SHOALHAVEN CITY COUNCIL

EFFLUENT DISPOSAL STUDY
JERBERRA ESTATE
ST GEORGES BASIN

G12023/1-AD

27 January 2000

Coffey

G12023/1-AD LPF;ck
27 January 2000

Shoalhaven City Council
Bridge Road
NOWRA NSW 2541

Attention: Mr Steve Robertson

Dear Sir,

RE: EFFLUENT DISPOSAL STUDY
JERBERRA ESTATE
ST GEORGES BASIN

Coffey Geosciences Pty Ltd (Coffey) are pleased to present five copies of our report at the above site.

Should you require further information regarding the report, please do not hesitate to contact either, Andrew Dawkins in our Sydney office on 9888 7444 or the undersigned.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

LAURIE FOX

Senior Environmental Geologist

Distribution: Original held by Coffey Geosciences Pty Ltd
1 copy to Coffey Geosciences Pty Ltd
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EXECUTIVE SUMMARY

Coffey Geosciences Pty Ltd (Coffey) were commissioned by Shoalhaven City Council (the Council) to carry out an effluent study at Jerberra Estate, St Georges Basin. The study was commissioned by Council to provide additional information on the suitability of the site for rural residential subdivision. The potential development area is 85 hectares and currently contains one legal and a number of illegal dwellings. The development is understood to contain 153 lots ranging from 860m^2 to 1.76ha with 102 lots less than 4000m^2.

The objective of the study is to ascertain whether effluent disposal for rural residential development is feasible and will meet the objective of nil pollutant export from the site. The following scope of work was carried out:

- desk study including a review of published information, aerial photographs, Council records and information held on Council files;
- site walkover by a senior environmental geologist;
- field investigation including the excavation of fifteen test pits and the collection of soil samples;
- laboratory analysis of selected samples for a suite of physical and chemical analytes;
- assessment of the data and reporting of the results including a discussion on the suitable lot size for effluent disposal.

The study has identified three terrain units related to landform and soil types. Unit 3, low lying land, is not considered suitable for on-site effluent disposal because of the potential for flooding and the height of the seasonal water table. Unit 3 comprises about 10% of the study area. Unit 1 Ridgeline and Unit 2, Side-slopes are considered suitable with the following major limitations to effluent disposal;

- low soil permeability in clay B horizons;
- erosion potential.

As the effluent disposal system would largely be based on evapotranspiration and nutrient up take in the root zone, significant percolation to the B horizon is not envisaged. To lower the risk of soil erosion, irrigation areas should be well grassed, well drained and preferably located on slopes less than 5° from the horizontal, that is, largely within Unit 1 Ridgeline. The potential locations for irrigation fields are indicated on Drawing G12023/1-4.

Based on the preliminary data collected for this study, it is considered that there are only two feasible options for waste-water disposal, either individual aerated water treatment system (AWTS) or a common effluent scheme (CES) for the estate

The recommended minimum lot size for an individual AWTS is about 2,500m^2 of which about 1500m^2 is recommended as the minimum area required for irrigation. It should be noted that, because of the site constraints, the AWTS irrigation field would need to be located within those areas indicated on Drawing G12023/1-4. These areas should be regarded as indicative only and would require further field survey to establish more accurate boundaries

The minimum lot size is based on preliminary calculations of the water balance, and assumed nutrient loading (nitrogen and phosphorous), hydraulic loading, the number of people per household and the area of a site devoted to social and recreational use. The minimum area for irrigation represents a nil pollutant export of nutrients from the site based on the available data and assumptions regarding the waste-water quantity and quality. The assumptions on which the lot size and irrigation areas are calculated are anticipated to change with more detailed data.

The responsibility for operation and maintenance of the individual AWTS lies with the householder Generally AWTS are not as suitable for use where occupancy is sporadic (such as a holiday homes) since servicing should be carried out at each start-up. Householders need to be aware of system limitations and correct operating use.

A CES would involve preliminary treatment of sewerage on each individual site, through say a septic tank. The waste-water would then be collected and piped to a centralised treatment plant and a fixed irrigation field Based on the size of the potential irrigation field, as indicated on Drawing G12023/1-4 and assuming a minimum irrigation area of 1500m^2 per household, it is estimated that about 85 households could potentially utilise the CES. These estimates are based on the current data and will be subject to change when more information becomes available.

