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SPECIALISTS MANAGING THE EARTH

PROPOSED 1000 LOT SUBDIVISION - PRELIMINARY GEOTECHNICAL, CONTAMINATION AND ACID SULFATE SOIL ASSESSMENT

L and T Pastoral Company Pty Ltd
Golf Course Estate, Sussex Inlet, NSW

GEOTUNAN02704AA-AA
18 June 2008

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18 June 2008

L and T Pastoral Company Pty Ltd
C/- Allen Price and Associates
75 Plunkett Street
NOWRA NSW 2541

Attention: Matt Philpott

Dear Sir,

RE: PROPOSED 1000 LOT SUBDIVISION
SUSSEX INLET MASTERPLAN, GOLF COURSE ESTATE
SUSSEX INLET, NSW

We are pleased to present our report on a preliminary geotechnical, contamination and acid sulphate soils assessment for the above site.

We draw your attention to the attached sheets titled "Important Information about your Coffey Report" and "Important Information about your Coffey Environmental Report". These sheets should be read in conjunction with this report.

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Thank you for your commission for this work and we look forward to the opportunity of being of assistance in the future. Should you have any questions in relation to the report, please do not hesitate to contact the undersigned.

For and on behalf of Coffey Geotechnics Pty Ltd

Authorised Signatory – Coffey Geotechnics	Authorised Reviewer – Geotechnical Aspects – Coffey Geotechnics	Authorised Reviewer – Environmental and Acid Sulfate Soil Aspects – Coffey Environments
Scott Morrison	**Jon Thompson**	**Manuel Fernandez**
Senior Geotechnical Engineer	Principal Geotechnical Engineer	Associate Environmental Engineer

Distribution: Original copy held by Coffey Geotechnics Pty Ltd

1 bound copy held by Coffey Geotechnics Pty Ltd

2 bound copies to L and T Pastoral Company Pty Ltd

1 bound copy to Allen Price and Associates

1 electronic copy to Allen Price and Associates

Appendices

1 INTRODUCTION

1.1 General

At the request of Allen Price and Associates (APA) and on behalf of L and T Pastoral Company Pty Ltd (L and T Pastoral), Coffey Geotechnics Pty Ltd (Coffey) has carried out a preliminary geotechnical, contamination and acid sulfate soil assessment for the Sussex Inlet Masterplan Development. The site is understood to be known at the 'Golf Course Estate' at Sussex Inlet, NSW.

Based on the supplied information and discussions with APA, we understand that the proposed Golf Course Estate will occupy a site of about 250 hectares located north of the township of Sussex Inlet, bounded by Golf Course Way to the south, Suncrest Avenue and St Georges Basin to the east and bushland to the north. It is understood that the proposed Golf Course Estate will include areas of low and medium density residential properties, an eighteen hole golf course with clubhouse facilities, a tourist resort development adjacent to St Georges Basin and associated roadways. It is also understood that planning and design are in the preliminary stages and the exact locations of the development may be altered depending on potential geotechnical or other constraints.

The objectives of this preliminary assessment were to :

- Assess the likelihood for contamination to exist on the site from past or present activities and to make recommendations on the need for further investigation.
- Assess and map, at a preliminary level, the likely presence & extent of acid sulfate soils on the site;
- Provide a broad assessment of geotechnical limitations at the site and design considerations to address these limitations.
- Assess and map the broad soil types, considering potential erodability, dispersability and characteristics which may be detrimental to water quality.
- Carry out soil sampling and provide design CBR values in 5 areas of the site as identified by APA to assist with cost estimates for roadways.

1.2 Scope of Work

The following scope of work was commissioned to address the objectives of the preliminary assessment:

- Carry out a field investigation including site mapping and excavation of five test pits, laboratory testing of five CBRs and five Emerson Class Number tests, and provide geotechnical advice in relation to earthworks, soil erodability, site preparation, subgrade CBR and broad indications of likely pavement thickness design in selected areas of the site.

- A site history and desk study to identify potential Areas of Environmental Concern (AECs) and Chemicals of Concern (COCs) including: a review of previous site ownership, review of Council records, review of aerial photographs, holding interviews with available people familiar with the history of the site (and surrounding sites, if available), review of published geological and topographic maps, review of Department of Environment and Climate Change (DECC) records for listing of the site, a search of nearby groundwater bores registered with the Department of Water Resources (DWR), review of dangerous goods licences held for the site by WorkCover and collation of this information.

- A site walkover to visually assess potential sources of contamination, observe surrounding landuses, topography, drainage, nearby sensitive environments, and assess details of the site history and desk study to further assess potential AECs and COCs.

- Conduct a desk study and preliminary field screening and laboratory analysis to assess the potential for acid sulphate soils to be present within the site, their potential locations and preliminary management options. Several chromium reducible sulphur tests were also commissioned to check the presence of acid sulphate soils at one location at the site.

2 SITE LANDUSE AND DESCRIPTION

2.1 Site Location and Landuse

The location and boundaries of the site are shown in Figure 1. The site is somewhat irregular in shape and comprises five lots. The site measures approximately 1.5km east-west by approximately 2km north-south and covers an area of approximately 250ha. The site is located approximately 1km to the north-west of the CBD of Sussex Inlet, NSW. The site is bounded by St Georges Basin and an existing subdivision to the east, Sussex Inlet Road to the south and west and undeveloped bushland to the north. Land with open paddocks and scattered trees are located to the west of parts of the western boundary of the site. Several structures/sheds, an Above-ground Storage Tank (AST) and other machinery is stored on a lot adjoining a portion of the south-western boundary. An operational service station adjoins part of the southern boundary of the site along Sussex Inlet Road. A summary of the site identification is presented below in Table 1.

A 45 ha portion of the site within Lot 5 is currently occupied by the Sussex Inlet Golf Course. The golf course is an 11 hole course and includes open fairways, greens and several dams along drainage channels. Some remnant bushland areas are located between fairways. The clubhouse and maintenance shed for the golf course are located in the southwestern corner of Lot 5. The remainder of the site is occupied by mainly undeveloped bushland.

The bushland areas of the site have a medium dense cover of trees with some mature eucalypts up to 10m to 15m tall with thick undergrowth. A sparse cover of grass and leaf litter/natural organic material cover the topsoil within the site.

TABLE 1: SUMMARY OF SITE IDENTIFICATION

Street Address	Lot 2442 DP1074478 Suncrest Avenue, Lot 125 DP 528699 Jacobs Drive, Lot 51 DP 1033684 Sussex Inlet Road, Lot 124 DP 528699 31 Jacobs Drive, Lot 5 DP 568283 7 Golf Course Way
Area	Lot 2442 DP1074478 - 54.5 ha Lot 125 DP 528699 - 12.2 ha Lot 51 DP 1033684 - 41.9ha Lot 124 DP 528699 - 41.6ha Lot 5 DP 568283 - 83.8ha Total Area of Lots - 234.1ha
Title Identifiers	Lot 2442 DP1074478; Lot 125 DP 528699; Lot 51 DP 1033684; Lot 124 DP 528699; and Lot 5 DP 568283.
Zoning	Lot 2442 DP1074478 – 1(a) Agricultural Production, 1(d) General Rural, 2(c) Living Areas, 6(a) Open Space Recreation (Existing) Lot 125 DP 528699 – 1(a) Agricultural Production, 1(b) Arterial and Main Road Protection, Special Rural Lifestyle Area Lot 51 DP 1033684 – 1(a) Agricultural Production Lot 124 DP 528699 – Special Rural Lifestyle Area Lot 5 DP 568283 – 1(b) Arterial and Main Road Protection, 1(d) General Rural, 1(g) Flood Liable
Local Government Area	Shoalhaven
Parish	Farnham
County	St Vincent
Grid Co-ordinates	35°08’55”E 150°35’00”S (Austral ian Map Grid (UTM))

A cadastral plan is also included in Appendix A.

According to the topographic map, the average rainfall for the area is 1230mm.

Nearby sensitive landuses are likely to include estuarine/tidalfalt areas to the south of the site near Budgee Inlet and to the north-east near Sussex Inlet, nearby residential and bushland areas.

2.2 Topography and Drainage

The general topography of the site consists of relatively flat to gently undulating bushland of overall ground slopes generally up to 5 degrees.

An approximate east-west orientated ridge dissects the site, with the site generally draining to the north and northeast on the northern slopes of the ridge, and to the south or southeast on the southern slopes of the ridge.

Several small dams have been constructed along two watercourses within the golf course area. These dams range in plan area from approximately 30m x 30m up to 50m x 100m. The locations of the dams are shown in Figure 1.

The more elevated parts of the site lie in the central and northern areas, with elevations up to about 23m above Australian Height Datumn (AHD). A relatively large low lying area (<1m AHD) is located in the southern part of the site near Badgee Inlet and extends to the west. The north eastern part of the site is also relatively low lying closer to St Georges Basin.

2.3 Review of Available Past Reports

Coffey has recently been carried out geotechnical investigations for a nearby subdivision, located near the southern boundary of the site, and has carried out investigations for several other sites within the township of Sussex Inlet. No other reports have been provided to Coffey prior to the preparation of this report.

Based on past experience by Coffey in the area, Sussex Inlet can be divided into two topographical areas. These areas comprise:

1. Low-lying areas with ground slopes less than about 1 degree. These areas are generally underlain by alluvial or estuarine soils, and in some areas the ground has undergone significant filling works to raise site levels above ground that was previously essentially flood prone or swamp type areas. Groundwater is often encountered at shallow depth in these areas, and the soil types can vary. The depth to highly weathered (or less weathered) rock is generally assessed to be greater than 10m below ground level in these areas.
2. Elevated areas with ground slopes ranging between about 1 degree and 5 degrees. Most of these elevated areas are located above about RL+2m AHD. These areas are generally underlain by alluvial or residual soils. In areas away from drainage channels/pathways, the alluvial/residual soil (beneath any topsoil) is generally stiff. Based on our experience on nearby sites, the thickness of soil cover above highly weathered rock in these areas can vary between about 1m to 10m depending on topographic location. Groundwater can be encountered at shallow depths (<1m below ground surface) in drainage channels or locally low-lying areas. No rock outcrops have been noted in previous investigations carried out in the vicinity of Sussex Inlet.

2.4 Soils, Geology, Hydrogeology and Groundwater Use

The Ulladulla 1:250,000 Geological Sheet[1] indicates that the site is underlain by the Wandrawandian Siltstone of the Shoalhaven Group, of Permian age. The bedrock may occur as a siltstone or silty sandstone (pebbly in part). The Geological sheet also indicates that areas around Badgee Inlet are likely to be covered by Alluvium, described as 'alluvium, gravels, beach and dune sand'.

A search of groundwater bores registered with Department of Water & Energy (carried out on the 7 May 2008) indicated that there are approximately 50 registered bores within a 1 kilometre radius of the site. One bore is noted as being within the site for Lot 5 DP 568283 (GW108618). Registration details for the bore indicate it was installed in 2008 and is registered for Irrigation (Recreation) – High Security. The bore was drilled to a depth of 48m. The water bearing zone was noted at 15.00m to 15.20m (no description of aquifer was supplied). The drillers log suggests that the water bearing zones were in black shale.

Two groundwater bores, located north and south of the site (GW012826 and GW065202) are registered for Recreation (Groundwater) and Domestic Stock Use purposes, respectively. Several other groundwater bores are located east and south of the site within the residential areas (GW059615, GW055684, GW055685, GW056062, and GW01451) and are registered for Domestic/General Use purposes. The search results are included in Appendix A.

Based on observations of the surrounding topography, groundwater across the site is expected to be located at a depth between about 3m to 5m with relatively shallow groundwater in low lying estuarine areas. Deeper aquifers are likely to be located within the rock between 10m to 20m in the more elevated parts of the site.

2.5 Acid Sulfate Soil Occurrence

ASS is naturally occurring soil and sediment containing iron sulfides which when exposed to oxygen can generate sulfuric acid.

A copy of the Sussex Inlet 1:25,000 Acid Sulfate Soil Risk Map (1997) edition 2, prepared by the Department of Land and Water Conservation (DLWC) is reproduced in Figure 2. The approximate site boundary has been marked on this figure. We note that the boundary is approximate.

According to the risk map the main central and western parts of the site are marked as 'no known occurrence' where ASS are not expected to occur.

Areas marked as 'low probability' of ASS occurrence are noted in the southern part of the site near Badgee Inlet and extending to the west and also in the north-eastern part of the site near St Georges Basin. These lower lying areas are generally noted as estuarine plains/interdial flat/supratidal flat where ASS (if present) would be expected at or near the ground surface to about 1m below the ground surface. A portion in the central southern part of the site is noted as an alluvial plain where ASS (if present) is expected to be located between 1 and 3m of the ground surface.

[1] 1:250,000 Ulladulla Geological Series Sheet, Department of Mines, NSW (1974)

Areas of low probability are noted as being within an environment of deposition that has generally not been suitable for the formation of ASS. ASS if present are likely to be sporadic and may be buried by alluvium or windblown sediments.

Areas with a high probability of ASS occurrence are marked within Sussex Inlet and Badgee Inlet in bottom sediments.

3 SITE HISTORY AND OBSERVATIONS

Information on the site history was obtained from:

- A historical land title search to review previous landowners and possible past uses of the site;
- Interviews with available people familiar with the history and operations of the site;
- Review of selected aerial photographs;
- A search of NSW DECC and Shoalhaven City Council records; and
- A search of dangerous goods licenses held for the site by WorkCover.

The site history information is presented in Appendix A and a summary is provided below.

3.1 Summary of Site History

Land title records and aerial photograph information indicate that site has predominantly been undeveloped bushland owned by private individuals (with listed occupations of boarding house proprietor, carpenter, solicitor and widow) or registered entities up until the present. A golf course has operated in the south-western part of the site (Lot 5 DP568283).

Aerial photographs indicated that the golf course may have been established as early as 1961, however Council records indicate that the land was acquired for this purpose in about 1976 (Building Application (BA) 79/546, BA 94/1474, BA 94/1199, BA 94/729 and BA/95/0560). Council records indicate that the golf course has undergone a series improvement to buildings up until its present configuration which has 11 holes and 18 tees and caters for a membership of 450 people (3A08/1002 and 3A2008/1000).

Anecdotal evidence suggested that there has been little evidence of illegal dumping within the site and that a bushfire affected the majority of the area in about 2000/2001.

The greenkeepers shed area is used to store some relatively small quantities of fuels, oils, lubricants with a 2000 litre diesel above ground storage tank. The age of the tank is not known. Some herbicides, pesticides and insecticides have been stored in small quantities in a shipping container for use on the golf course. Anecdotal information indicates that only small quantities are used on the course and they do not blanket spray the course. They are only used on selected tees and greens as needed.

From the 1980's until recent the site has been openly discussed as a area of future urban expansion which has been undergoing state and local legislative review processes that have required detailed studies due to State Environmental Planning Policy (SEPP) 14 wetlands surrounding the Badgee Inlet (3A08/1002 and 3A2008/1000).

A development application for Lot 124 DP528699 indicates that there is the possibility of imported fill been used along the border of the current site on the adjacent site, Lot 42 DP 30379. Development consent was approved but completion of site works was unable to be verified from Council records (DA 02/4234).

Aerial photographs taken from 1987 indicated what appeared to be two cleared/disturbed areas. These are located along the central southern boundary of the site which appears to be within Lot 125 DP528699 opposite the intersection of Sussex Inlet Road and The Springs Road. No Council records were found relating to any activities within this area. The 1:25,000 Sussex Inlet Topographic Map shows these areas as being a 'quarry or gravel pit'.

The WorkCover search of the Stored Chemical Information Database (SCID) for licenses to keep dangerous goods indicated that no records pertaining to dangerous goods storage existed for the site.

There are currently no NSW DECC notices for the site under the Environmentally Hazardous Chemicals Act (1985) or the Contaminated Land Management Act (1997).

