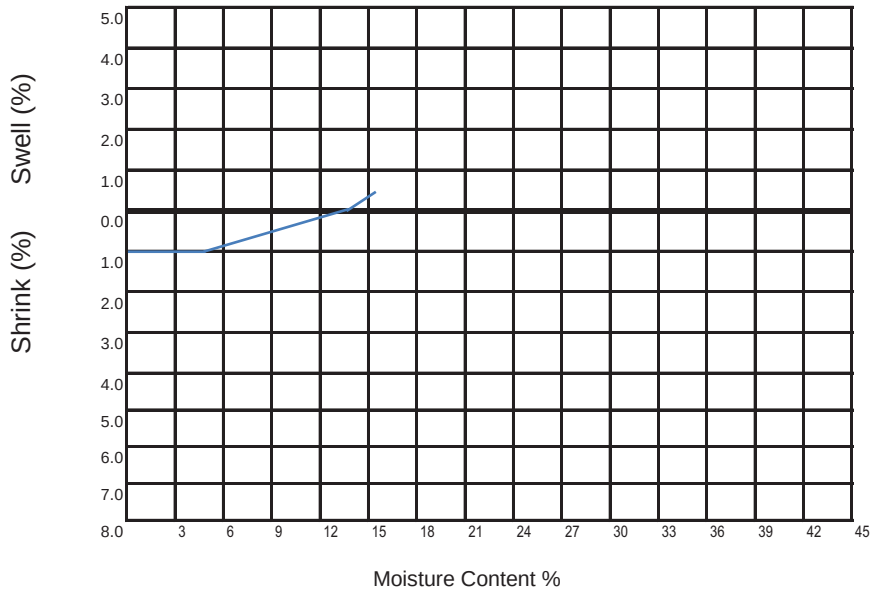
Client:	Regional Geotechnical Soln's	Project No.	P10003	Report No:	P10003-73
Address:	5/97 Isabella Street Wingham NSW	Test Date:	12/01/11	By:	SC
Project:	Settlers Ridge	Sample No.	S-1311	Page:	2 of 3

SOIL REACTIVITY REPORT
SHRINK-SWELL INDEX - AS 1289 7.1.1

Material Description: Sandy CLAY, light brown. Test Pit 8, 0.3 - 0.6 metres.

CORE SHRINKAGE TEST		**SWELL TEST**	
Moisture Content - Air Dried	4.6%	Pocket Penetrometer - Initial	600kPa
Shrinkage - Air Dried	1.0%	Pocket penetrometer - Final	250kPa
Field Moisture Content - Oven Dried	13.4%	Moisture Content - Final	15.3%
Shrinkage - Oven Dried	1.0%	Swell under load	0.48%