Preliminary construction and maintenance guidelines for the CES irrigation field include the following:

- the irrigation field should be landscaped, with minimum vegetated buffer distances of:
  - 40m from the edge of drainage;
  - 6m from property boundaries, buildings and swimming pools;
- irrigation fields should not include areas of ponded water or shallow rock exposures unless substantial ground improvements are made;
- sprinklers with a throw of not more than 2m, producing coarse droplets, not a fine mist, should be used to lower the risk of aerosol dispersion and wind drift of effluent. The spray height should not be more than 400mm above the finished level of the surface irrigation disposal area;
- effluent quality should conform to the requirements of Environmental Health Protection Guidelines (1998) and the NSW EPA. This may be superseded if the EPA require the disposal system to be licensed, in which case the effluent quality requirements will be provided;
- effluent should not be used for irrigation of fruit and vegetables;
- disposal areas should be carefully managed to ensure that the infiltration capacity of the soil is maintained as outlined below and that the vegetation cover is well established. Irrigation disposal methods are primarily designed to ensure most of the treated effluent is held in the soil profile, taken up by plants or lost as evaportranspiration with only a small percentage infiltrating below the topsoil. No effluent should be allowed to run-off from the site and it would be necessary to store effluent for several days during prolonged rain events.
- Field grass cuttings should be mowed regularly and removed from site;
- earth bunding to about 0 3m height should be installed around the field to provide temporary storage within the irrigation field. Wet weather storage overflows from the field should be intercepted by a downstream catch drain and diverted into stormwater pond/dam if possible;
- effluent quality should be maintained with regular servicing of the treatment plants This service should be provided by the manufacturer in the form of an ongoing servicing contract. The servicing contract usually requires six monthly or annual maintenance, depending on the systems selected. De-sludging of the plants will also be required from time to time depending on the volume of effluent processed.

To ensure acceptable long term performance of the effluent disposal system, EPA Licensing Agreements generally require monitoring and testing of downstream ground and surface waters adjacent to the disposal areas. Monitoring should be conducted periodically (usually once/year) or after uncontrolled discharges into the rivers/creeks have occurred.

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1 INTRODUCTION

Coffey Geosciences Pty Ltd (Coffey) were commissioned by Shoalhaven City Council (the Council) to carry out an effluent study at Jerberra Estate, St Georges Basin The study was in general accordance with our proposal dated 29 January 1999 (Proposal No GP12532/1-AB).

The study was commissioned by Council to provide additional information on the suitability of the site for rural residential subdivision. The potential development area is 85 hectares and currently contains one legal and a number of illegal dwellings The development is understood to contain 153 lots ranging from 860m^2 to 1.76ha with 102 lots less than 4000m^2.

1.1 Objectives and Scope of Work

The objective of the study is to ascertain whether effluent disposal for rural residential development is feasible and will meet the objective of nil pollutant export from the site.

The following scope of work was carried out:

- desk study including a review of published information, aerial photographs, Council records and information held on Council files;
- site walkover by a senior environmental geologist;
- field investigation including the excavation of fifteen test pits and the collection of soil samples;
- laboratory analysis of selected samples for a suite of physical and chemical analytes;
- assessment of the data and reporting of the results including a discussion on the suitable lot size for effluent disposal.

2 BACKGROUND

The study area was registered as a subdivision in 1922 and individual lots have been bought and sold since that time though there has been no guarantee (from Council) that future development approval would be granted Following submissions from the Pacific Pastures Progress Association the Council commissioned Mitchell McCotter and Associates in 1994 to carry out an Environmental Study of the site to support a rezoning application (Report No 93152RP1) The main conclusions of the report with respect to effluent disposal were:

- there were three practical options for waste-water management, namely:
  - individual on-site disposal systems for each dwelling;
  - collective package treatment plant for all dwellings within the estate;
  - connection to the existing reticulated sewerage system
- for individual on-site systems aerated water treatment systems (AWTS) were preferable with a recommended minimum irrigation area of 470m^2;
- a collective package treatment system was feasible and would require about 14 ha for irrigation.

It should be noted that there is no supporting data regarding the calculations of irrigation area within the copy of the Mitchell McCotter (1994) report supplied to Coffey. The assumptions upon which these calculations are based are therefore unknown and the data cannot be verified.

3. SITE CHARACTERISTICS

3.1 Site Description

The site is located approximately 150km south of Sydney and about 5km from Tomerong, the nearest township. The site is rectangular in shape and has an area of about 85 hectares of which approximately 20% has been cleared. Drawing G12023/1-2 show the locality of the site and Drawing G12023/1-1 shows the current lot layout and street configuration. The majority of the site is without power, town water and sewer.

There are several unsealed roads that traverse the study area. There is evidence of erosion in the form of rilling and minor gullying along the road alignments. Most of the site is timbered apart from some individual lots where clearing has taken place.