3.2 Site Observations

A site visit was carried out by a senior geotechnical engineer and an associate environmental engineer on the 9 May 2008. Additional observations were made during the test pitting investigation work on 13 May 2008. Selected photographs are included in Appendix E. The following main observations were noted:

General

- The majority of the site (approximately 75%) was inaccessible due to the presence thick vegetative growth (bushland). Site observations were made whilst accessing the fire trails at the site. Site features located away from fire trails or inaccessible areas could not be viewed by Coffey at the time of the site visit;
- The southwestern portion of the site (approximately 45ha) has been partially cleared to provide golf course facilities for the Sussex Inlet Golf Course. The fairways and greens for the golf course are well established and the golf course appears to have been in operation for at least 10 years. The golf course appeared to have undergone some minor filling work and landscaping, associated with construction of fairways, greens and gravel access roads. Several dams are located across the golf course area;
- The site area not covered by the golf course comprises essentially undeveloped bushland. Several fire trails were located across the site, and the locations of the fire trails observed by Coffey are shown in Figure 1.
- Some localised areas of ponded water were noted on the ground surface in some areas at the time of the mapping work and the excavation of test pits. This appeared to be due to recent rainfall, and may indicate the presence of relatively low permeability soils at the site;
- No rock outcrops were observed over the site during the fieldwork.
- Some low lying or swampy areas were noted during the site visit. These generally occurred in the south near Badgee Inlet and further to the west, and in the north eastern part of the site near St Georges Basin. The approximate extent of these areas has been mapped in Figure 1.
- Areas near Badgee Inlet and near St Georges Basin were noted to have mangrove vegetation and other more salt tolerant grass sedges;
- One dumped/burnt vehicle was noted near a fire trail in the northern part of the site. An additional dumped car was noted just to the north of the site (See Figure 5).

- Some localised evidence of unauthorised dumped waste was noted in relatively isolated areas of the site near the fire trails and also in a partially cleared area in the central southern part of the site. The waste observed included corrugated iron, bottles, paper, plastic, car parts etc. (See Photos 7, 9 and 10). This was observed on the east-west fire train in the central part of the site and in an exposed area in the southern part of the site;
- Water within a small creek/drainage line near Lakeshore Parade was observed to have a dark appearance (possibly associated with natural organic decay – see Appendix E, Photo 6);
- Two fragments of fibre cement were observed on the ground surface on the edge of a golf course fairway, near the central northern boundary of the course. The fibro observed appeared to be two isolated fragments with no obvious evidence of structures or fill in the nearby area.
- Some localised and shallow (<0.2m deep) gully erosion areas were noted in areas with exposed soil at the site. This may indicate that the soils are potentially erodible at this site if vegetative cover is stripped from the overlying soil.

Golf Course Greenkeepers Area

- Observations at the golf course noted the presence of an equipment shed. The shed was used to store various pieces of equipment associated with green keepers duties (including a backhoe, mowers, tyres, tools, oils, lubricants etc. – See Appendix E, Photo 3);
- Relatively small quantities of oils, lubricants (probably less than 50 litres in total) were stored on a bench/shelf within the shed (See Appendix E, Photo 2). The shed had a concrete floor and was observed to be in a relatively good condition;
- An AST was located in front of the shed. The AST was used to store diesel and was of 2000 litre capacity. The AST was elevated with a concrete bund (See Appendix E, Photo 1);
- A shipping container was located to the north of the main shed and Coffey was advised that golf course chemicals were stored in the shed comprising some herbicides, fungicides and insecticides (See Appendix E, Photo 4). Coffey was advised that less than 40 litres of chemicals were stored.

4 POTENTIAL AREAS OF ENVIRONMENTAL CONCERN (AEC) AND CHEMICALS OF CONCERN (COC)

Based on the results of the site history and site observations some potential Areas of Environmental Concern (AEC) and Chemicals of Concern (COCs) were identified at the site. These areas generally make up a small proportion of the overall site, with the majority of the site having been undeveloped bushland. The AECs and COCs are summarised in the following table and are also noted in Figure 5.

TABLE 2: SUMMARY OF POTENTIALLY CONTAMINATING ACTIVITIES, AREAS OF ENVIRONMENTAL CONCERN, LIKELIHOOD OF CONTAMINATION AND CHEMICALS OF CONCERN

Potentially Contaminating Activity	Sub Component / Description	Potential Areas of Environmental Concern (See also Figure 5)	Likelihood of Contamination*	Potential Chemicals of Concern
AEC 1. Potential Weathering of hazardous building materials from site structures	Weathering of hazardous building materials such as lead paint, fibre cement containing asbestos and galvanised iron. Potentially present from former and existing site structures. Also includes possible use of pesticides near buildings.	The golf course has two main structures associated with member's facilities and green keepers shed. Impacts (if any) are likely to be within a few metres of structures. These are located in the central western area of the site. Soil media potentially impacted.	Low to moderate likelihood of soil contamination. Older and former structures are likely to have contained hazardous building materials which could have possibly weathered into surrounding surface soils. The presence of materials with lead paint or asbestos has not been confirmed at this stage. Spraying for pesticides could have also occurred around building structures.	Lead, zinc, asbestos and OCP
AEC 2. Storage of fuels and chemicals near greenkeepers shed	Storage and use of insecticides, herbicides and fungicides.	Possible localised areas in the vicinity of the area near the workshop shed and the shipping container and parts of the golf course. Dams/drainage lines on the course could act as sinks for contamination. Soil and surface water media potentially impacted.	Low likelihood of contamination. Chemicals appear to have generally been stored and used in small quantities.	OCP, herbicides and fungicides
	Storage and use of fuels, oils and lubricants.	Possible localised areas in the vicinity of the workshop shed and adjacent to the AST located near the greenkeepers shed. Soil media potentially impacted.	Low to moderate likelihood of contamination. Fuels/oils and lubricants in the workshop appear to be stored on paved area and in relatively small quantities. Areas near the AST could have a slightly higher likelihood of impact due to spillages.	TPH, BTEX, PAH and VHC,

Continued

TABLE 2 (CONTINUED): SUMMARY OF POTENTIALLY CONTAMINATING ACTIVITIES, AREAS OF ENVIRONMENTAL CONCERN, LIKELIHOOD OF CONTAMINATION AND CHEMICALS OF CONCERN

Potentially Contaminating Activity	Sub Component / Description	Potential Areas of Environmental Concern (See also Figure 5)	Likelihood of Contamination*	Potential Chemicals of Concern
AEC 4. Fibre cement fragments in golf course		Two fragments of fibre cement were noted on the edge of a golf course fairway, near the central northern boundary of the course	High likelihood of contamination. The fibre cement could potentially contain asbestos (however was not tested as part of this study). The fragments observed appeared to be two isolated fragments with no obvious evidence of structures or fill in the nearby area.	Asbestos
AEC 3. Potential leaks from septic tanks	Effluent discharges from septic tank near the golf course	Areas near and downslope of the septic tank(s). The golf course is likely to be on a septic system. A septic tank was not observed during the site walkover, but is likely to be present. Soil and groundwater media potentially impacted.	Low likelihood of contamination.	Nutrients and pathogens.
AEC 4. Fill of Unknown Origin and Quality	Fill soils possibly imported to the site as part of land filling activities	No obvious areas noted except near some dams within the golf course.	Low likelihood of contamination. No obvious site evidence of extensive filling noted.	TPH, BTEX, PAH, OCP, PCB, heavy metals and asbestos.
AEC 5. Unauthorised dumped waste/burnt out cars off track in bushland areas		Three relatively small areas within the central fire trail and in the exposed area to the south (See Figure 5) were noted with some dumped waste. One dumped car was noted in the northern part of the site. . Soil media potentially impacted.	Moderate likelihood of contamination within the areas where dumped materials/car noted.	TPH, BTEX, PAH, OCP, heavy metals and asbestos.
AEC 6. Disturbed area(s) in southern part of site		Two areas are noted as 'quarry or gravel pit' on topographic map and cleared of vegetation (disturbed area noted in central southern part of site, see Figure 5). This area was also noted to have some dumped wastes and cars.	Low to moderate likelihood of contamination. Exact activities in this area not know. Based on topography/geology, area is unlikely to have been a quarry.	TPH, BTEX, PAH, OCP, PCB, heavy metals and asbestos.

Continued

TABLE 2: SUMMARY OF POTENTIALLY CONTAMINATING ACTIVITIES, AREAS OF ENVIRONMENTAL CONCERN, LIKELIHOOD OF CONTAMINATION AND CHEMICALS OF CONCERN

Potentially Contaminating Activity	Sub Component / Description	Potential Areas of Environmental Concern (See also Figure 5)	Likelihood of Contamination*	Potential Chemicals of Concern
AEC 7. Area near service station		Land areas immediately adjacent and downslope of the service station (located to the south of the site approximately where Sussex Inlet Road turns south into township) from potential leakages of stored fuels. Soil and groundwater are likely to be impacted.	Moderate likelihood of contamination. The site is located in an inferred downgradient direction of the service station and contamination from the service station (if any) could potentially migrate onto the site.	TPH, BTEX, PAH and lead.

Notes:

* *It is important to note that this is not an assessment of financial risk associated with the AEC in the event contamination is detected, but a qualitative assessment of probability of contamination being detected at the potential AEC, based on the site history study and field observations.*

TPH = Total Petroleum Hydrocarbons BTEX = Benzene, Toluene, Ethylbenzene, Xylene PAH = Polycyclic Aromatic Hydrocarbons Heavy Metals = arsenic, cadmium, chromium, copper, lead, nickel, mercury, zinc OCP = Organochlorine Pesticides PCB = Polychlorinated Biphenyl

5 SUBSURFACE INVESTIGATION

Fieldwork for the subsurface investigation was carried out on 13 May 2008. Five test pits, numbered CTP1 to CTP5, were excavated at the site at the locations shown in Figure 3. The test pits were advanced to depths of between 1.8m and 2.3m using a backhoe equipped with a 450mm wide toothed bucket.

Hand Penetrometer tests were carried out at regular intervals in clay soils.

Five bulk disturbed samples were collected (1 from each test pit) and five additional disturbed samples were collected (1 from each test pit). These samples were collected and placed in sealed plastic bags for transport back to our soil testing laboratories.

Six samples from the test pits were collected for Acid Sulfate Soil testing purposes. Each sample was tightly wrapped in plastic film to exclude air and in turn placed into sealed plastic bags. Each ASS sample was then placed into an ice cooled chest and transported to the testing laboratory (Biotrack Pty Ltd) under chain of custody conditions.

The field work was carried out in the full-time presence of a Coffey Engineering Geologist, who located the test sites, prepared field logs and collected the soil samples.

6 LABORATORY TESTING

6.1 Geotechnical

One bulk disturbed sample and one small disturbed sample were collected from each test pit. The bulk samples were tested for CBR and the disturbed samples were tested for Emerson Class Number. All geotechnical testing was conducted at Coffey NATA accredited laboratories.

6.2 Acid Sulfate Soil Screening and Analysis

Six soil samples were screened by Biotrack Pty Ltd using the field pH and peroxide test, generally as described in the QLD Department of Natural Resources, Mines and Energy (2004) Acid Sulfate Soils – Laboratory Methods Guidelines. Initially the pH of the soil was tested in a 1:5 solution of distilled water and then also tested following reaction with 30% hydrogen peroxide.

The results of the acid sulfate soil screening tests are presented in Appendix D.

Two samples were selected for analysis using chromium reducible sulphur method (S_{CR}) (which includes total actual acidity and potassium chloride extractable sulphur).

7 RESULTS OF FIELD AND LABORATORY INVESTIGATIONS

7.1 Subsurface Conditions

Test pits CTP1 to CTP5 encountered alluvial soil, residual soil or extremely weathered siltstone (a soil material) throughout their full profile.

Minor groundwater seepage was encountered in CTP1 at 2.1m. Groundwater was not encountered in any other test pits.

Engineering logs of the test pits are given in Appendix B. A summary of the subsurface conditions is given in Table 3, below:

TABLE 3: SUMMARY OF SUBSURFACE CONDITIONS

Unit	Depth to top of Unit (m, B.G.L)	General Material Description	Consistency/ Density	Moisture Condition
Unit 1 - Topsoil	0	Clayey Sand, Silty Sand, Sandy Silt: Fine grained sand, grey some rootlets	Loose	Dry
Unit 2 - Alluvium	0.10 – 0.20	Sandy Clay and Silty Clay: high plasticity, pale grey and orange-brown, fine to medium grained sand	Stiff to Very Stiff	Wetter than Plastic Limit
		Clayey Sand and Silty Sand: fine to medium grained sand, pale grey, pale brown	Medium Dense	Dry to Moist
Unit 3 - Residual	0.10 – 0.15	Silty Clay: medium plasticity, orange brown/ red-brown. Some fine to medium grained sand and gravel	Hard/ Friable	Drier than Plastic Limit
		Clayey Sand: fine to medium grained, yellow-brown	Loose to Medium Dense	Moist
Unit 4 - Extremely Weathered Siltstone	0.90 – 1.0	Silty Sandy Clay: low to medium plasticity, fine to medium grained sand, grey/red-brown/orange-brown, trace of gravel Some highly weathered siltstone pockets encountered from 1.5m	Hard/ Friable	Drier than Plastic Limit

7.2 Geotechnical Test Results

CBR and Emerson Class Number tests were carried out as part of the geotechnical scope of work for the investigation. The full results of the laboratory geotechnical testing program are presented in Appendix C. A summary of the laboratory results is presented in Table 4, below.

TABLE 4 SUMMARY OF RESULTS OF LABORATORY TESTING

TEST PIT NUMBER	Sample Depth (m) below ground level	Material Description	Moisture Content (%)	Standard Optimum Moisture Content (%)	Standard Maximum Dry Density (t/m3)	CBR Value*	Assumed CBR Value	Emerson Class Number
CTP1	0.4-0.5	Alluvial soil - silty clay	16.6	15.7	1.78	6/6	6	3
CTP2	0.4-0.5	Residual soil - silty clay	13	13.4	1.99	15/19	15	5
CTP3	0.4-0.5	Residual soil - silty clay	24.6	26.4	1.55	5/6	5	3
CTP4	0.4-0.5	Alluvial soil - silty clay	15.5	14.8	1.8	10/11	10	2
CTP5	0.4-0.5	Alluvial soil - silty clay	19.9	20.1	1.62	3/2.5	2.5	2

Notes to Table 4:(CBR value)

**First Result is CBR at 2.5mm penetration*

**Second Result is CBR at 5mm penetration*

The laboratory test results indicate the following:

- One CBR result from CTP5 returned a CBR result of 2.5. The remainder of the CBR results ranged between 5 and 15.
- The moisture content of the sampled soils were within 0.4% and 2.0% of Standard Optimum Moisture Content.
- The Emerson Class Number test results indicate the soils are partially dispersive, or dispersive upon disturbance (remoulding or shaking in water).

7.3 Results of Acid Sulfate Soil Screening Tests

The ASS screening results are included in Appendix D, and the results are summarised in Table 6.

A field pH below 4 can indicate that actual acid sulfate soils are present (i.e. soils in which oxidation of iron sulfides has occurred and have produced acid). Generally a pH drop below 3 following oxidation with hydrogen peroxide indicates the probable presence of unoxidised sulfides in the samples, and for the purposes of the screening test, is taken as an indication of the probable presence of potential acid sulfate soils.

The screening results indicated the following:

- Six soil samples selected for screening recorded field pH values greater than 4, where sample CTP1/0.3-0.4m recorded the lowest field pH value of 4.5;
- Three soil samples (CTP2/0.1-0.2m, CTP3/0.05-0.1m and CTP4/0.3-0.4m) recorded a pH drop below 3 following oxidation with hydrogen peroxide which could suggest the presence of unoxidised sulfides.

It is noted that samples from CTP2 and CTP3 comprised residual soil and topsoil, respectively. The screening test is known to be affected by false positive results.

7.4 Acid Sulfate Soil Action Levels

In order to assess the significance of the ASS potential, the laboratory results were compared to action levels found in the Acid Sulfate Soil Manual (1998) prepared by the Acid Sulfate Soil Management Advisory Committee (ASSMAC 1998).

The ASSMAC action criteria triggers the need to prepare a management plan and obtain development consent. The action criteria are based on oxidisable sulfur concentrations for three differing soil textures. The manual provides different action levels depending on the amount of ASS that is to be disturbed. As the exact volume of ASS to be disturbed by the project is not known, the action criteria for a project that will disturb greater than 1000 tonnes of ASS materials has been adopted as a conservative approach. The action criteria provided in the ASSMAC manual are summarised in Table 5 below.