Iss = 0.69 % per ΔpF



21/1/11

Approved Signatory: **S Chandler** Date

NATA Accredited Laboratory No. 17255

NATA
WORLD RECOGNISED ACCREDITATION

Chandler Morrison Geotechnical Pty Ltd

Unit 3, 18 Jambali Road, Port Macquarie NSW 2444 **ABN 55 139 985 050**

CMG

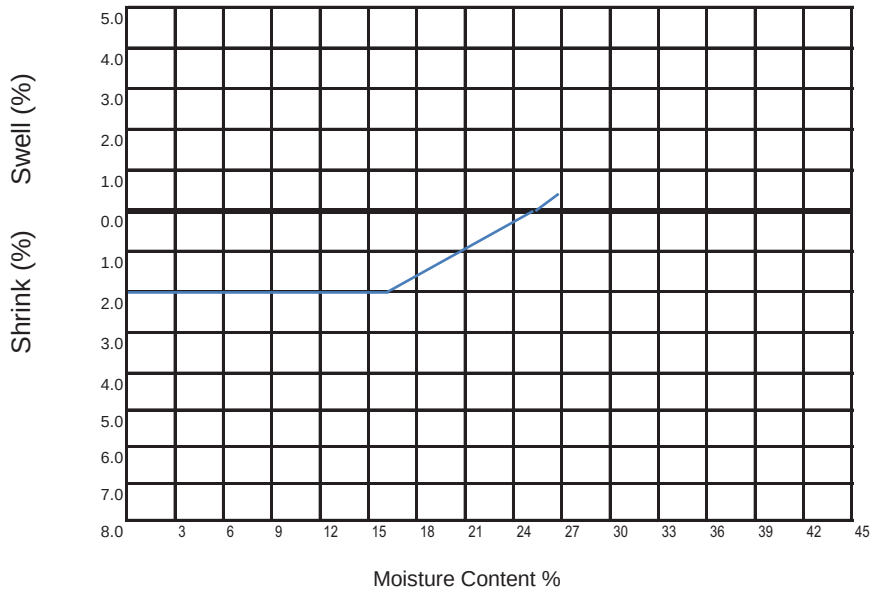
Client:	Regional Geotechnical Soln's	Project No.	P10003	Report No:	P10003-73
Address:	5/97 Isabella Street Wingham NSW	Test Date:	12/01/11	By:	SC
Project:	Settlers Ridge	Sample No.	S-1312	Page:	3 of 3

SOIL REACTIVITY REPORT
SHRINK-SWELL INDEX - AS 1289 7.1.1

Material Description: Sandy CLAY, light brown. Test Pit 10, 0.6 - 0.9 metres.

CORE SHRINKAGE TEST		SWELL TEST	
Moisture Content - Air Dried	16.1%	Pocket Penetrometer - Initial	>600kPa
Shrinkage - Air Dried	2.0%	Pocket penetrometer - Final	>600kPa
Field Moisture Content - Oven Dried	25.3%	Moisture Content - Final	26.9%
Shrinkage - Oven Dried	2.3%	Swell under load	0.28%

Iss = 1.19 % per ΔpF



21/1/11

Approved Signatory: **S Chandler** Date

NATA Accredited Laboratory No. 17255

NATA
WORLD RECOGNISED ACCREDITATION

RESULTS OF SOIL ANALYSIS (Page 1 of 1)

2 samples requested by Regional Geotechnical Solutions Pty Ltd on the 23rd December, 2010 - Lab Job No. B2179
Analysis requested by Tim Morris. **Project: RGS20027.1 Settlers Ridge**

	Method	Sample 1 TP3 1.0-2.0	Sample 2 TP5 0.2-0.8
	EAL job No.	***B2179/1***	***B2179/2***
Texture	*See note 2 below.*	Light Clay	Loamy Sand
Soil pH (1:5 water)	Rayment and Higgins 4A1	4.97	6.55
Soil Conductivity (1:5 water dS/m)	Rayment and Higgins 4B1	0.064	0.020
Soil Resistivity (ohm.mm)	Calculation	156,250	500,000
Chloride (mg/kg)	Water Extract- Rayment and Higgins	50	50
Chloride **(as %)**	Calculation	0.005	0.005
Sulfate (mg/kg)	Water Extract- Rayment and Higgins	69	11
Sulfate **(as % SO_3)**	Calculation	0.006	0.001
Chloride / Sulfate Ratio	calculation	0.7	4.8
Emerson Aggregate Test [note 8]	inhouse	EAT Class 6 (Flocculation)	EAT Class 3 (Dispersion)

Notes:
1. ppm = mg/Kg dried soil
2. For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays
3. All results as dry weight DW - soils were dried at 6OoC for 48hrs prior to crushing and analysis.
4. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
5. Methods from Rayment and Higgins, 1992. Australian Laboratory Handbook of Soil and Water Chemical Methods.
6. Based on Australian Standard AS: 159-1995
7 - Methods from Ahern, CR, McElnea AE , Sullivan LA (2004). ***Acid Sulfate Soils Laboratory Methods Guidelines.*** QLD DNRME.
8. EAT Method from AS1289.3.8.1-2006 Method 3.8.1.

checked:.....

■

COPYRIGHT AND USAGE NOTE