3.2 Topography and Drainage

The highest elevation on the site occurs towards Pine Road in the west and is about 50m above Australian Height Datum (AHD). The site slopes gently (< 5 degrees from the horizontal) down towards the east along a broad ridgeline that separates two drainage catchments. The side slopes generally range from about 5 to 10 degrees from the horizontal and comprise north and south facing slopes.

The two catchments form the headwaters of Moona Moona Creek which flows in an easterly direction and eventually discharging to Jervis Bay, some 5km to the east. Drawing G12023/1-2 shows the catchment configuration and the regional setting of the site. The catchment shown on Drawing G12023/1-2 is about 10 km^2 and the study area comprises about 8% of the catchment area. According to Mitchell McCotter (1994) the study site comprises about 2% of the total Moona Moona Creek catchment.

3.3 Soils Geology and Hydrogeology

Published geological information (Ulladulla 1:250,000 sheet) indicates that the site is underlain by rocks belonging to the Wandandian Siltstone formation, part of the Shoalhaven Group. This formation consists of siltstone, silty sandstone and is pebbly in part. This rock type differs from that described in the Mitchell McCotter (1994) Report where Nowra sandstone is given as the underlying geology. Nowra sandstone outcrops further west of the study area.

There is little published information regarding the soil types in the study area. Mitchell McCotter (1994) inferred soil types from the 1:100,000 Kiama Sheet on the assumption that similar geology will produce similar soils. The Wandandian Siltstone does not occur on the Kiama Sheet and therefore inferring soil types from that sheet for the study area is not appropriate.

Site specific soil descriptions found in Mitchell McCotter (1994), give two soil types for the study area, namely:

- duplex soils where the soil texture shows a distinct contrast with depth ie soils where a sand or loam topsoil (A Horizon) overlies a clay subsoil (B Horizon)
- gradational soils where the soil texture shows a gradual change with depth.

Groundwater beneath the study area is expected to occur generally within the weathered rock, between 5m and 10m depth. Groundwater flow would follow the surface topography and discharge zones would most likely occur along drainage depressions eventually providing base flow for Moona Moona Creek.

3.4 Climatic Conditions

Most of the site would receive considerable sun with little sheltered areas. The existing tree cover, however, means that parts of the ground surface would be shaded during each day. As is common along the east cost of southern and central NSW, north facing slopes are generally drier than south facing slopes. This is because of the prevailing southerly wind patterns which would account for the majority of the rainfall within the study area. The south facing slopes would be expected to remain wetter for longer periods of time than the north facing slopes.

Average rainfall in the Jervis Bay region is 1,177mm. The wettest months are January to March and October and November. Evaporation exceeds rainfall in all months except June. Further information on rainfall and evaporation is given in Mitchell McCotter (1994).

4. STUDY METHODOLOGY

4.1 Fieldwork and Mapping

Fieldwork was carried out on 8 and 9 of March 1999 and consisted of a site walkover and mapping by a senior environmental geologist who noted topographic features, drainage characteristics, slope morphology and soils. Fifteen test pits were excavated in selected areas corresponding to the terrain units identified during the field mapping. The test pits were excavated by a rubber tyred backhoe in the full-time presence of an environmental engineer from our Wollongong office.

Test pits were excavated to a maximum depth of 2.5m and samples of both topsoil (A Horizon) and subsoil (B Horizon) were collected for texture classification and later laboratory analysis. Drawing G12023/1-1 shows the approximate location of the test pits and a description of the soils, using the Unified Classification System, is included in Appendix A.

4.2 Laboratory Analysis

4.2.1 Physical Testing

The following physical testing program was implemented:

- Emerson crumb test on four samples;
- pH on four samples; and
- Electrical conductivity on four samples

Samples were dispatched to our Sydney materials testing laboratory who is NATA registered for the tests performed. The original laboratory reports are included in Appendix B1.

4.2.2 Chemical Testing

The following chemical testing program was implemented:

- Phosphorus adsorption on four samples;
- Exchangeable sodium percentage (ESP) on four samples; and
- Cation exchange capacity (CEC) on four samples.