Table 5: ASSMAC (1998) Acid Sulfate Soil Action Criteria*

Soil Texture Category	Approximate Clay Content (%)	Action Criteria*	
		Sulfur Trail Percent Oxidisable Sulfur	Acid Trail
		(S_{POS} or S_{CR}) (%)	TAA, TPA or TSA (mol H^+/tonne)
Coarse	<5%	0.03	18
Medium	5% to 40%	0.03	18
Fine	>40%	0.03	18

***Notes**:*

** - Action criteria where greater than 1000 tonnes of ASS is to be disturbed*

S_{POS} Peroxide oxidisable sulphur

S_{CR} Chromium reducible sulphur

TAA Total Actual Acidity

TPA Total Potential Acidity

TSA Total Sulfidic Acidity

7.5 Comparison of Acid Sulfate Soil Laboratory Results to Action Criteria

The ASS laboratory results are summarised in Table 6, which are compared to action criteria provided in the ASSMAC manual. Original laboratory reports are presented in Appendix D.

TABLE 6:
SUMMARY OF ASS RESULTS
Field Screening and Chromium Reducible Sulfur

Sample ID		CTP1	CTP2	CTP3	CTP4	CTP4	CTP5
Unit		ALLUVIAL	RESIDUAL	TOPSOIL	ALLUVIAL	ALLUVIAL	ALLUVIAL
Material		Sandy Clay	Silty Sand	Silty Clayey Sand	Sandy Clay	Silty Clay	Silty Clay
Date of Sampling		13/05/2008	13/05/2008	13/05/2008	13/05/2008	13/05/2008	13/05/2008
Depth (m)	Action Criteria	0.3-0.4	0.1-0.2	0.05-.1	0.3-0.4	1.75-1.8	0.3-0.4
Screening Results							
pH Field		4.5	5.3	5.2	4.0	5.5	5.1
pH after oxidation with H2O2		3.2	2.3	2.5	2.5	3.1	3.9
pH Change		-1.3	-3.0	-2.7	-1.5	-2.4	-1.2
Observed reaction		2	3	2	2	1	0
Temperature Increase		0	0	0	0	0	0
Scr Test Results							
pH KCl		-	-	-	4.64	4.63	-
TAA (moles H+/ tonne)	18 [1]	-	-	-	**20**	**25**	-
S KCl (%)		-	-	-	<0.01	<0.01	-
SCr	0.03 [1]	-	-	-	<0.01	<0.01	-

NOTES:

Bold Concentration exceeds ASSMAC (1998) action level

[1] Based on ASSMAC (1998) Acid Sulfate Soil Manual (greater than 1000 tonnes)

\- Not Analysed

TAA Total Actual Acidity

S KCL Potasium chloride extractable sulfur

Scr Chromium reducible sulfur

Observed reaction (Visual observation at 0-5 minutes

0 None
1 Slight
2 Moderate
3 High
4 Very High (Steam evolved)

Two samples from CTP4 at depths of 0.3-0.4m and 1.75-1.8m recorded Total Actual Acidity (TAA) levels of 20m/t and 25m/t which exceed the action criteria of 18m/t. It is noted that potassium chloride extractable sulfur was not noted in the samples, therefore the acidity is not likely to sulfuric and therefore these soils are not considered to be ASS.

8 DISCUSSION AND RECOMMENDATIONS

8.1 Geotechnical

8.1.1 Overall Site Model and Setting

Based on the results of the site history, background data and fieldwork at the site:

- The areas of the site shown in Figure 3 with no shading are located in topographically elevated areas within relatively good drainage and stiff subsoils. For residential subdivisional purposes, there is a relatively low risk of encountering problematic ground conditions in these areas. Careful control of surface erosion is still considered important in all areas of this site, as discussed further in Section 8.1.2, below.
- The areas of the site shown in Figure 3 with shading are located in drainage channels with potentially shallow water inflows or in areas with potential acid sulphate soils. Also there is an increased risk of low strength soils and low CBR soils in these areas. Careful control of surface erosion is considered important in all areas of this site, as discussed further in Section 8.1.2, below.

Figure 3 outlines these topographical areas, and the limitations for each of these areas, in greater detail.

8.1.2 Soil Erodibility

The Emerson Class Number tests indicate that the alluvial soils tested had an Emerson Class Number of 2 to 3, and residual clay soils tested had an Emerson Class Number of 5. These results suggest that the alluvial soils are likely to be more dispersive than the residual soils at the site, however we note that the Emerson Class Number test allows identification of potentially dispersive soils, but does not provide a direct measurement of their erodibility. It is a considered a preliminary check on soil dispersivity.

Further testing of the alluvial soils at the site (Pinhole Dispersion Classification testing) is recommended during further stages of development to further investigate the erodibility of the alluvial clay soils.

Earthworks construction using dispersive soils can be undertaken safely provided certain precautions are taken, including:

- Incorporating filters into design of embankments; and
- Ensuring proper compaction of soils around buried structures, beneath pavements, around pipes in trenches and other engineered structures.
- Control of water ingress and flow through soils

8.1.3 Earthworks and Site Preparation

Excavation of the test pits on the day of the investigation was carried out with moderate resistance to a backhoe to a maximum depth of 2.3m. It is expected that excavation conditions over the site would be favourable for normal construction plant to the depths investigated. Rock was not encountered within CTP1 to CTP5. Excavations over the site during construction are likely to encounter soil materials to a depth of at least 1.5m. Some rock hammering may be required in deep excavations, however no rock was encountered in the test pits.

It is anticipated that in many areas of the golf course the ground may have undergone some filling and disturbance due to the formation of fairways, tees, bunkers, greens etc. In the areas marked as 'Alluvial Soils' (green), or in low lying areas on the site (yellow or red) in Figure 2, there is an increased risk of encountering deeper soft or water charged soils.

It is recommended that earthworks be undertaken in accordance with 'Level 1' of AS3798-2007. The implementation of good onsite earthworks control is considered particularly important as:

- potentially erodible soils exist on this site.
- there are potentially relatively thick deposits of soft, water charged soils along drainage gullies and in the lower lying areas of the site.
- It is known to Coffey that some areas of Sussex Inlet are prone to rapid rises in groundwater levels during or following periods of wet weather. Deeper excavations/cuts within this site will need to account for these potential water inflows during construction, and earthworks advice would likely need to be provided during these periods.

8.1.4 Pavement Thickness Design

Pavements for roads and accessways within the site will need to consider projected traffic movements and the subgrade conditions following preliminary earthworks. A preliminary pavement thickness design for upper and lower CBR values over a range of traffic loadings (ESA) is presented in Table 7. Pavement Design Reference: "A guide to the design of new pavements for light traffic", APRG Report No. 21 (1998).

TABLE 7: PRELIMINARY PAVEMENT THICKNESS DESIGN

Equivalent Standard Axles (ESAs)	Indicative Road Type based on ESAs	CBR (%)	Flexible Pavement Thickness (mm)
$5x10^4$	Minor	2.5	550 to 600 #
		15	250#
$1x10^5$	Local Access	2.5	570 to 620 #
		15	250*
$5x10^5$	Collector	2.5	630 to 680 #
		15	250*

Includes subgrade replacement, or stabilisation and assumes subgrade replacement or stabilisation to a thickness of between 100mm and 150mm is required. Assumes a thin bituminous surfacing and is based on a 95% Confidence level.

** Likely minimum pavement for Shoalhaven City Council.*

The large range of CBR values shown in the laboratory testing indicate a considerable variability in proposed subgrade materials over the site. It is therefore recommended that a further detailed pavement investigation be conducted on the site when the grades of the roads are finalised and the minimum pavement depth has been excavated. Other designs including deeper subgrade replacement, stabilised pavements and thicker wearing courses (asphalt) may be considered for roads with low CBR values.

It is possible that the Alluvial soil is of lower CBR value then the residual soils at this site, although further sampling and testing for CBR would be required to confirm this. It is known that some softer or water charged soils exist at the site particularly in the drainage channels and low lying areas. Subject to detailed subsurface investigation, these areas may require treatment that could include:-

- Over excavation (up to 600mm) of unsuitable subgrade, and replacement with suitable granular materials.
- Placement of geotextile fabric and geotextile grid materials over the unsuitable subgrade to improve stiffness of the subgrade soils. It is recommended that this is done in conjunction with a site trial to check on pavement performance. This method could prove cost effective against the traditional 'subgrade replacement approach'.

8.1.5 Footings and Bearing Capacity

It is assumed that the buildings for the proposed site will comprise mainly of single or two storey residential dwellings situated on cut/fill building platforms or suspended over the existing surface. In areas where the buildings are developed on cut/fill platforms it is recommended that all perimeter and internal stiffening beams or strip footings be founded uniformly in very stiff to hard natural clay soils or alternatively be deepened by closely spaced piers to extremely weathered rock. All footings should be socketed a minimum depth of 0.5m into natural stiff soils (i.e.below any topsoil or fill materials). Where buildings are entirely in cut and the exposed soil/weathered rock conditions are variable then footings should generally be deepened to found uniformly in the weathered rock.

Where footing excavations encroach into areas of soft ground where large trees have been removed or previous filling has been placed, footings must be extended below all deleterious material, topsoil and fill, and be founded in the weathered Siltstone/Sandstone.

Based on the test pit information the following bearing pressures are advised for the Unit 2,3, and 4 materials.

TABLE 8: FOOTING DESIGN PARAMETERS

Unit	Depth to Top of Unit in CTP1 to CTP5	Type of Footing	Serviceability End Bearing Pressure (kPa) (1)	Ultimate End Bearing Pressure (kPa)	Ultimate Shaft Adhesion (kPa) (2 and 3)
Stiff to hard silty clays, sandy clays (Unit 2 and 3)	0.1m to 0.2m	Strip, Pad or Bored Pile	200	300	N/A
Extremely weathered rock (Unit 4)	0.9m to 1.0m	Strip, Pad or Bored Pile	300	500	150

Notes to Table 8

1. *End bearing pressures for bored piles should result in settlement of less than 1% of the minimum footing width or pile diameter.*
2. *Adopt shaft adhesion values only where the embedded length into the relevant bearing stratum is at least 2 pile diameters.*
3. *For bored piles, the surface of the pile shaft should be cleared of clay smear and roughened using a suitable tool fitted to the pile-boring rig. Augers and drilling buckets do not clean and roughen sockets adequately unless they are fitted with tools that protrude laterally from the sides of the auger or bucket.*

8.1.6 Drainage

Drainage over the site should be controlled by the constructed site drainage structures and directed into the current stormwater system or suitable onsite detention. The road layout should be designed to act as cut off drains for overland flow and concentrated discharges should be avoided. Any areas disturbed during and after construction should be protected from erosion.

8.2 Contamination Issues

The results of the site history study and site observations indicate that in general the majority of the site has a low likelihood of being affected by soil contamination that would preclude the proposed development. The majority of the site appears to have been bushland. Some potential AECs were noted at the site (as summarised in Table 2). These AECs generally make up a relatively small proportion of the site. In general each of the potential AECs have been noted as having a low to moderate potential for contamination to actually exist.

Further investigation would be required in each of the identified AECs to assess if contamination actually exists through sampling and testing of soil and groundwater. Assessment of these areas should be carried out in general accordance with guidelines endorsed by the NSW Department of Environment and Climate Change (DECC).

The following general recommendations are made with respect to land contamination:

- Areas of localised dumping or where car bodies are located should be removed and disposed to a licensed landfill. Remaining soils should be assessed to check for contamination prior to redevelopment.
- Sampling and testing of soils should be carried out to check for contamination following dismantling and removal of the greenkeepers shed, AST and septic pits;
- Fibre cement fragments should be tested for asbestos and/or removed from the site by a suitably qualified contractor, assuming they contain asbestos;
- Preliminary testing should be carried out in areas of the golf course for residual pesticide, herbicide and fungicide contamination (particularly if these soils are to be used in other areas of the site);
- Sampling and testing should be carried out in the disturbed area in the southern part of the site and near the service station.

Based on the results of this assessment, it is considered that other bushland areas of the site do not warrant further assessment.

8.3 Acid Sulfate Soils

An assessment of the potential for ASS to be present at the site was made through a site walkover/mapping, reference to ASS risk maps, topographic maps, aerial photographs, geological maps and some site investigation work, field screening and laboratory analysis. The desk study and field mapping component of the works provided the majority of the information in relation to this assessment.

Based on the results of this assessment areas where ASS have a potential to be present are noted in Figures 3 and 4. These areas generally correspond to lower lying areas of the site in the south near Badgee Inlet (and adjacent areas to the west), and the area in the north-eastern part of the site near Sussex Inlet. It appears that areas at or below about RL+1mAHD to RL+2mAHD have a higher likelihood of being underlain by ASS. There areas are generally characterised as low lying estuarine/wetland areas with mangroves and more salt tolerant plant species. The current proposed development layout provided to Coffey suggests that the majority of these areas where ASS are likely to fall into ‘proposed open space dedication’ areas. The proposed golf club house and part of a medium density development area fall within an area marked on the ASS risk map as an alluvial plain with a ‘low probability’ of ASS occurrence and if present would be below about 1-3m depth. Preliminary sampling from one test pit in this area (CTP4) encountered alluvial soils down to 2m depth and were not considered to be ASS. Although this area is considered to have a lower likelihood of ASS being present than other areas on the site, at this stage, the presence of ASS at deeper intervals in this area cannot be discounted.

ASS investigations comprising soil sampling and testing are recommended for areas where any development has the potential to affect ASS as marked on Figures 3 and 4. Also, any development that may have the potential to draw down the water table to a level where it could impact upon nearby ASS should also be assessed. Based on the results of further assessment (if needed) and depending on the level and quantity of ASS disturbance an ASS management plan may be required to be prepared to manage these soils.

9 LIMITATIONS

The findings contained in this report are the result of discrete/specific methodologies used in accordance with normal practices and standards. To the best of 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.

During construction, subsurface conditions may be encountered which differ from those described or anticipated in this report. Coffey should be informed immediately if any apparently different subsoil conditions are encountered, so that recommendations can be reviewed and amended if necessary.

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Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.

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Important information about your **Coffey** Report

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other project design professionals who are affected by the report. Have Coffey explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Data should not be separated from the report*

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way.

Logs, figures, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel) and laboratory evaluation of field samples. These logs etc. should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Geoenvironmental concerns are not at issue

Your report is not likely to relate any findings, conclusions, or recommendations about the potential for hazardous materials existing at the site unless specifically required to do so by the client. Specialist equipment, techniques, and personnel are used to perform a geoenvironmental assessment.
Contamination can create major health, safety and environmental risks. If you have no information about the potential for your site to be contaminated or create an environmental hazard, you are advised to contact Coffey for information relating to geoenvironmental issues.

Rely on Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to a project, from design to construction. It is common that not all approaches will be necessarily dealt with in your site assessment report due to concepts proposed at that time. As the project progresses through design towards construction, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

* For further information on this aspect reference should be made to "Guidelines for the Provision of Geotechnical Information in Construction Contracts" published by the Institution of Engineers Australia, National Headquarters, Canberra, 1987.

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Important information about your **Coffey** Environmental Report

Uncertainties as to what lies below the ground on potentially contaminated sites can lead to remediation costs blow outs, reduction in the value of the land and to delays in the redevelopment of land. These uncertainties are an inherent part of dealing with land contamination. The following notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report has been written for a specific purpose

Your report has been developed on the basis of a specific purpose as understood by Coffey and applies only to the site or area investigated. For example, the purpose of your report may be:

- To assess the environmental effects of an on-going operation.
- To provide due diligence on behalf of a property vendor.
- To provide due diligence on behalf of a property purchaser.
- To provide information related to redevelopment of the site due to a proposed change in use, for example, industrial use to a residential use.
- To assess the existing baseline environmental, and sometimes geological and hydrological conditions or constraints of a site prior to an activity which may alter the sites environmental, geological or hydrological condition.

For each purpose, a specific approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible, quantify risks that both recognised and unrecognised contamination pose to the proposed activity. Such risks may be both financial (for example, clean up costs or limitations to the site use) and physical (for example, potential health risks to users of the site or the general public).

Scope of Investigations

The work was conducted, and the report has been prepared, in response to specific instructions from the client to whom this report is addressed, within practical time and budgetary constraints, and in reliance on certain data and information made available to Coffey. The analyses, evaluations, opinions and conclusions presented in this report are based on those instructions, requirements, data or information, and they could change if such instructions etc. are in fact inaccurate or incomplete.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man and may change with time. For example, groundwater levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project and/or on the property.

Interpretation of factual data

Environmental site assessments identify actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from indirect field measurements and sometimes other reports on the site are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how well qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of Coffey through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other problems encountered on site.

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Important information about your **Coffey** Environmental Report

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered with redevelopment or on-going use of the site. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and pers ons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. In particular, a due diligence report for a property vendor may not be suitable for satisfying the needs of a purchaser. Your report should not be applied for any purpose other than that originally specified at the time the report was issued.

Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, retain Coffey to work with other professionals who are affected by the report. Have Coffey explain the report implications to professionals affected by them and then review plans and specifications produced to see how they have incorporated the report findings.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists, engineers or geologists based on their interpretation of field logs (assembled by field personnel), field testing and laboratory evaluation of field samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

Contact Coffey for additional assistance

Coffey is familiar with a variety of techniques and approaches that can be used to help reduce risks for all parties to land development and land use. It is common that not all approaches will be necessarily dealt with in your environmental site assessment report due to concepts proposed at that time. As a project progresses through planning and design toward construction and/or maintenance, speak with Coffey to develop alternative approaches to problems that may be of genuine benefit both in time and cost.

Responsibility

Environmental reporting relies on interpretation of factual information based on judgement and opinion and has a level of uncertainty attached to it, which is far less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. To help prevent this problem, a number of clauses have been developed for use in contracts, reports and other documents. Responsibility clauses do not transfer appropriate liabilities from Coffey to other parties but are included to identify where Coffey's responsibilities begin and end. Their use is intended to help all parties involved to recognise their individual responsibilities. Read all documents from Coffey closely and do not hesitate to ask any questions you may have.

72510 / 07-06

Figures

drawn	DH
approved	
date	2/6/08
scale	AS SHOWN
original size	A4

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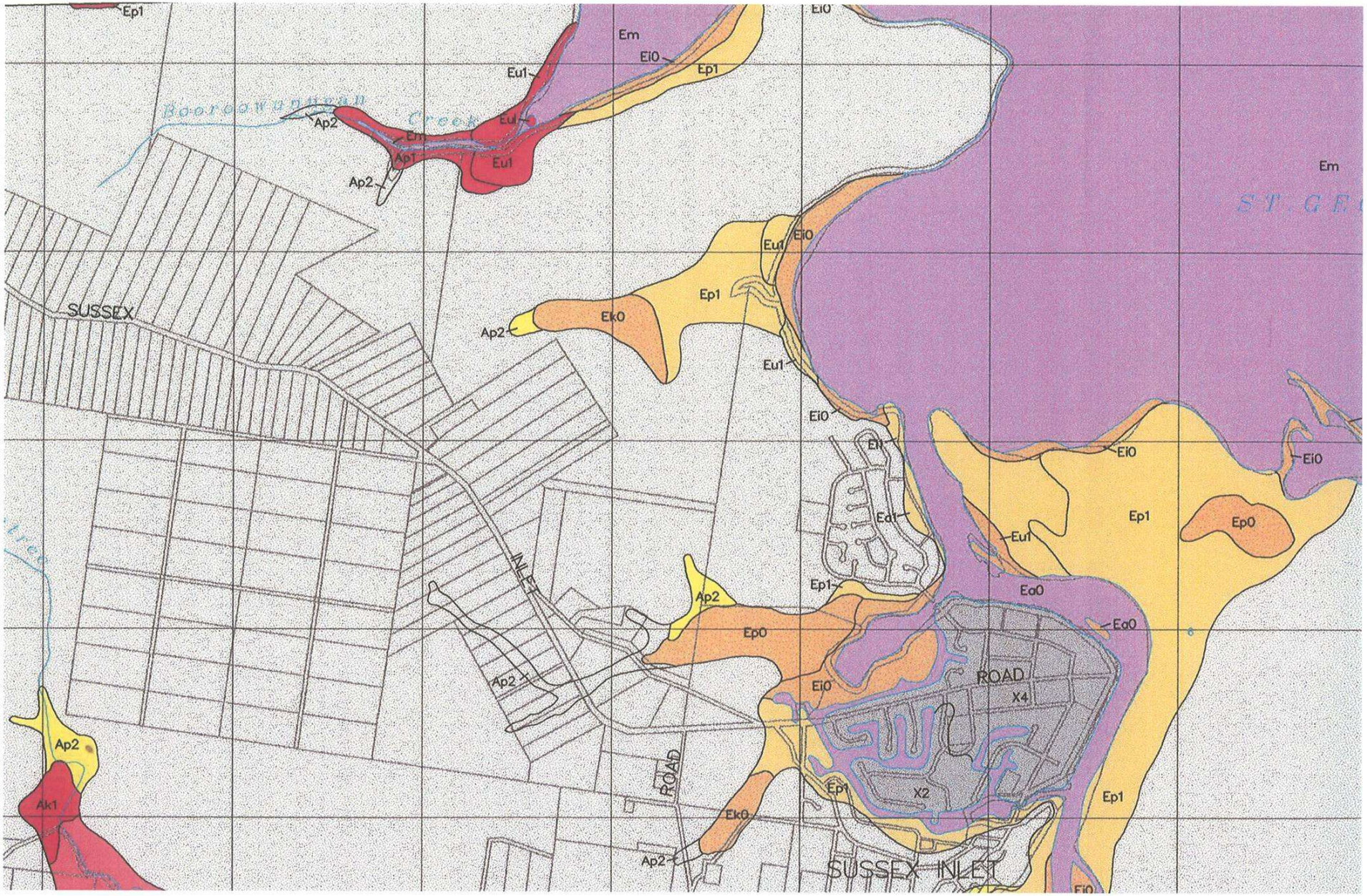
client:	ALLEN PRICE AND ASSOCIATES
project:	PROPOSED 1000 LOT SUBDIVISION PRELIMINARY GEOTECHNICAL, CONTAMINATION AND ACID SULFATE SOILS ASSESSMENT
title:	SITE LOCALITY PLAN
project no: GEOTUNAN02704-AA-AA	figure no: FIGURE 1



revision	description	drawn	approved	date

0
Not To Scale

drawn	DH
approved	
date	2/6/08
scale	N/A
original size	A3

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client: ALLEN PRICE AND ASSOCIATES

project: PROPOSED 1000 LOT SUBDIVISION
PRELIMINARY GEOTECHNCIAL, CONTAMINATION
AND ACID SULFATE SOILS ASSESSMENT

title: ACID SULFATE SOIL RISK MAP

project no: GEOTUNAN02704AA

figure no: FIGURE 2

KEY

Map Class Description	Depth to Acid Sulfate Soil Materials		Environmental Risk	Typical Landform Types
HIGH PROBABILITY High probability of occurrence of acid sulfate soil material within the soil profile. The environment of deposition has been suitable for the formation of acid sulfate soil materials. Acid sulfate soil materials are widespread or sporadic and may be buried by alluvium or windblown sediments.	Below water level	Bottom sediments.	Severe environmental risk if bottom sediments are disturbed by activities such as dredging.	Bottom sediments of lakes, lagoons, tidal creeks, rivers and estuaries.
		At or near the ground surface.	Severe environmental risk if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.	Estuarine swamps, intertidal flats and supratidal flats.
		Within 1 metre of the ground surface.	Severe environmental risk if acid sulfate soil materials are disturbed by activities such as shallow drainage, excavation or clearing.	Low alluvial plains, estuarine sandplains, estuarine swamps, backswamps, and supratidal flats.
		Between 1 and 3 metres below the ground surface.	Environmental risk if acid sulfate soil materials are disturbed by activities such as deep excavation for pipelines, dams or deep drains.	Alluvial plains, alluvial swamps, alluvial levees and sandplains.
		Greater than 3 metres below the ground surface.*	Environmental risk if acid sulfate soil materials are disturbed by activities such as deep excavations, eg, large structure foundations or deep dams.	Elevated levees and sandplains, alluvial plains and alluvial swamps in estuarine reaches of catchments.
LOW PROBABILITY Low probability of occurrence of acid sulfate soil materials within the soil profile. The environment of deposition has generally not been suitable for the formation of acid sulfate soil materials. Soil materials are often Pleistocene in age. Acid sulfate soil materials, if present, are sporadic and may be buried by alluvium or windblown sediments.	Below water level	Bottom sediments.	The majority of these landforms are not expected to contain acid sulfate soil materials. Therefore, land management is generally not affected by acid sulfate soils. However, highly localised occurrences may be found, especially near boundaries with environments with a high probability of occurrence. Disturbance of these soil materials will result in an environmental risk that will vary with elevation and depth of disturbance.	Elevated alluvial plains and levees dominated by fluvial sediments. Plains and dunes dominated by aeolian soils. Pleistocene plains. Lacustrine and alluvial bottom sediments.
		At or near the ground surface.		
		Within 1 metre of the ground surface.		
		Between 1 and 3 metres below the ground surface.		
		Greater than 3 metres below the ground surface.*		
NO KNOWN OCCURRENCE Acid sulfate soils are not known or expected to occur in these environments.		No known occurrences of acid sulfate soil materials.	Land management activities not likely to be affected by acid sulfate soils.	Bedrock slopes, elevated Pleistocene and Holocene dunes and elevated alluvial plains.
DISTURBED TERRAIN		Disturbed terrain may include filled areas, which often occur during reclamation of low lying swamps for urban development. Other disturbed terrain includes areas which have been mined or dredged, or have undergone heavy ground disturbance through general urban development or construction of dams or levees. Soil investigations are required to assess these areas for acid sulfate potential.		

*Deep occurrences of acid sulfate soil materials not able to be confirmed by field inspection and sampling

LANDFORM CODES

Landform Process Class		Landform Element				Elevation#	
W.....	Aeolian	b.....	Backplain	t.....	Levee toe	0.....	0-1 m
A.....	Alluvium	k.....	Backswamp	o.....	Ox-bow	1.....	1-2 m
B.....	Beach	m.....	Bottom sediments	p.....	Plain	2.....	2-4 m
E.....	Estuarine	n.....	Channel	a.....	Sandplain	4.....	>4 m
L.....	Lacustrine	d.....	Dune	s.....	Swamp		
S.....	Swamp	r.....	Interbarrier swamp	y.....	Splay		
		i.....	Intertidal flat	u.....	Supratidal flat		
		g.....	Lagoon	w.....	Swale		
X.....	Disturbed Terrain*	l.....	Levee	c.....	Tidal creek		

REF: DLWC (1997) ACID SULFATE SOIL RISK MAP EDITION 2 – WOLLONGONG SHEET

revision	description	drawn	approved	date

0

Not To Scale

drawn	SM/DH
approved	
date	30/5/08
scale	N/A
original size	A3

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SPECIALISTS MANAGING THE EARTH

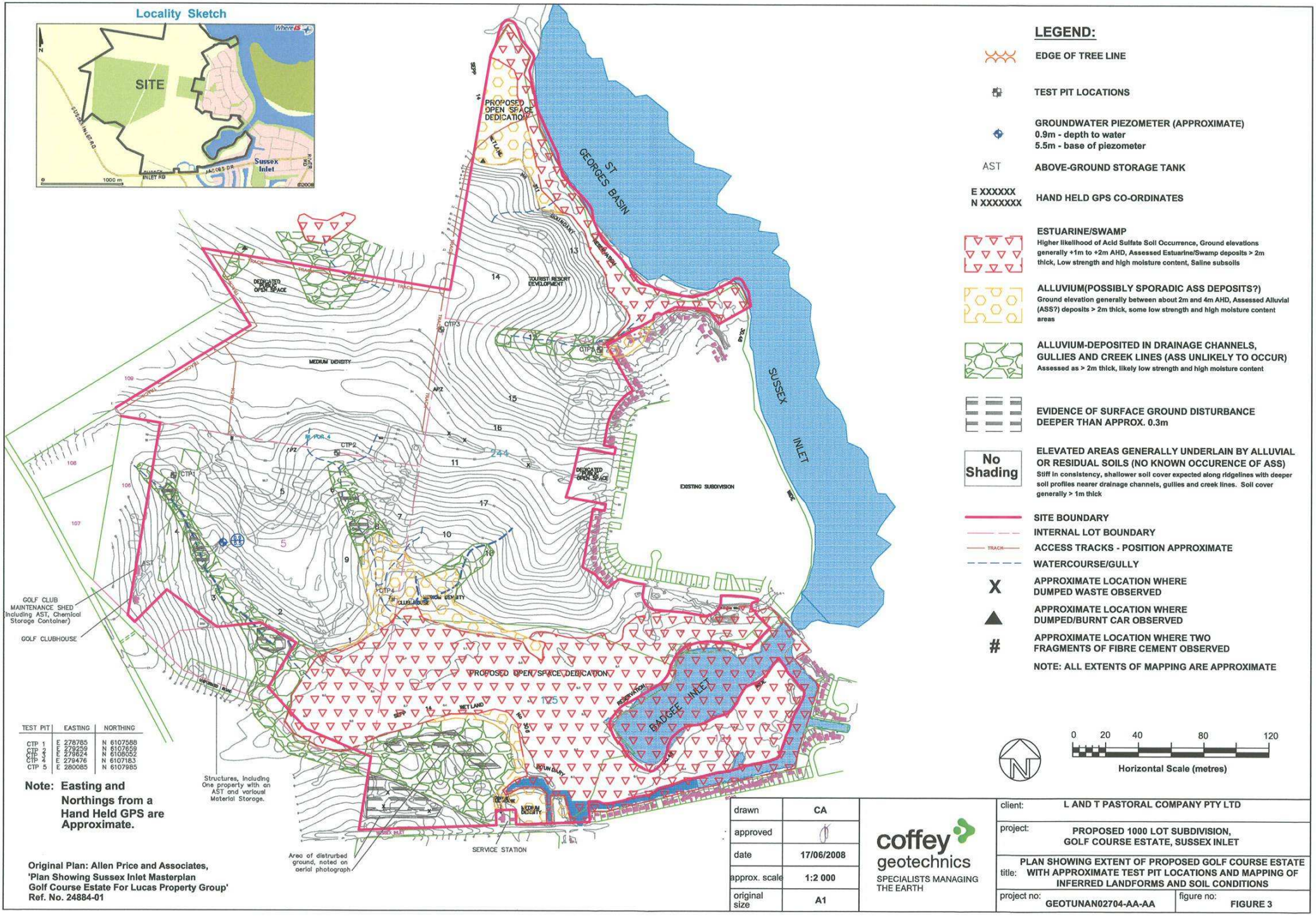
client: ALLEN PRICE AND ASSOCIATES

project: PROPOSED 1000 LOT SUBDIVISION PRELIMINARY GEOTECHNCIAL, CONTAMINATION AND ACID SULFATE SOILS ASSESSMENT

title: ACID SULFATE SOIL RISK MAP

project no: GEOTUNAN02704AA

figure no: FIGURE 2B



TEST PIT	EASTING	NORTHING
CTP 1	E 278785	N 6107588
CTP 2	E 279259	N 6107659
CTP 3	E 279624	N 6108052
CTP 4	E 279476	N 6107183
CTP 5	E 280085	N 6107985

Note: Easting and Northings from a Hand Held GPS are Approximate.

Original Plan: Allen Price and Associates, 'Plan Showing Sussex Inlet Masterplan Golf Course Estate For Lucas Property Group' Ref. No. 24884-01

drawn	CA
approved	
date	17/06/2008
approx. scale	1:2 000
original size	A1

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client: L AND T PASTORAL COMPANY PTY LTD

project: PROPOSED 1000 LOT SUBDIVISION, GOLF COURSE ESTATE, SUSSEX INLET

title: PLAN SHOWING EXTENT OF PROPOSED GOLF COURSE ESTATE WITH APPROXIMATE TEST PIT LOCATIONS AND MAPPING OF INFERRED LANDFORMS AND SOIL CONDITIONS

project no: GEOTUNAN02704-AA-AA

figure no: FIGURE 3

LEGEND:

- EDGE OF TREE LINE
- TEST PIT LOCATIONS
- GROUNDWATER PIEZOMETER (APPROXIMATE)
  0.9m - depth to water
  5.5m - base of piezometer
- AST — ABOVE-GROUND STORAGE TANK
- E XXXXXX, N XXXXXXX — HAND HELD GPS CO-ORDINATES
- APPROXIMATE AREAS WHERE ACID SULFATE SOILS ARE LIKELY TO BE ENCOUNTERED
  (Based on available photographs, survey maps, topographic maps, ASS Risk Map and Site Observations)
- SITE BOUNDARY
- INTERNAL LOT BOUNDARY
- ACCESS TRACKS - POSITION APPROXIMATE
- WATERCOURSE/GULLY

ST GEORGES BASIN

SUSSEX INLET

BADGEE INLET

PROPOSED OPEN SPACE DEDICATION

TOURIST RESORT DEVELOPMENT

MEDIUM DENSITY

EXISTING SUBDIVISION

DEDICATED PUBLIC OPEN SPACE

GOLF CLUB MAINTENANCE SHED (Including AST, Chemical Storage Container)

GOLF CLUBHOUSE

SERVICE STATION

Structures, including One property with an AST and various Material Storage.