Samples were dispatched under standard Coffey Chain of Custody documentation to Sydney Analytical Laboratories (SAL) who are NATA registered for the tests performed. The original laboratory reports are included in Appendix B2

5. FIELDWORK AND MAPPING RESULTS

5.1 Terrain Units

Three terrain units were identified from the desk study and the field mapping and are shown on Drawing G12023/1-3. The three units are;

UNIT 1 RIDGELINE	This unit is characterised by gentle slopes, generally less than 5 degrees from the horizontal, shallow soil profiles comprising a clayey sand A horizon overlying a sandy silty clay B horizon Weathered rock is generally encountered within 1.5m depth. Groundwater in this unit would be expected to be at a depth of about 10m or greater. This unit comprises about 30% of the study area.
UNIT 2 SIDESLOPES	Flanking the ridgeline are the side-slopes. These are characterised by slopes of between 5 to 10 degrees from the horizontal and deeper soil profiles (than Unit 1) The soil types are similar to the Unit 1 soils though the B horizon extends to a greater depth Groundwater would be expected to be at a depth of between 5 and 10m. This unit comprises about 60% of the study area.
UNIT 3 LOW LYING LAND	Low-lying land was identified in the north-east corner and then along the southern boundary of the study area This unit is characterised by gently sloping to near level terrain and gradational soils comprising sandy clay A horizons overlying silty clay B horizons. Groundwater would be expected to vary seasonally and be generally less than 3 0m depth This unit comprises about 10% of the study area

5.2 Subsurface Conditions

The subsurface conditions encountered at the test pit locations consisted of:

- Topsoil comprising silty clayey sand, fine grained light grey to a depth of 0.35m (A HORIZON); overlying
- Sandy silty clay and silty clay, medium to high plasticity light grey, mottled red to depth of about 1 9m (B HORIZON); overlying
- Extremely to highly weathered rock comprising weathered sandstone (C HORIZON)

Groundwater was not encountered in the test pits.

5.3 Soil Texture Classification

Ten soil samples were classified according to their texture and principal profile forms (PPF) as described in Northcote (1979). The results are summarised in Table 1

TABLE 1: TEXTURE CLASSIFICATION

SAMPLE IDENTIFICATION	SOIL HORIZON	TERRAIN UNIT	DESCRIPTION	PRINCIPAL PROFILE FORM[1] (PPF)	ESTIMATED PERMEABILITY[2] m/day
JPT4 0.0-0.15m	A	2	Sandy Clay Loam	Duplex	0.1 to 0.5
0.6-0.7m	B		Medium to Heavy Clay		<0.06
JPT7 0.0-0.15m	A	3	Sandy Clay Loam	Gradational	0.1 to 0.5
0.4-0.5m	B		Fine Sandy Clay Loam		0.1 to 0.5
JPT9 0.0-0.1m	A	1	Sandy Clay Loam	Duplex	0.1 to 0.5
0.4-0.5m	B		Medium to Heavy Clay		<0.06
JPT11 0.0-0.1m	A	1	Sandy Clay	Duplex	0.06 to 0.1
0.4-0.5m	B		Medium to Heavy Clay		<0.06
JPT14 0.0-0.15m	A	2	Sandy Clay Loam	Gradational	0.1 to 0.5
0.4-0.5m	B		Sandy Clay		0.06 to 0.1

Notes:

Principal Profile as per Northcote (1979);

Permeability estimated from Hazelton and Murphy (1992)

The texture classification show that there are two principal profile forms (PPF) namely duplex soils and gradational soils. This confirms earlier data contained in Mitchell McCotter (1994). The estimated soil permeabilities for Terrain Units 1 and 2 are similar and generally range from 0.06 to 0.1m/day for the B horizon clays.

6. LABORATORY RESULTS

6.1 Physical Testing Results

The results of the physical testing are presented in Table 2 below:

TABLE 2: SUMMARY OF PHYSICAL TESTING RESULTS

PARAMETERS/ SAMPLE IDENTIFICATION	SOIL HORIZON/ TERRAIN UNIT	EMERSON CLASS	pH (UNITS)	ELECTRICAL CONDUCTIVITY (mS/cm)
JTP9 (0.4 to 0.5m)	B horizon Unit 1	2	5.1	0.56
JTP12 (0.4 to 0.5m)	B horizon Unit 1	6	4.7	0.04
JPT3 (0.5 to 0.6m)	B horizon Unit 2	5	5.2	0.07
JPT10 (0.4 to 0.5m)	B horizon Unit 2	5	5.3	0.03

The Emerson class number for B horizons in both Terrain Unit 1 and 2 show a moderate erodibility potential. The pH in both units is acidic and the electrical conductivity is low to moderate

6.2 Chemical Testing Results

The results of the chemical testing are presented in Table 3. The results shown are considered representative of the soil profile, including the A horizon, to the depths indicated by the sampling

TABLE 3: SUMMARY OF CHEMICAL TESTING RESULTS

PARAMETER/ SAMPLE IDENTIFICATION	SOIL HORIZON/ TERRAIN UNIT	PHOSPHORUS ADSORPTION CAPACITIES (mg/kg)	EXCHANGEABLE SODIUM PERCENTAGE (ESP) %	CATION EXCHANGE CAPACITY (CEC) meq %
JTP 4 (0.6-0.7m)	B horizon / Unit 2	600	2.0	8.0
JPT 7 (0.4-0.5m)	B horizon / Unit 3	44	0.9	2.3
JTP 11 (0.4-0.5m)	B horizon / Unit 1	550	2.9	7.5
JPT 14 (0.4-0.5m)	B horizon / Unit 2	560	2.0	6.0

Terrain Unit 1 and 2 show a moderate to high phosphorus adsorption capacity with a low ESP and CEC Based on the chemical results the B horizon clays in units 1 and 2 have relatively low salinity and have a low capacity for metals adsorption.

Terrain unit 3, B horizon clays have a lower phosphorus adsorption capacity, low salinity and low capacity for metals adsorption.

7. PRELIMINARY WATER BALANCE

The following calculations have generally been based on Appendix 6 of the Environmental & Health Protection Guidelines On-Site Sewage Management for Single Households (1998). In compiling the preliminary water balance, the following assumptions have been made:

- each dwelling will have three bedrooms and is expected to accommodate five people and generate 1000 litres of waste-water per day as per the Environmental & Health Guidelines (1998);
- the dwelling is part of a subdivision on land identified as suitable for re-development using on-site sewage management;
- average nutrient loading rates and waste-water concentrations have been taken from Table 14 of the Environmental & Health Protection Guidelines (1998);
- the percolation rate is 5mm/week;
- 520m^2 has been allowed for the dwelling footprint, vehicular access and social and recreational space

The water balance calculations are presented in Appendix C. A summary of the preliminary calculations is provided below:

- Design waste-water flow rate:	1000 l/day
- Recommended Irrigation Area:	1480m^2 (based on nitrogen loading)
- Recommended Wet Weather Storage:	53m^3 (based on hydraulic loading)
- Recommended minimum lot size:	2,500m^2 (1480 + 1020)

The recommended minimum lot size refers to the irrigation area, combined with an assumed area of 1020m^2, comprising a single storey dwelling, vehicular access areas, social and recreational areas. It should be noted that by applying the buffer distances set out in Section 8 1 the minimum lot size may increase

It should be noted that the preliminary water balance indicates that precipitation and irrigation (inputs) exceeds evapotranspiration and percolation (outputs) during five months of the year (ie from February to July). Using this model, there would be periods when irrigation would not be possible, such as during high rainfall events and storage of effluent would be required

8. SITE CONSTRAINTS

8.1 Buffer Distances

The following buffer distances are recommended for on-site disposal systems from the Environmental and Health Protection Guidelines (1998):-

- 100m to permanent surface water – creeks, rivers, lakes;
- 250m to domestic groundwater well;
- 40m to other waters – farm, dams intermittent creeks drainage channels;
- 6m from driveways and property boundaries;
- 15m to dwelling;
- 6m to swimming pool;
- 3m to paths and walkways

8.2 Physical Features

The site specific physical features are presented in Table 4 and have been compared to the rating system given in the Environmental and Health Protection Guidelines (1998)

TABLE 4: PRELIMINARY SITE ASSESSMENT RATING FOR ON-SITE SYSTEM

	FEATURE (UNITS)	RELEVANT DISPOSAL SYSTEM	TERRAIN UNIT	JERBERRA ESTATE	EPH GUIDELINES (1998) [1] LIMITATIONS
1	Depth to rock	Surface and subsurface irrigation	All units	1 0 to 1.5m	Moderate Limitation
		Absorption	All units	1.5m	Minor Limitation
2	Depth to Watertable	Surface and subsurface irrigation	Units 1& 2 Unit 3	+3m * 1-3m *	Minor Limitation **Major Limitation**
		Absorption	All units	same as above	same as above
3	Soil Permeability (m/day)	All land application systems	All units	A horizon - 0.1 to 0 5* B horizon --<0 06 to 0 5 *	Minor Limitation **Major Limitation**
4	pH	All land application systems	All units	5 0 (average)	Moderate Limitation
5	ESP %	Surface and subsurface irrigation (0-0 4m)	All units	2.0 to 2.9	Moderate Limitation
		Absorption (0-1.5m)	All units	same as above	same as above
6	Electrical Conductivity (ds/cm)	All land application system	All units	0.001 to 0.05	Minor Limitation
7	CEC (% meq)	Surface and subsurface irrigation	Units 1 & 2 Unit 3	6 to 8 2	Mod Limitation **Major Limitation**