Area of disturbed ground, noted on aerial photograph

TEST PIT	EASTING	NORTHING
CTP 1	E 278785	N 6107588
CTP 2	E 279259	N 6107659
CTP 3	E 279624	N 6108052
CTP 4	E 279476	N 6107183
CTP 5	E 280085	N 6107985

Note: Easting and Northings from a Hand Held GPS are Approximate.

Original Plan: Allen Price and Associates, 'Plan Showing Sussex Inlet Masterplan Golf Course Estate For Lucas Property Group' Ref. No. 24884-01

0 20 40 80 120
Horizontal Scale (metres)

drawn	CA
approved	
date	17/06/2008
approx.scale	1:2 000
original size	A1

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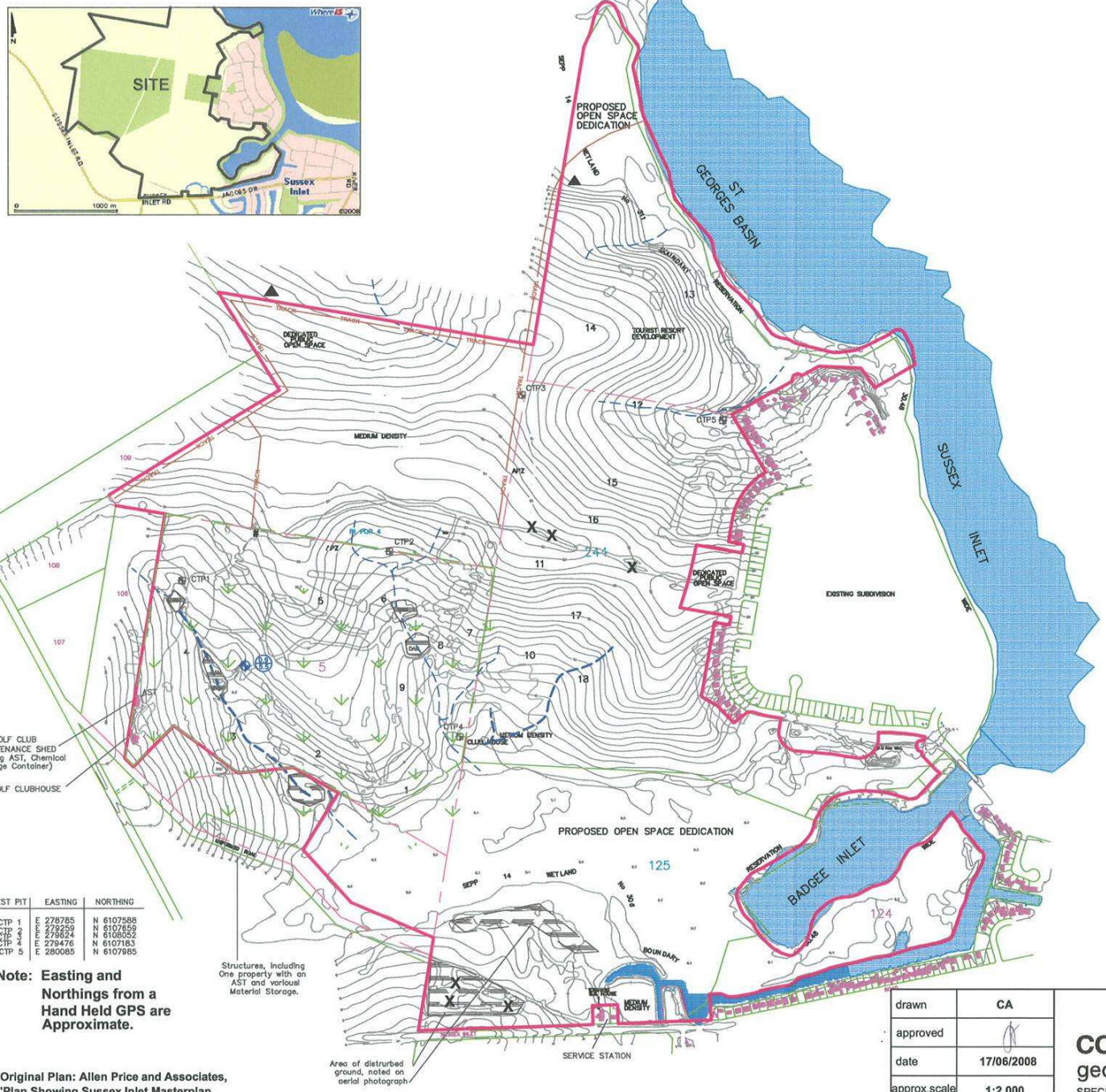
SPECIALISTS MANAGING THE EARTH

client:	L AND T PASTORAL COMPANY PTY LTD
project:	PROPOSED 1000 LOT SUBDIVISION, GOLF COURSE ESTATE, SUSSEX INLET
title:	AREAS WHERE ACID SULFATE SOIL ARE LIKELY TO BE ENCOUNTERED
project no:	GEOTUNAN02704-AA-AA
figure no:	FIGURE 4



LEGEND:

- EDGE OF TREE LINE
- TEST PIT LOCATIONS
- GROUNDWATER PIEZOMETER (APPROXIMATE)
  0.9m - depth to water
  5.5m - base of piezometer
- AST — ABOVE-GROUND STORAGE TANK
- E XXXXXX / N XXXXXXX — HAND HELD GPS CO-ORDINATES
- AREA OF DISTURBED GROUND, NOTED ON AERIAL PHOTOGRAPH
- APPROXIMATE LOCATION OF GOLF COURSE
- SITE BOUNDARY
- INTERNAL LOT BOUNDARY
- TRACK — ACCESS TRACKS - POSITION APPROXIMATE
- WATERCOURSE/GULLY
- X — APPROXIMATE LOCATION WHERE DUMPED WASTE OBSERVED
- ▲ — APPROXIMATE LOCATION WHERE DUMPED/BURNT CAR OBSERVED
- # — APPROXIMATE LOCATION WHERE TWO FRAGMENTS OF FIBRE CEMENT OBSERVED
- NOTE: ALL EXTENTS OF MAPPING ARE APPROXIMATE

TEST PIT	EASTING	NORTHING
CTP 1	E 278785	N 6107588
CTP 2	E 279259	N 6107859
CTP 3	E 279624	N 6108052
CTP 4	E 279476	N 6107183
CTP 5	E 280085	N 6107985

Note: Easting and Northings from a Hand Held GPS are Approximate.

Original Plan: Allen Price and Associates, 'Plan Showing Sussex Inlet Masterplan Golf Course Estate For Lucas Property Group' Ref. No. 24884-01

drawn	CA
approved	
date	17/06/2008
approx.scale	1:2 000
original size	A1

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

client: L AND T PASTORAL COMPANY PTY LTD

project: PROPOSED 1000 LOT SUBDIVISION, GOLF COURSE ESTATE, SUSSEX INLET

title: POTENTIAL AREAS OF ENVIRONMENTAL CONCERN

project no: GEOTUNAN02704-AA-AA

figure no: FIGURE 5

Appendix A

site history

Refer to hard copy.

Appendix B

Engineering Logs of Test Pits CTP1 to CTP5, with explanatory notes

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Soil Description Explanation Sheet (1 of 2)

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil. Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 μm to 2.36 mm
	medium	200 μm to 600 μm
	fine	75 μm to 200 μm

MOISTURE CONDITION

Dry Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.

Moist Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.

Wet As for moist but with free water forming on hands when handled.

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 - 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 - 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 - 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 - 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	–	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 - 35
Medium Dense	35 - 65
Dense	65 - 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: <5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material — Structure and fabric of parent rock visible.

Residual soil — Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil — Deposited by wind.

Alluvial soil — Deposited by streams and rivers.

Colluvial soil — Deposited on slopes (transported downslope by gravity).

Fill — Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.

Lacustrine soil — Deposited by lakes.

Marine soil — Deposited in ocean basins, bays, beaches and estuaries.

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Soil Description Explanation Sheet (2 of 2)

SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)								USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of materials less than 63 mm is larger than 0.075 mm	(About the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.				GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.				GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)				GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)				GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes missing				SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.				SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).				SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).				SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)		IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.						
			DRY STRENGTH	**DILATANCY**	**TOUGHNESS**				
		SILTS & CLAYS Liquid limit less than 50	None to Low	Quick to slow	None			ML	SILT
			Medium to High	None	Medium			CL	CLAY
			Low to medium	Slow to very slow	Low			OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low to medium			MH	SILT
			High	None	High			CH	CLAY
			Medium to High	None	Low to medium			OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS		Readily identified by colour, odour, spongy feel and frequently by fibrous texture.						Pt	PEAT

• Low plasticity – Liquid Limit W_L less than 35%. • Modium plasticity – W_L between 35% and 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2 m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect.	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

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Rock Description Explanation Sheet (1 of 2)

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Rock Substance	In engineering terms roch substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogenous material, may be isotropic or anisotropic.
Defect	Discontinuity or break in the continuity of a substance or substances.
Mass	Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME Simple rock names are used rather than precise geological classification.

PARTICLE SIZE Grain size terms for sandstone are:

Coarse grained	Mainly 0.6mm to 2mm
Medium grained	Mainly 0.2mm to 0.6mm
Fine grained	Mainly 0.06mm (just visible) to 0.2mm

FABRIC Terms for layering of penetrative fabric (eg. bedding, cleavage etc.) are:

Massive	No layering or penetrative fabric.
Indistinct	Layering or fabric just visible. Little effect on properties.
Distinct	Layering or fabric is easily visible. Rock breaks more easily parallel to layering of fabric.

CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	Definition
Residual Soil	**RS**	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely Weathered Material	**XW**	Material is weathered to such an extent that it has soil properties, ie, it either disintegrates or can be remoulded in water. Original rock fabric still visible.
Highly Weathered Rock	**HW**	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
Moderately Weathered Rock	**MW**	The whole of the rock substance is discoloured, usually by iron staining or bleaching , to the extent that the colour of the fresh rock is no longer recognisable.
Slightly Weathered Rock	**SW**	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Fresh Rock	**FR**	Rock substance unaffected by weathering.

Notes on Weathering:

1. AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction. DW may be used with the definition given in AS1726.
2. Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.

ROCK SUBSTANCE STRENGTH TERMS

Term	Abbrev-iation	Point Load Index, $I_{S}50$ (MPa)	Field Guide
Very Low	**VL**	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
Low	**L**	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm bows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	**M**	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	**H**	1 to 3	A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	**VH**	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
Extremely High	**EH**	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.

Notes on Rock Substance Strength:

1. In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.
2. The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.
3. The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fall across the planar anisotropy) is typically 10 to 25 times the point load index (Is50). The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.

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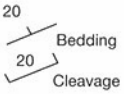
Rock Description Explanation Sheet (2 of 2)

COMMON DEFECTS IN ROCK MASSES Term	Definition	Diagram	Map Symbol	Graphic Log (Note 1)
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg, cleavage). May be open or closed.			 (Note 2)
Joint	A surface or crack across which the rock has little or no tensile strength. but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.			 (Note 2)
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.			
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.			
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.			
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint, infilled seams less than 1mm thick may be described as veneer or coating on joint surface.			
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formad by weathering of the rock substance in place.			

DEFECT SHAPE TERMS	
Planar	The defect does not vary in orientation
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps
Irregular	The defect has many sharp changes of orientation

Note: The assessment of defect shape is partly influenced by the scale of the observation.

ROUGHNESS TERMS	
Slickensided	Grooved or striated surface, usually polished
Polished	Shiny smooth surface
Smooth	Smooth to touch. Few or no surface irregularities
Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.

COATING TERMS	
Clean	No visible coating
Stained	No visible coating but surfaces are discoloured
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein.

BLOCK SHAPE TERMS	
Blocky	Approximately equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greate than cross section

Notes on Defects:

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significant.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

72710 / 07-06

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Engineering Log - Excavation

Excavation No. **CTP1**

Sheet 1 of 1

Project No: **GEOTUNAN02704AA**

Client: **ALLEN, PRICE AND ASSOCIATES**

Date started: **13.5.2008**

Principal: **L AND T PASTORAL COMPANY PTY LTD**

Date completed: **13.5.2008**

Project: **1000 LOT SUBDIVISION - SUSSEX INLET MASTERPLAN**

Logged by: **DH**

Test pit location: **GOLF COURSE ESTATE, SUSSEX INLET RD, SUSSEX INLET**

Checked by:

equipment type and model: BACKHOE | Pit Orientation: | Easting: 278785 m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.5m wide | Northing: 6107588 m | datum:

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N						SC	Clayey SAND: fine grained sand, grey, some roots and rootlets	M	L		TOPSOIL
								CL	Sandy CLAY/Clayey SAND: medium plasicity, fine to medium grained sand, pale grey with trace of orange-brown staining, trace of roots	>Wp	F/St	×	ALLUVIUM
				E									
				Bs,Ds		0.5		CH	Silty CLAY: high plasticity, pale grey with trace of orange-brown staining		St		
						1.0						×	
											VSt		
						1.5						×	
						2.0							Very slow groundwater seepage from 2.1m due to slightly more permeable sandy clay. actual standing water level possibly higher however high plasticiy clay is low permeability so no seepage after 30mins
			▼					CL	Sandy CLAY: medium plasticity, pale grey, fine grained sand			×	
						2.5			Test pit CTP1 terminated at 2.3m				End on slow progress

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

coffey geotechnics

Engineering Log - Excavation

Excavation No. **CTP2**

Sheet 1 of 1

Project No: **GEOTUNAN02704AA**

Client: **ALLEN, PRICE AND ASSOCIATES**

Date started: **13.5.2008**

Principal: **L AND T PASTORAL COMPANY PTY LTD**

Date completed: **13.5.2008**

Project: **1000 LOT SUBDIVISION - SUSSEX INLET MASTERPLAN**

Logged by: **DH**

Test pit location: **GOLF COURSE ESTATE, SUSSEX INLET RD, SUSSEX INLET**

Checked by:

equipment type and model: BACKHOE | Pit Orientation: | Easting: 279259 m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.5m wide | Northing: 6107659 m | datum:

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	NONE OBSERVED				SM	Silty SAND: fine to medium grained sand, grey, some roots and rootlets	D	L		TOPSOIL
				E			SC	Clayey SAND: fine to medium grained, yellow-brown, some roots	M	L/MD		RESIDUAL
				Bs,Ds	0.5		CL	Silty CLAY: medium plasticity, orange-brown with red-brown mottling, some fine to medium grained sand and some fine to medium grained subangular gravel	<Wp	H/Fb	×	
					1.0		CL	Silty Sandy CLAY: low to medium plasticity, fine to medium grained sand, pale grey/red-brown/orange-brown mottled, trace of fine to medium grained subangular gravel				XW SILTSTONE
					1.5							Some HW pockets from 1.5m
					2.0			Test pit CTP2 terminated at 1.8m				End on slow to very slow progress
					2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TESTPIT GU2704AA-LOGS.GPJ COFFEY.GDT 2.6.08

Form GEO 5.2 Issue 3 Rev 2

coffey geotechnics

Engineering Log - Excavation

Excavation No. **CTP3**

Sheet 1 of 1

Project No: **GEOTUNAN02704AA**

Client: **ALLEN, PRICE AND ASSOCIATES**

Date started: **13.5.2008**

Principal: **L AND T PASTORAL COMPANY PTY LTD**

Date completed: **13.5.2008**

Project: **1000 LOT SUBDIVISION - SUSSEX INLET MASTERPLAN**

Logged by: **DH**

Test pit location: **GOLF COURSE ESTATE, SUSSEX INLET RD, SUSSEX INLET**

Checked by:

equipment type and model: BACKHOE

Pit Orientation:

Easting: 279624 m

R.L. Surface: Not Measured

excavation dimensions: 2m long 0.5m wide

Northing: 6108052 m

datum:

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	NONE OBSERVED	E				SM	Silty Clayey SAND: fine to medium grained sand, pale grey, some roots	D	L		TOPSOIL
				Bs,Ds		0.5		CL	Silty CLAY: medium plasticity, orange-brown with red-brown mottling, some fine to medium grained sand and some fine to medium grained subangular gravel	<Wp	H/Fb	×	RESIDUAL
						1.0		CL	Silty Sandy CLAY: low to medium plasticity, fine to medium grained sand, pale grey/red-brown/orange-brwon mottled, trace of fine to medium grained subangular gravel				XW SILTSTONE
						1.5							Some HW pockets from 1.5m
						2.0			Test pit CTP3 terminated at 1.8m				End on slow to very slow progress
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

TESTPIT GU2704AA-LOGS.GPJ COFFEY.GDT 2.6.08

Form GEO 5.2 Issue 3 Rev 2

coffey geotechnics

Engineering Log - Excavation

Excavation No. **CTP4**

Sheet 1 of 1

Project No: **GEOTUNAN02704AA**

Client: **ALLEN, PRICE AND ASSOCIATES**

Date started: **13.5.2008**

Principal: **L AND T PASTORAL COMPANY PTY LTD**

Date completed: **13.5.2008**

Project: **1000 LOT SUBDIVISION - SUSSEX INLET MASTERPLAN**

Logged by: **DH**

Test pit location: **GOLF COURSE ESTATE, SUSSEX INLET RD, SUSSEX INLET**

Checked by:

equipment type and model: BACKHOE | Pit Orientation: | Easting: 279476 m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.5m wide | Northing: 6107183 m | datum:

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
BH		N	NONE OBSERVED					ML	Sandy SILT: fine grained sand, grey, some roots	D	L		TOPSOIL
								SC	Clayey SAND: fine grained sand, pale brown, some roots		MD		ALLUVIUM
				E									
				Bs.Ds		0.5		CH	Silty CLAY: high plasticity, orange-brown and pale grey mottled, trace of roots	>Wp	VSt		
						1.0						×	
						1.5		SM	Silty SAND: fine to medium grained sand, pale grey, trace of pale yellow staining, trace of clay	M	MD		Sulfurous odour noted from 1.5m
				E		2.0							
									Test pit CTP4 terminated at 2m				End on steady to slow progress
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index

VS	very soft
S	soft
F	firm
St	stiff
VSt	very stiff
H	hard
Fb	friable
VL	very loose
L	loose
MD	medium dense
D	dense
VD	very dense

TESTPIT GU2704AA-LOGS.GPJ COFFEY.GDT 17.6.08

Form GEO 5.2 Issue 3 Rev.2

coffey geotechnics

Engineering Log - Excavation

Excavation No. **CTP5**

Sheet 1 of 1

Project No: **GEOTUNAN02704AA**

Client: **ALLEN, PRICE AND ASSOCIATES**

Date started: **13.5.2008**

Principal: **L AND T PASTORAL COMPANY PTY LTD**

Date completed: **13.5.2008**

Project: **1000 LOT SUBDIVISION - SUSSEX INLET MASTERPLAN**

Logged by: **DH**

Test pit location: **GOLF COURSE ESTATE, SUSSEX INLET RD, SUSSEX INLET**

Checked by:

equipment type and model: BACKHOE | Pit Orientation: | Easting: 280085 m | R.L. Surface: Not Measured

excavation dimensions: 2m long 0.5m wide | Northing: 6107985 m | datum:

excavation information | **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components.	moisture condition	consistency/ density index	pocket penetrometer kPa (100 200 300 400)	structure and additional observations
BH		N	NONE OBSERVED	E Bs,Ds		0.5		SM	Silty SAND: fine to medium grained sand, brown, some roots	D	L		TOPSOIL
								CH	Silty CLAY: high plasticity, pale grey and orange-brown mottled, tarce of fine grained sand, trace of roots	>Wp	St		ALLUVIUM
						1.0					VSt	×	
						1.5						×	
						2.0						×	
									Test pit CTP5 terminated at 2m				End on slow progress
						2.5							

Sketch

method
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R ripper
- E excavator

support
- S shoring
- N nil

penetration 1 2 3 4 — no resistance ranging to refusal

water
- water level on date shown
- water inflow
- water outflow

notes, samples, tests
- U_{50} undisturbed sample 50mm diameter
- U_{63} undisturbed sample 63mm diameter
- D disturbed sample
- V vane shear (kPa)
- Bs bulk sample
- E environmental sample
- R refusal

classification symbols and soil description based on unified classification system

moisture
- D dry
- M moist
- W wet
- Wp plastic limit
- W_L liquid limit

consistency/density index
- VS very soft
- S soft
- F firm
- St stiff
- VSt very stiff
- H hard
- Fb friable
- VL very loose
- L loose
- MD medium dense
- D dense
- VD very dense

TESTPIT GU2704AA-LOGS.GPJ COFFEY.GDT 2.6.08

Form GEO 5.2 Issue 3 Rev.2

Appendix C

Geotechnical Laboratory Testing Results

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unanderra, Wollongong Laboratory

Coffey Geotechnics Pty Ltd
ABN 93 056 929 483
1/222 Berkeley Road
Unanderra NSW 2526

Telephone: +61 2 4272 6071
Facsimile: +61 2 4272 6075

California Bearing Ratio

Report No: CBR:UNAN08S-01549
Issue No: 1
This report replaces all previous issues of report no 'CBR:UNAN08S-01549'.

Client:	Coffey Geotechnics Pty Ltd (Unanderra) 1/222 Berkeley Road Unanderra NSW 2525
Principal:	Allen Price & Associates Pty Ltd
Job No:	LABTUNAN00207AA
Project:	GEOTUNAN02704AA - Proposed Subdivision - Sussex Inlet
Lot No:	**TRN:**

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Clint Manning (Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 30/05/2008

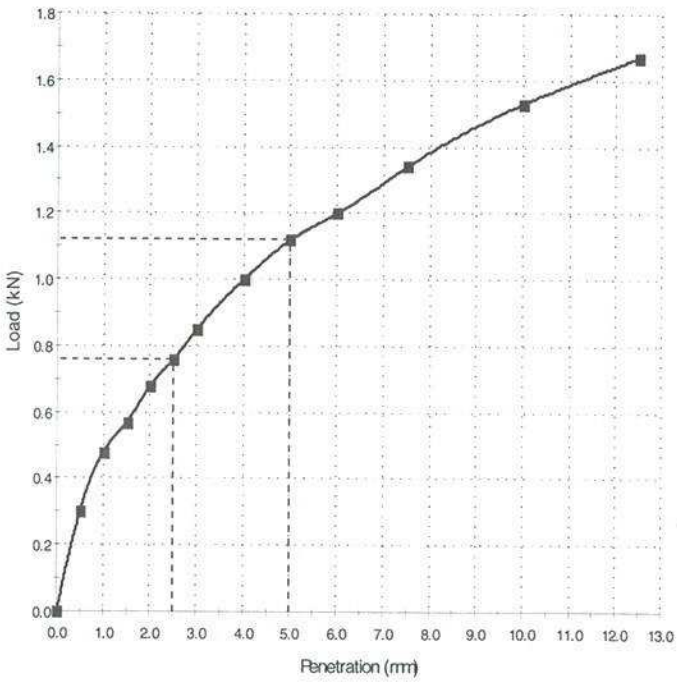
Sample Details

Product:	Sandy CLAY/Clayey SAND - orange brown	**Date Sampled:**	13/05/2008
Source:	CTP 1 - Depth 0.4m to 0.5m	**Sampling Method:**	AS1289.1.2.1 Clause 6.5
Location:	Sussex Inlet Road, Sussex Inlet	**Sample ID:**	UNAN08S-01549
Client Ref:	00001		

Test Results

Description	Result
Test Method	AS 1289.6.1.1
Maximum Dry Density (t/m³)	1.780
Optimum Moisture Content (%)	15.7
CBR 2.5mm (%)	**6.0**
CBR 5.0mm (%)	**6.0**
Preparation	Soaked
Initial Moisture Content (%)	16.6
Achieved Dry Density (t/m³)	1.777
Achieved Moisture Content (%)	16.6
Swell (%)	-0.5
Moisture After Penetration (%)	16.9
Period of Soaking (days)	4
Moisture Content of Top 30mm (%)	15.8
Moisture of Penetrated End (%)	15.8
Compaction Type	Standard
Surcharge Mass (kg)	4.50
Laboratory Moisture Ratio After Compaction (%)	106
Laboratory Density Ratio After Compaction (%)	100
Oversize Material Excluded	NO
Percent Oversize Excluded	0.0
Rate of Penetration	1.0

Chart



CBR (%): 6.0

Comments

N/A

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unanderra, Wollongong Laboratory

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California Bearing Ratio

Report No: CBR:UNAN08S-01550
Issue No: 1
This report replaces all previous issues of report no 'CBR:UNAN08S-01550'.

Client:	Coffey Geotechnics Pty Ltd (Unanderra) 1/222 Berkeley Road Unanderra NSW 2525
Principal:	Allen Price & Associates Pty Ltd
Job No:	LABTUNAN00207AA
Project:	GEOTUNAN02704AA - Proposed Subdivision - Sussex Inlet
Lot No:	**TRN:**

Approved Signatory: Clint Manning (Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 30/05/2008

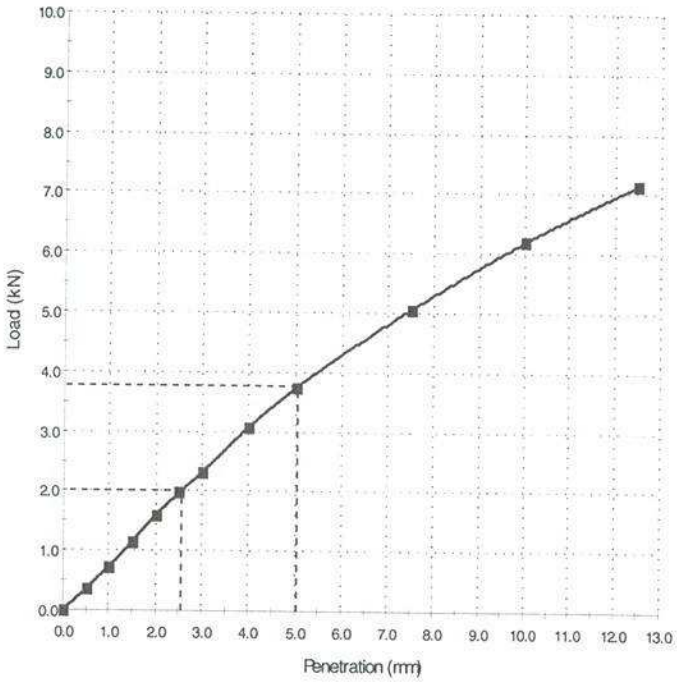
Sample Details

Product:	Silty CLAY - orange brown	**Date Sampled:**	13/05/2008
Source:	CTP 2 - Depth 0.4m to 0.5m	**Sampling Method:**	AS1289.1.2.1 Clause 6.5
Location:	Sussex Inlet Road - Sussex Inlet	**Sample ID:**	UNAN08S-01550
Client Ref:	00002		

Test Results

Description	Result
Test Method	AS 1289.6.1.1
Maximum Dry Density (t/m³)	1.990
Optimum Moisture Content (%)	13.4
CBR 2.5mm (%)	15
CBR 5.0mm (%)	**19**
Preparation	Soaked
Initial Moisture Content (%)	13.0
Achieved Dry Density (t/m³)	2.002
Achieved Moisture Content (%)	13.0
Swell (%)	0.0
Moisture After Penetration (%)	12.9
Period of Soaking (days)	4
Moisture Content of Top 30mm (%)	12.0
Moisture of Penetrated End (%)	12.0
Compaction Type	Standard
Surcharge Mass (kg)	4.50
Laboratory Moisture Ratio After Compaction (%)	97
Laboratory Density Ratio After Compaction (%)	101
Oversize Material Excluded	NO
Percent Oversize Excluded	0.0
Rate of Penetration	1.0

Chart



CBR (%): 19

Comments

N/A

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unanderra, Wollongong Laboratory

Coffey Geotechnics Pty Ltd
ABN 93 056 929 483
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California Bearing Ratio

Report No: CBR:UNAN08S-01551
Issue No: 1
This report replaces all previous issues of report no 'CBR:UNAN08S-01551'.

Client:	Coffey Geotechnics Pty Ltd (Unanderra) 1/222 Berkeley Road Unanderra NSW 2525
Principal:	Allen Price & Associates Pty Ltd
Job No:	LABTUNAN00207AA
Project:	GEOTUNAN02704AA - Proposed Subdivision - Sussex Inlet
Lot No:	**TRN:**

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Clint Manning
(Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 30/05/2008

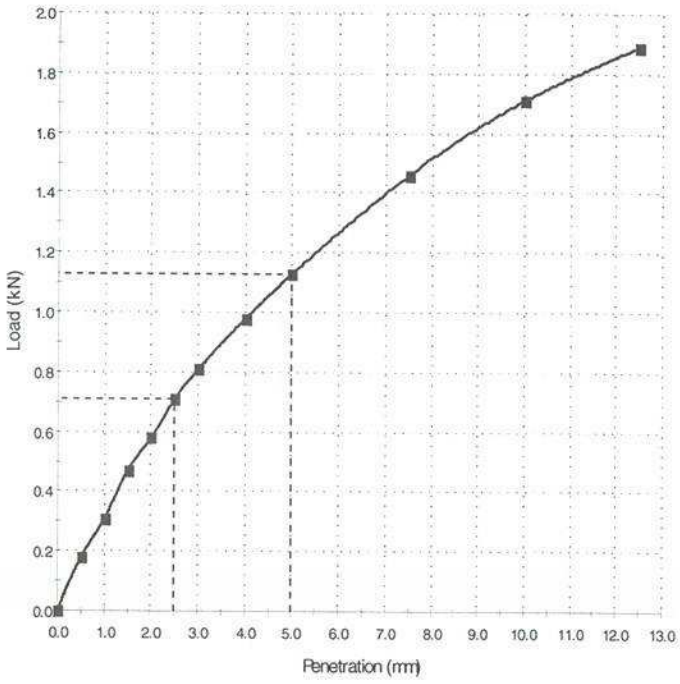
Sample Details

Product:	Silty CLAY - orange brown	**Date Sampled:**	13/05/2008
Source:	CTP 3 - Depth 0.4m to 0.5m	**Sampling Method:**	AS1289.1.2.1 Clause 6.5
Location:	Sussex Inlet Road - Sussex Inlet	**Sample ID:**	UNAN08S-01551
Client Ref:	00003		

Test Results

Description	Result
Test Method	AS 1289.6.1.1
Maximum Dry Density (t/m³)	1.550
Optimum Moisture Content (%)	26.4
CBR 2.5mm (%)	5.0
CBR 5.0mm (%)	**6.0**
Preparation	Soaked
Initial Moisture Content (%)	24.6
Achieved Dry Density (t/m³)	1.575
Achieved Moisture Content (%)	24.6
Swell (%)	0.0
Moisture After Penetration (%)	23.9
Period of Soaking (days)	4
Moisture Content of Top 30mm (%)	19.8
Moisture of Penetrated End (%)	19.8
Compaction Type	Standard
Surcharge Mass (kg)	4.50
Laboratory Moisture Ratio After Compaction (%)	93
Laboratory Density Ratio After Compaction (%)	102
Oversize Material Excluded	NO
Percent Oversize Excluded	0.0
Rate of Penetration	1.0

Chart



CBR (%): 6.0

Comments

N/A

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unanderra, Wollongong Laboratory

Coffey Geotechnics Pty Ltd
ABN 93 056 929 483
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California Bearing Ratio

Report No: CBR:UNAN08S-01552
Issue No: 1
This report replaces all previous issues of report no 'CBR:UNAN08S-01552'.