TABLE 4: PRELIMINARY SITE ASSESSMENT RATING FOR ON-SITE SYSTEM (CONTINUED)

	FEATURE	RELEVANT DISPOSAL SYSTEM	TERRAIN UNITS	JERBERRA ESTATE	EPH GUIDELINE LIMITATIONS
8	Phosphorus sorption (Kg/ha)	All land application systems	All units	7200	Minor Limitation
9	Flood Potential	Al land application systems	Units 1 & 2 Unit 3	above 1 in 20 year * below 1 in 20 years *	Minor Limitation Major Limitation
10	Exposure	All land application systems	All units	High sun & wind exposure	Minor Limitation
11	Slope	All application systems	All units	5-10° from horizontal *	Minor Limitation
12	Landform	All application systems	Unit 1 and 2 Unit 3	Ridges & slopes Floodplain	Minor Limitation **Major Limitation**
13	Erosion Potential	All application systems	All units	Emerson Class 2,5 Evidence of erosion (rills) along roadways	**Moderate to Major Limitation**
14	Site Drainage	All application systems	Unit 1 and 2 Unit 3	Fair to good poor	Minor Limitation **Major Limitation**
15	Land Area	All systems	All units	Land areas available	Minor Limitation
16	Rock & Rock Outcrops	All land application systems	All units	Less than 10% of area*	Minor Limitation

Notes:

Environmental and Health Protection Guidelines for On-site Sewage Management for Single Households (1998)

** - estimate only.*

The major limitations to the use of on-site effluent treatment systems in Terrain Units 1 and 2 are the following:

- low soil permeability in clay B horizons;
- erosion potential;

In addition to the above Unit 3 has major limitations with respect to landform, site drainage and cation exchange capacity and this unit is not considered suitable for on-site effluent disposal

9. CONCLUSION

The study has identified three terrain units related to landform and soil types. Unit 3, low lying land, is not considered suitable for on-site effluent disposal because of the potential for flooding and the height of the seasonal water table. Unit 3 comprises about 10% of the study area. Unit 1 Ridgeline and Unit 2, Side-slopes are considered suitable with the following major limitations to effluent disposal;

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  - 40m from the edge of drainage;

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To ensure acceptable long term performance of the effluent disposal system, EPA Licensing Agreements generally require monitoring and testing of downstream ground and surface waters adjacent to the disposal areas. Monitoring should be conducted periodically (usually once/year) or after uncontrolled discharges into the rivers/creeks have occurred

The following analytical suite is recommended:

- biological oxygen demand (BOD);
- suspended solids;
- pH, electrical conductivity (EC), Total Dissolved Solids (TDS);
- ammonia, total keldahl nitrogen, and nitrate; and
- total Phosphorous.

The frequency of testing may change with results. Baseline data of existing surface and groundwaters would also be required prior to the operation commencing.

10. 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 in question. Under no circumstances, however, can it be considered that these findings represent the actual state of this site at all points

In preparing this report, Coffey has relied upon certain verbal information and documentation provided by the client and/or third parties. Coffey did not attempt to independently verify the accuracy or completeness of that information. To the extent that the conclusions in this report are based in whole or in part on such information, they are contingent on its validity. Coffey assume no responsibility for any consequences arising from any information or condition that was concealed, withheld, misrepresented, or otherwise not fully disclosed or available to Coffey

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

LAURIE FOX

Senior Environmental Geologist

Coffey

APPENDIX A

Test Pit Logs

Soil Description

Explanation Sheet

Coffey

DEFINITION:
In engineering terms soil includes every type of uncemented or partially cemented inorganic 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

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

UCS & SOIL NAME
Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on the following page

MOISTURE CONDITION

Dry Looks and feels dry Cohesive and cemented soils 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 Sμ (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	9 – 15
Loose	15 – 35
Medium Dense	35 – 65
Dense	65 — 85
Very Dense	85 – 100

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 600μm
	fine	75 μm to 200 μm

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION
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 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 differential material		