Client:	Coffey Geotechnics Pty Ltd (Unanderra) 1/222 Berkeley Road Unanderra NSW 2525
Principal:	Allen Price & Associates Pty Ltd
Job No:	LABTUNAN00207AA
Project:	GEOTUNAN02704AA - Proposed Subdivision - Sussex Inlet
Lot No:	**TRN:**

NATA
WORLD RECOGNISED ACCREDITATION

Approved Signatory: Clint Manning (Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 30/05/2008

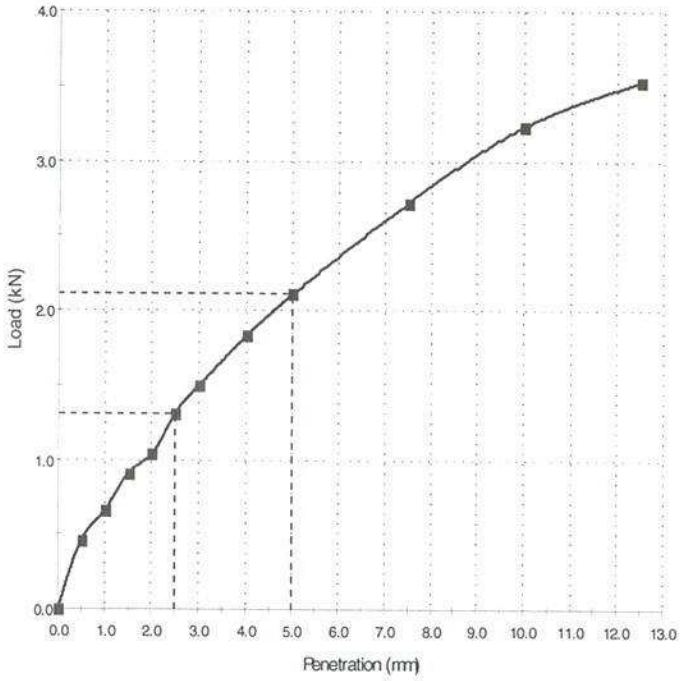
Sample Details

Product:	Silty CLAY - orange brown, pale grey	**Date Sampled:**	13/05/2008
Source:	CTP 4 - Depth 0.4m to 0.5m	**Sampling Method:**	AS1289.1.2.1 Clause 6.5
Location:	Sussex Inlet Road - Sussex Inlet	**Sample ID:**	UNAN08S-01552
Client Ref:	00004		

Test Results

Description	Result
Test Method	AS 1289.6.1.1
Maximum Dry Density (t/m³)	1.800
Optimum Moisture Content (%)	14.8
CBR 2.5mm (%)	10.0
CBR 5.0mm (%)	**11**
Preparation	Soaked
Initial Moisture Content (%)	15.5
Achieved Dry Density (t/m³)	1.798
Achieved Moisture Content (%)	15.5
Swell (%)	1.0
Moisture After Penetration (%)	16.9
Period of Soaking (days)	4
Moisture Content of Top 30mm (%)	15.7
Moisture of Penetrated End (%)	15.7
Compaction Type	Standard
Surcharge Mass (kg)	4.50
Laboratory Moisture Ratio After Compaction (%)	105
Laboratory Density Ratio After Compaction (%)	100
Oversize Material Excluded	NO
Percent Oversize Excluded	0.0
Rate of Penetration	1.0

Chart



CBR (%): 11

Comments

N/A

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unanderra, Wollongong Laboratory

Coffey Geotechnics Pty Ltd
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California Bearing Ratio

Report No: CBR:UNAN08S-01553
Issue No: 1
This report replaces all previous issues of report no 'CBR:UNAN08S-01553'.

Client:	Coffey Geotechnics Pty Ltd (Unanderra) 1/222 Berkeley Road Unanderra NSW 2525
Principal:	Allen Price & Associates Pty Ltd
Job No:	LABTUNAN00207AA
Project:	GEOTUNAN02704AA - Proposed Subdivision - Sussex Inlet
Lot No:	**TRN:**

Approved Signatory: Clint Manning (Laboratory Manager)
NATA Accredited Laboratory Number: 431
Date of Issue: 30/05/2008

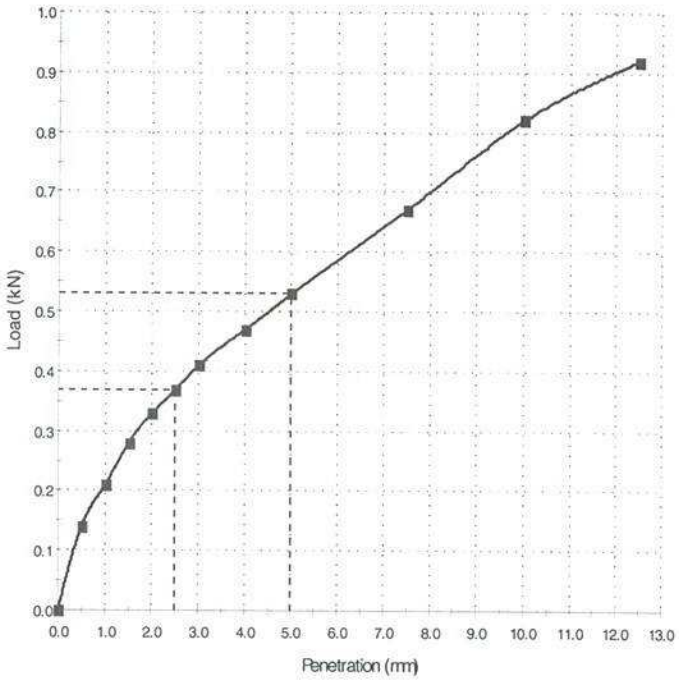
Sample Details

Product:	Silty CLAY - pale grey and orange brown	**Date Sampled:**	13/05/2008
Source:	CTP 5 - Depth 0.4m to 0.5m	**Sampling Method:**	AS1289.1.2.1 Clause 6.5
Location:	Sussex Inlet Road - Sussex Inlet	**Sample ID:**	UNAN08S-01553
Client Ref:	00005		

Test Results

Description	Result
Test Method	AS 1289.6.1.1
Maximum Dry Density (t/m³)	1.620
Optimum Moisture Content (%)	20.1
CBR 2.5mm (%)	**3.0**
CBR 5.0mm (%)	2.5
Preparation	Soaked
Initial Moisture Content (%)	19.9
Achieved Dry Density (t/m³)	1.631
Achieved Moisture Content (%)	19.9
Swell (%)	2.5
Moisture After Penetration (%)	1144.6
Period of Soaking (days)	4
Moisture Content of Top 30mm (%)	19.0
Moisture of Penetrated End (%)	19.0
Compaction Type	Standard
Surcharge Mass (kg)	4.50
Laboratory Moisture Ratio After Compaction (%)	99
Laboratory Density Ratio After Compaction (%)	101
Oversize Material Excluded	NO
Percent Oversize Excluded	0.0
Rate of Penetration	1.0

Chart



CBR (%): 3.0

Comments

N/A

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unit 8/12 Mars Road, Lane Cove West, NSW, 2066
Ph: (02) 9911 1000 Fax (02) 9911 1003

determination of emerson class number

client : *COFFEY GEOTECHNICS PTY LTD. (GEOTUNAN02704AA)*
job no : *LABTLCOV00290AA*

principal : *ALLEN, PRICE AND ASSOCIATES*
laboratory : *SYDNEY*

project : *1000 LOT SUBDIVISION*
date : *May 21, 2008*

location : *SUSSEX INLET ROAD, SUSSEX INLET*
test report no. : *IOLT 1414*

test procedure : *AS1289.3.8.1* date sampled: - material source: -

sample number: *LCOV08S-01428*

sample identification: *CTP 1 (0.40 to 0.50m)*

test data

air dried crumbs

time start of test: *16/05/08 08:52*

time dispersion commences: -

time dispersion completed: -

remoulded material

time start of test: *20/05/08 14:28*

time dispersion commences: *Not Observed*

time dispersion completed: *Not Observed*

material description

(Cl) SANDY SILTY CLAY - medium plasticity, light grey, fine to coarse sand.

type of water used: *distilled*

water temperature: *20° C*

immersion of air dried crumbs

- does not slake ☐
- slakes ☒
  - swell ☐ (7)
  - does not swell ☐ (8)
  - complete dispersion ☐ (1)
  - partial dispersion ☐ (2)
  - no dispersion ☒

immersion of remoulded material

- disperses ☒ (3)
- does not disperse ☐
  - calcite or gypsum
    - present ☐ (4)
    - absent ☐
      - vigorous shaking
        - disperses ☐ (5)
        - flocculates ☐ (6)

Emerson class number: 3

Form Number L4.8R1 Version 6.0

NATA WORLD RECOGNISED ACCREDITATION

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.

NATA Accredited Laboratory No. 431
Approved Signatory: *Garry K Collins*
Associate Geotechnician

Date: *21/05/08*

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unit 8/12 Mars Road, Lane Cove West, NSW, 2066
Ph: (02) 9911 1000 Fax (02) 9911 1003

determination of emerson class number

client : *COFFEY GEOTECHNICS PTY LTD. (GEOTUNAN02704AA)*
job no : *LABTLCOV00290AA*
principal : *ALLEN, PRICE AND ASSOCIATES*
laboratory : *SYDNEY*
project : *1000 LOT SUBDIVISION*
date : *May 21, 2008*
location : *SUSSEX INLET ROAD, SUSSEX INLET*
test report no. : *IOLT 1415*

test procedure : *AS1289.3.8.1* date sampled: - material source: -
sample number: *LCOV08S-01429*
sample identification: *CTP 2 (0.40 to 0.50m)*

test data

air dried crumbs

time start of test: *16/05/08 08:57*
time dispersion commences: -
time dispersion completed: -

remoulded material

time start of test: *20/05/08 15:02*
time dispersion commences: -
time dispersion completed: -

material description

(CI) SANDY SILTY CLAY - medium plasticity, mottled yellow brown, fine to coarse sand, trace of fine gravel.

type of water used: *distilled*
water temperature: *20° C*

immersion of air dried crumbs

- does not slake ☐
- slakes ☒
  - swell ☐ (7)
  - does not swell ☐ (8)
  - complete dispersion ☐ (1)
  - partial dispersion ☐ (2)
  - no dispersion ☒

immersion of remoulded material

- disperses ☐ (3)
- does not disperse ☒
  - calcite or gypsum
    - present ☐ (4)
    - absent ☒
      - vigorous shaking
        - disperses ☒ (5)
        - flocculates ☐ (6)

Emerson class number: 5

NATA Accredited Laboratory No. 431
Approved Signatory: *Garry K Collins*
Associate Geotechnician
Date : *21/05/08*

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unit 8/12 Mars Road, Lane Cove West, NSW, 2066
Ph: (02) 9911 1000 Fax (02) 9911 1003

determination of emerson class number

client : *COFFEY GEOTECHNICS PTY LTD. (GEOTUNAN02704AA)*
job no : *LABTLCOV00290AA*

principal : *ALLEN, PRICE AND ASSOCIATES*
laboratory : *SYDNEY*

project : *1000 LOT SUBDIVISION*
date : *May 21, 2008*

location : *SUSSEX INLET ROAD, SUSSEX INLET*
test report no. : *IOLT 1416*

test procedure : *AS1289.3.8.1* date sampled: - material source: -

sample number: *LCOV08S-01430*

sample identification: *CTP 3 (0.40 to 0.50m)*

test data

air dried crumbs

time start of test: *16/05/08 08:53*

time dispersion commences: -

time dispersion completed: -

remoulded material

time start of test: *20/05/08 14:34*

time dispersion commences: *Not Observed*

time dispersion completed: *Not Observed*

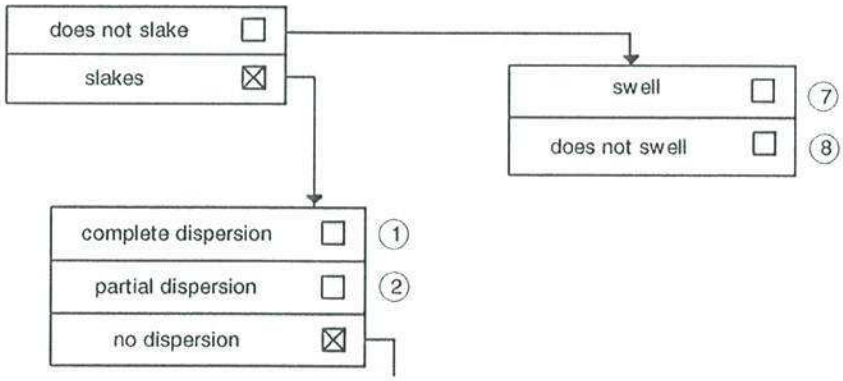
material description

(CI/CH) SANDY SILTY CLAY - medium to high plasticity, mottled grey-red brown, fine to coarse sand.

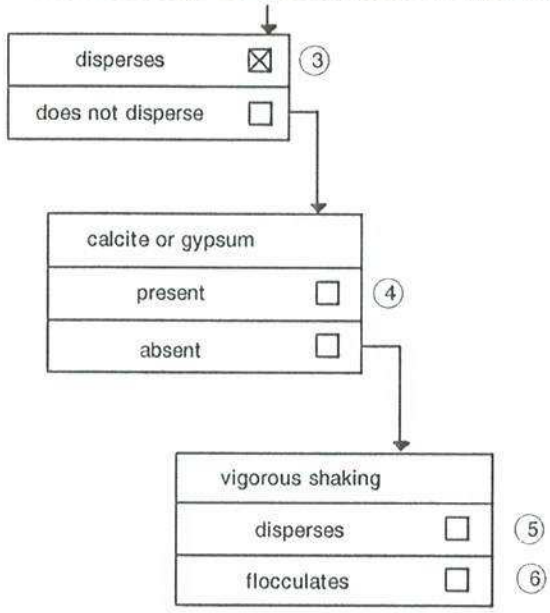
type of water used: *distilled*

water temperature: *20° C*

immersion of air dried crumbs



immersion of remoulded material



Emerson class number **3**

Form Number L4.8R1 Version 5.0

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NATA Accredited Laboratory No. 431
Approved Signatory:
Garry K Collins
Associate Geotechnician

Date : *21/05/08*

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unit 8/12 Mars Road, Lane Cove West, NSW, 2066
Ph: (02) 9911 1000 Fax (02) 9911 1003

determination of emerson class number

client : *COFFEY GEOTECHNICS PTY LTD. (GEOTUNAN02704AA)*
job no : *LABTLCOV00290AA*
principal : *ALLEN, PRICE AND ASSOCIATES*
laboratory : *SYDNEY*
project : *1000 LOT SUBDIVISION*
date : *May 21, 2008*
location : *SUSSEX INLET ROAD, SUSSEX INLET*
test report no. : *IOLT 1417*

test procedure : *AS1289.3.8.1* date sampled: - material source: -
sample number: *LCOV08S-01431*
sample identification: *CTP 4 (0.40 to 0.50m)*

test data

air dried crumbs

time start of test: *16/05/08 08:56*
time dispersion commences: *16/05/08 11:10*
time dispersion completed: *Not Observed*

remoulded material

time start of test: -
time dispersion commences: -
time dispersion completed: -

material description

(Cl) SANDY SILTY CLAY - medium plasticity, light grey to grey, fine to coarse sand.

type of water used: *distilled*
water temperature: *20° C*

immersion of air dried crumbs

- does not slake ☐
- slakes ☒
  - swell ☐ (7)
  - does not swell ☐ (8)
  - complete dispersion ☐ (1)
  - partial dispersion ☒ (2)
  - no dispersion ☐

immersion of remoulded material

- disperses ☐ (3)
- does not disperse ☐
  - calcite or gypsum
    - present ☐ (4)
    - absent ☐
      - vigorous shaking
        - disperses ☐ (5)
        - flocculates ☐ (6)

Emerson class number: 2

Form Number L4.8R1 Version 6.0

NATA Accredited Laboratory No. 431
Approved Signatory:
Garry K Collins
Associate Geotechnician

Date : *21/05/08*

coffey geotechnics
SPECIALISTS MANAGING THE EARTH

Unit 8/12 Mars Road, Lane Cove West, NSW, 2066
Ph: (02) 9911 1000 Fax (02) 9911 1003

determination of emerson class number

client : *COFFEY GEOTECHNICS PTY LTD. (GEOTUNAN02704AA)*
job no : *LABTLCOV00290AA*
principal : *ALLEN, PRICE AND ASSOCIATES*
laboratory : *SYDNEY*
project : *1000 LOT SUBDIVISION*
date : *May 21, 2008*
location : *SUSSEX INLET ROAD, SUSSEX INLET*
test report no. : *IOLT 1418*

test procedure : *AS1289.3.8.1* date sampled: - material source: -
sample number: *LCOV08S-01432*
sample identification: *CTP 5 (0.40 to 0.50m)*

test data

air dried crumbs

time start of test: *16/05/08 08:58*
time dispersion commences: *16/05/08 09:04*
time dispersion completed: *Not Observed*

remoulded material

time start of test: -
time dispersion commences: -
time dispersion completed: -

material description

(Cl) SANDY SILTY CLAY - medium plasticity, mottled yellow-grey brown, fine to coarse sand.

type of water used: *distilled*
water temperature: *20° C*

immersion of air dried crumbs

- does not slake ☐
- slakes ☒
  - swell ☐ (7)
  - does not swell ☐ (8)
  - complete dispersion ☐ (1)
  - partial dispersion ☒ (2)
  - no dispersion ☐

immersion of remoulded material

- disperses ☐ (3)
- does not disperse ☐
  - calcite or gypsum
    - present ☐ (4)
    - absent ☐
      - vigorous shaking
        - disperses ☐ (5)
        - flocculates ☐ (6)

Emerson class number 2

NATA Accredited Laboratory No. 431
Approved Signatory:
Garry K Collins
Associate Geotechnician

Date : *21/05/08*

Appendix D

Acid Sulfate Soils Laboratory Testing Results

A.S.S. FIELD SCREEN ANALYSIS REPORT

CERTIFICATE OF ANALYSIS

Analysis By: **Bio-Track Pty Ltd** ABN 91 056 237 275 781 Mt. Glorious Road Highvale, Brisbane, Australia, 4520 Ph. 07 3289 7179 EMAIL **pe@biotrack.com.au**

DATE OF REPORT	15 MAY 2008
CLIENT NAME	MR SCOTT MORRISON
CLIENT FIRM	COFFEY GEOTECHNICS PTY LTD YOUR PROJECT/JOB REFERENCE GEOUNAN02704AA
CLIENT ADDRESS	PO BOX 346 UNANDERRA WOLLONGONG
PROJECT NAME	GEOUNAN02704AA SAMPLING DATE 13/5/2008
NUMBER OF SAMPLES	6 SAMPLE TYPE SOIL SAMPLE FOR ACID SULFATE STUDY
PACKAGING	SAMPLES LABELLED - INTACT - BAGGED - STORED ON ICE
SAMPLES DISPOSED ON	1/9/2008
LOG-IN DATE	15 MAY 2008 LAB REF. LR15058.529

TEST METHODOLOGY FOR pH_f AND pH_fox AS PER QASSIT 2004 Laboratory Methods. Indications based on pH data only.
RATE: 0=none 1=slight 2=moderate 3=high 4=very high (steam evolved) visual observation at 0-5 minutes.
TEMP: Surface temperature rise ('C) oxidised sample at 5 minutes.

SAMPLE ID	Upper	Lower (m)	pH_f	pH_fox	change	RATE	TEMP	INDICATION
CTP1	0.3	0.4	4.5	3.2	-1.3	2	0	low TAA & moderate TPA
CTP2	0.1	0.2	5.3	2.3	-3.0	3	0	low TAA & high TPA & sulphide possible
CTP3	0.05	0.1	5.2	2.5	-2.7	2	0	low TAA & moderate TPA & sulphide possible
CTP4	0.3	0.4	4.0	2.5	-1.5	2	0	moderate TPA
CTP4	1.75	1.8	5.5	3.1	-2.4	1	0	low TAA & moderate TPA & sulphide possible
CTP5	0.3	0.4	5.1	3.9	-1.2	0	0	low TAA

Coffey
Unanderra
RECEIVED
11 JUN 2008
Job No: Gu 2704AA
Action:
Rec'd by

Signatory For and behalf of Bio-Track Pty Ltd

coffey

Chain of Custody

No: 13502

Laboratory Quotation / Order No:

Job No: GU2704AA

Sheet 1 of 1

Dispatch to: (Address & Phone No.) Biotrack 781 Mt Glorious Road, Highvale QLD, 4520 ph: (07) 3289-7179	Sampled by: Daniel Horan	Consigning Officer: Date Dispatched: 14/5/08
Attention: Peter Edmiston	Project Manager: (report results to) SCOTT MORRISON	Courier Service: [redacted] TNT Consignment Note No: 85914497Z

Relinquished by:	Date:	Time:	Received by:	Date:	Time:
Daniel Horan	14/5/08	12:40pm			

Comments	Sample Matrix	Container Type and Preservative	Sample No.	Date Sampled	Analyses Required: PAHs	TPHs	MAHs = BTEX	Metals:	ASS Screening	Sample Condition on Receipt
CTP1 0.3-0.4	SOIL	Plastic bag + Cling Film	CTP1-0.3-0.4	13/5/08					/	
CTP2 0.1-0.2	SOIL	↓	CTP2-	↓					/	
CTP3 0.05-0.1	SOIL		CTP3-						/	
CTP4 0.3-0.4	SOIL		CTP4-						/	
CTP4 1.75-1.8	SOIL		CTP5-						/	
CTP5 0.3-0.4	SOIL		CTP6-						/	

Special Laboratory Instructions: Please call with results & hold samples for possible further testing: SPOCAS

Detection Limits:

Turnaround Required: ASAP

JOB NUMBER **MUST** BE REFERENCED ON ALL SUBSEQUENT PAGES

64220/9-06

Copies: **WHITE:** Sign on release. **YELLOW:** If dispatched to interstate Lab, Lab to sign on receipt and fax back to Coffey. **BLUE:** To be returned with results.

FOR THE ATTENTION OF MR SCOTT MORRISON

6 test samples have been received by Bio-Track for analysis. Thank You

Project: GEOUNAN02704AA Lab Ref. LR15058.529

The following details have been recorded for this sample batch.

FIRM	COFFEY GEOTECHNICS PTY LTD
REPORT MAILED TO	MR SCOTT MORRISON
MAILING ADDRESS	PO BOX 346 UNANDERRA WOLLONGONG
REPORT FAXED TO	02 42726075 email
CLIENT PHONE No.	02 42726071
LOGIN DATE	15 MAY 2008
YOUR JOB REFERENCE	GEOUNAN02704AA CLIENT ORDER NUMBER PER CHAIN OF CUSTODY #13502

SAMPLE TYPE:	SOIL SAMPLE FOR ACID SULFATE STUDY
SAMPLE DATE	13/5/2008
SAMPLE CONDITION	SAMPLES LABELLED - INTACT - BAGGED - STORED ON ICE
SAMPLE STORAGE	samples stored in sealed 02 barrier film bag at field moisture until 1/9/2008

CUSTODY RECORD: 6 samples now held by Bio-Track. Please check for any missing samples or labelling errors.

All samples listed for analysis have been received.

Hole/Sample	Upper	Lower	Test	Bio-Track Sample No.
CTP1	0.3	0.4	ASS field screen	## 69085
CTP2	0.1	0.2	ASS field screen	## 69086
CTP3	0.05	0.1	ASS field screen	## 69087
CTP4	0.3	0.4	ASS field screen	## 69088
CTP4	1.75	1.8	ASS field screen	## 69089
CTP5	0.3	0.4	ASS field screen	## 69090

SAMPLE DISPOSAL DATE 1/9/2008

CONTACT BIO-TRACK Phone=07 32897179 Fax=07 32897155 Post= 781 MT GLORIOUS RD; HIGHVALE 4520

DETERMINATION OF ACID SULFATE SOIL PROPERTIES

CERTIFICATE OF ANALYSIS

Analysis By: **Bio-Track Pty Ltd** ABN 91 056 237 275 781 Mt. Glorious Road Highvale, Brisbane, Australia, 4520 Ph. 07 3289 7179 Fx. 07 3289 7155

LAB REFERENCE LR30058.653 DATE OF REPORT 12 JUNE 2008 @09:26:33
CLIENT NAME MR SCOTT MORRISON c/o
PROJECT NAME GEOUNAN02704AA YOUR PROJECT/JOB REFERENCE GEOUNAN02704AA
SAMPLING DATE 13/5/2008 NUMBER OF SAMPLES 2 Samples supplied by client SAMPLE TYPE:SOIL SAMPLE FOR ACID SULFATE STUDY
DATE RECEIVED 30 MAY 2008 PACKAGING SAMPLES LABELLED - INTACT - BAGGED - STORED ON ICE Ground Oven Dry Samples DISPOSED ON 1/2/2009

Sample ID as received. METHODOLOGY: As per (DNR QASSIT May 2004), oven dried (85'C), >1000 um shell removed, fine grind. All reported values gravimetric, dry mass.
LIME1 rates calculated to neutralise TPA (or TAA if >TPA)+ aS_RAS -ANC_E/1.5 LIME2 rates calculated to neutralise TAA + aS_POS or S_Cr + aS_RAS -ANC_BT/1.5
NB. Lime rates assume 97% lime neutralisation but DO NOT include any safety factors. Suggested factor=1.5-2. Rates are kg/ton. Multiply by bulk density to convert to kg/m3.
Fineness Factor=1.5 CBN POS= moles carbonate alkalinity released by oxidation assuming (Ca POS - Ca KCl) + (Mg POS - Mg KCl) is due to carbonate solution.
Blanks represent unmeasured values, zeros & <0.x represent measured values. If pH KCl>4.5 then s-RAS (calculated from acid extract) may be zero for undisturbed soil. Ca/ar is the acid reactive calcium calculated as the difference between 1 M KCl and 4 M HCl soluble Ca.

ID. DEPTH	pH	pH	TAA	TPA	TSA	S KCl	S P	S POS	S Cr	s-NAS	s EQ	Ca KCl	Ca P	Mg KCl	Mg P	CBN POS	LIME1	LIME2	sANC_BT	Ca/ar
m	KCL	ox	m/t	m/t	m/t	%	%	%	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	m/t	kg/t	kg/t	%	mg/kg
Analytical Method Codes	23A	23B	23F	23G	23H	23Ce	23De	23Ee	22B	s20Je	s	23Vh	23Wh	23Sm	23Tm	a23U&X			s19A2	
CTP4 0.3-0.4	4.64		20			<0.01			<0.01	<0.01	0.038	48		54				1		13
CTP4 1.75-1.8	4.63		25			<0.01			<0.01	<0.01	0.045	64		109				1		<10

Signatory P. Eshuton For and on behalf of Bio-Track Pty Ltd

ACID SULFATE SOILS – BACKGROUND INFORMATION

Background

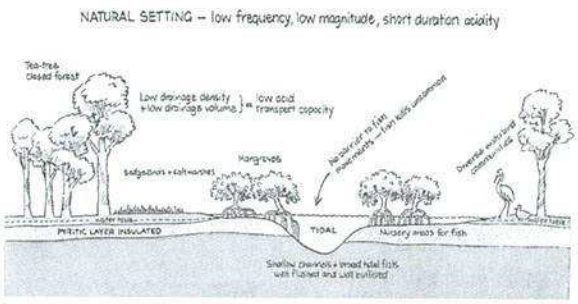
Acid Sulfate Soils (ASS) are soils containing significant concentrations of pyrite, which when exposed to oxygen in the presence of sufficient moisture, oxidise resulting in the generation of sulfuric acid. Unoxidised pyritic soils are referred to as potential ASS (PASS). When the soils are exposed, the oxidation of pyrite occurs and sulfuric acids are generated, and the soils are said to be actual ASS (AASS).

Pyritic soils typically form in waterlogged, saline sediments rich in iron and sulfate. Typical environments for the formation of these soils include tidal flats, salt marshes and mangrove swamps below about RL 5m AHD. They can also form as bottom sediments in coastal rivers and creeks.

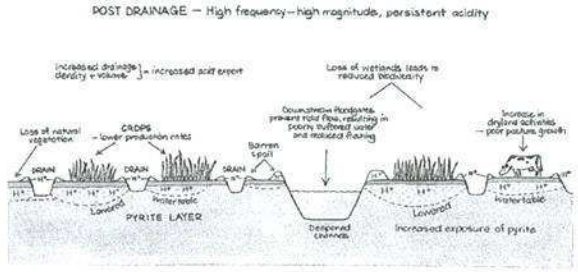
ASS soils occur across about 40,000km^2 of low lying coastal lands in every state of Australia (Sammut 2000), and mostly formed in the Holocene period (10,000 years ago to present day) predominantly in the 7,000 years since the last rise in sea level. It is generally considered that pyritic soils which formed prior to the Holocene period (greater than 10,000 years ago) would already have oxidised and leached during periods of low sea level which occurred during ice ages, exposing pyritic coastal sediments to oxygen.

Significance of ASS

In their natural setting, ASS soils are buried beneath the water table and have a healthy vegetation cover. Any localised areas of acid generation are typically diluted by water runoff or neutralised by tidal flows of alkaline seawater.



Disturbance or poorly managed development and use of acid sulfate soils can generate significant amounts of sulfuric acid, which can lower soil and water pH to extreme levels (generally less than 4) and produce acid salts, resulting in high salinity. The low pH, high salinity soils can reduce or altogether preclude vegetation growth and can produce aggressive soil conditions which may be detrimental to concrete and steel components of structures, foundations, pipelines and other engineering works.



Generation of the acid conditions often releases aluminium, iron and other naturally occurring elements from the otherwise stable soil matrices. High concentrations of some such elements, coupled with low pH and alterations to salinity can be detrimental to aquatic life. In severe cases, affected waters flowing off-site into aquatic ecosystems can have a detrimental effect on these ecosystems.

This background information sheet was compiled by the Coffey, Acid Sulfate Soil – Centre of Specialist Knowledge.

Appendix E

Selected Photos taken at the time of the site visit on 9 May 2008

Photo 1: AST near green keepers shed

Photo 2: Oils/chemicals stored in green keepers shed

Photo 3: General equipment storage in green keepers shed

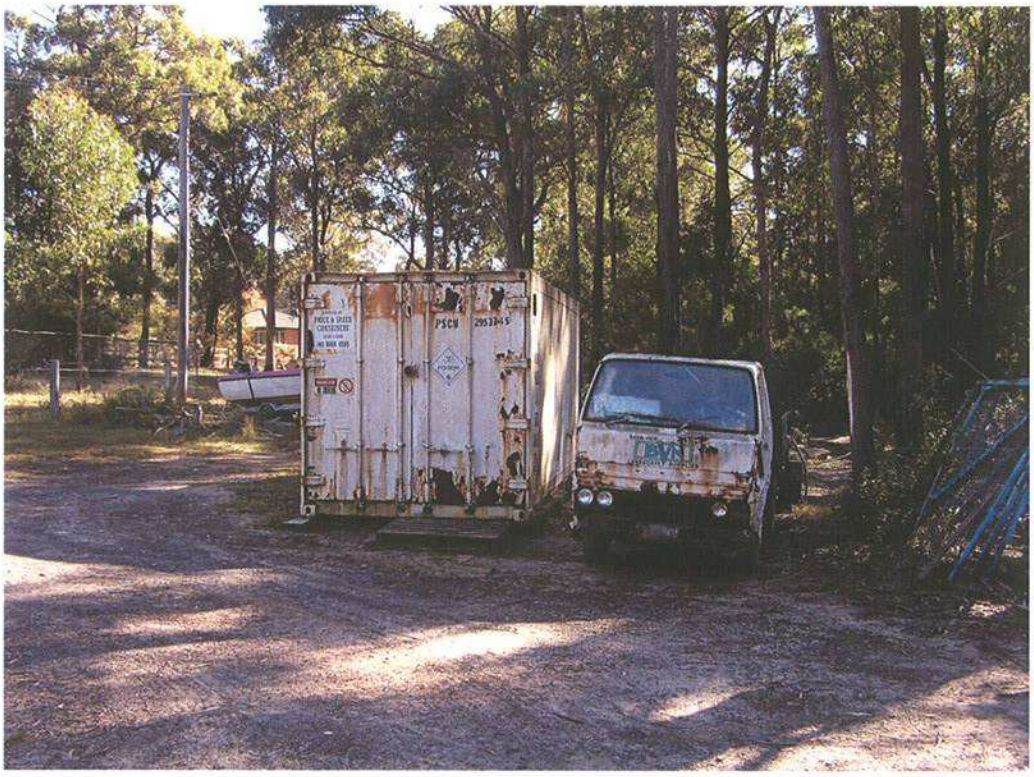


Photo 4: Shipping container used to store golf course chemicals

Photo 5: General golf course area

Photo 6: Dark coloured water in north eastern part of site (near Lakeshore Parade)

Photo 7: Burnt car in northern part of site

Photo 8: Fibro fragment noted on golf course in central part of site

Photo 9: Example of general waste noted on trails

Photo 10: Example of general waste noted on trails