SOIL STRUCTURE

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

Coffey Geosciences Pty Ltd
ACN 056 335 516

engineering log - excavation

COFFEY

pit no JTP1
sheet 1 of 1

office job no: 612023/1

client:	SHOALHAVEN CITY COUNCIL	pit commenced:	30-03-99
principal:		pit completed:	30-03-99
project:	EFFLUENT DISPOSAL STUDY	logged by:	AMF
pit location:	JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)	checked by:	
equipment type and model:	BACKHOE	R L Surface:	NOT MEASURED
excavation dimensions:	4 m long 0.45 m wide	orientation:	datum:

method	penetration 1 2 3 4	support	water	samples, tests etc	R.L.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D				SC	CLAYEY SAND: fine grained, light grey-white with some silt and some fine roots	D	L		TOPSOIL leaf litter on surface
								CH	SANDY SILTY CLAY: medium to high plasticity, orange mottled white & red with sand fine to medium grained	<Wp	H		RESIDUAL
				D		1							
				D					SANDY SILTY CLAY: medium plasticity, orange red & white with sand fine to medium grained				EXTREMELY WEATHERED ROCK
				D		2			SANDSTONE: fine grained, orange, red, & white with ironstained sections highly weathered				HIGHLY WEATHERED ROCK
						3			Pit JTP1 Terminated at 2.20 m				
						4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools

SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 — little resistance ranging to very slow progress

WATER
D none observed
¥ not measured
water level
water outflow
water inflow

SAMPLES TESTS, ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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 Geosciences Pty Ltd
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engineering log - excavation

COFFEY

pit no JTP2
sheet 1 of 1

office job no: 612023/1
pit commenced: 30-03-99
pit completed: 30-03-99
logged by: MF
checked by:

client: SHOALHAVEN CITY COUNCIL
principal:
project: EFFLUENT DISPOSAL STUDY
pit location: JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)

R.L. Surface: NOT MEASURED
datum:

equipment type and model: BACKHOE
excavation dimensions: 4 m long 0.45 m wide orientation:

method	penetration 1 2 3 4	support	water	samples tests etc	R.L. depth metres	graphic log	classification SYMBOL	material: soil type: plasticity or particle characteristics; colour; secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D			SC	CLAYEY SAND: fine grained, light grey-grey with some silt and some fine roots	M W	L		TOPSOIL some leaf litter
							CH	SILTY CLAY: medium to high plasticity, orange, mottled red, with a trace to some sand fine grained	<Wp	H		RESIDUAL
				D								
				D	1		CI	SILTY CLAY: medium to high plasticity, light grey-white, & red, mottled with red ironstained sections and a trace of sand fine grained				RESIDUAL
				D	2			SILTY CLAY: medium plasticity, light grey-white & red mottled with red ironstained sections				EXTREMELY WEATHERED ROCK (fissured structure)
								Pit JTP2 Terminated at 2.40 m				
					3							
					4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools
SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress

WATER
D none observed
✱ not measured
water level
water outflow
water inflow

SAMPLES TESTS ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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

COFEXCA VERSION B4. 18 / 5/99 12 :32 :15

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engineering log - excavation

COFFEY

pit no: JTP3
sheet 1 of 1

office job no: G12023/1

client: SHOALHAVEN CITY COUNCIL
principal:
project: EFFLUENT DISPOSAL STUDY
pit location: JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)

pit commenced: 30-03-99
pit completed: 30-03-99
logged by: UHE
checked by: UHE

equipment type and model: BACKHOE
excavation dimensions: 4 m long 0.45 m wide orientation:

R L Surface: NOT MEASURED - datum:

method	penetration 1 2 3 4	support	water	samples tests etc	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics colour secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		NIL	D	D			SC	CLAYEY SAND: fine grained light grey with some silt and some roots	M	L		TOPSOIL
							CI	SANDY SILTY CLAY: medium plasticity orange, with some light grey sand fine grained some fissuring	<Wp	H		RESIDUAL
					1			SANDSTONE: Highly Weathered fine grained orange & light grey				HIGHLY WEATHERED ROCK
					2							
					3			Pit JTP3 Terminated at 2.20 m				
					4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools
SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress
WATER
D none observed
* not measured
water level
water outflow
water inflow

SAMPLES TESTS ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system
MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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

COFEXCA VERSION 84. 18 / 5/99 12 : 9 :41

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engineering log - excavation

pit no: JTP4
sheet 1 of 1

office job no: G12023/1

client: SHOALHAVEN CITY COUNCIL
principal:
project: EFFLUENT DISPOSAL STUDY
pit location: JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)

pit commenced: 30-03-99
pit completed: 30-03-99
logged by: JMF
checked by:

equipment type and model: BACKHOE
excavation dimensions: 4 m long 0.45 m wide orientation:

R.L. Surface: NOT MEASURED
datum:

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		NIL	D	D				SC	CLAYEY SAND: fine grained, light grey-grey with some silt and some roots throughout	M W	L		TOPSOIL
								CH	SILTY CLAY: medium to high plasticity, orange, mottled red with some sand fine to medium grained old tree roots in western end of pit from 0.3m to 1.1m	=Wp	VSt/ H		RESIDUAL
						1		CI	SANDY SILTY CLAY: medium plasticity, light grey, mottled orange, & red, sand fine grained, clay has a closely fissured structure with a trace of roots	<Wp	H		
						2			SANDY SILTY CLAY: medium plasticity, light grey mottled orange & red with sand fine grained				EXTREMELY WEATHERED ROCK
						3			Pit JTP4 Terminated at 2.50 m				
						4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools

SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress

WATER
D none observed
¥ not measured
▽ water level
+/- water outflow
▽△ water inflow

SAMPLES, TESTS ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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

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engineering log - excavation

pit no: JTP5
sheet 1 of 1

office job no: G12023/1
pit commenced: 30-03-99
pit completed: 30-03-99
logged by: PMF
checked by:

client: SHOALHAVEN CITY COUNCIL
principal:
project: EFFLUENT DISPOSAL STUDY
pit location: JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)

equipment type and model: BACKHOE
excavation dimensions: 4 m long 0.45 m wide orientation:

R L Surface: NOT MEASURED
datum:

method	penetration 1 2 3 4	support	water	samples; tests, etc	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics; colour secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D			SC	CLAYEY SAND: fine grained, light grey, with some fine roots breaks up in clump with some silt from 0 15m	M	L		TOPSOIL
							CH	SILTY CLAY: medium to high plasticity light grey, mottled orange & red, with some sand fine grained clay breaks up into 20-50mm pedals fissured rock structure light ironstained former root hairs	<Wp	H		
				D	1							
				D	2		CI	SANDY SILTY CLAY: low to medium plasticity, light grey mottled orange & red with sand fine grained				EXTREMELY WEATHERED ROCK
								Pit JTP5 Terminated at 2 50 m				
					3							
					4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools
SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress

WATER
D none observed
* not measured
water level
water outflow
water inflow

SAMPLES TESTS ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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

COFEXCA VERSION B4.
18 / 5/99 12 :32 :45

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engineering log - excavation

COFFEY

pit no JTP6
sheet 1 of 1

office job no: G12023/1
pit commenced: 30-03-99
pit completed: 30-03-99
logged by: DMF
checked by:

client: SHOALHAVEN CITY COUNCIL
principal:
project: EFFLUENT DISPOSAL STUDY
pit location: JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)

R L Surface: NOT MEASURED
datum:

equipment type and model: BACKHOE
excavation dimensions: 4 m long 0.45 m wide orientation:

method	penetration 1 2 3 4	support	water	samples tests etc	R.L.	depth metres	graphic log	classification SYMBOL	material: soil type: plasticity or particle characteristics; colour secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		NIL	D	D				SC	CLAYEY SAND: fine grained grey-brown with some silt and fine roots	M	L		TOPSOIL
								CI	SANDY CLAY: medium plasticity orange-brown with sand fine to medium grained; clay from 0.2-0.5m breaks up in hard lumps to 0.1m in size	<Wp	H		RESIDUAL
				D				CH	SILTY CLAY: medium to high plasticity light grey mottled orange, & red, with a trace of sand fine grained breaks up into pedals 20-50mm in size				
						1		CI	SANDY SILTY CLAY: highly fissured structure low to medium plasticity light grey some red ironstaining sand fine grained				EXTREMELY WEATHERED ROCK
									SANDSTONE: fine grained light grey-orange highly weathered				HIGHLY WEATHERED ROCK
						2			Pit JTP6 Terminated at 2.40 m				
						3							
						4							

B4. VERSION COFEXCA 16 / 5/99 12 :33 :25

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools

SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress

WATER
D none observed
✱ not measured
water level
water outflow
water inflow

SAMPLES TESTS ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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 Geosciences Pty Ltd
ACN 056 335 516

COFFEY

pit no JTP7
sheet 1 of 1

engineering log - excavation

office job no: G12023/1

client:	SHOALHAVEN CITY COUNCIL	pit commenced:	31-03-99
principal:		pit completed:	31-03-99
project:	EFFLUENT DISPOSAL STUDY	logged by:	JNE
pit location:	JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)	checked by:	
equipment type and model:	BACKHOE	R.L. Surface:	NOT MEASURED
excavation dimensions:	4 m long 0.45 m wide	orientation:	datum:

method	penetration 1 2 3 4	support	water	samples, tests etc	R.L.	depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics; colour; secondary and minor components	moisture condition	consistency/density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D				SC	CLAYEY SAND: fine grained, light grey-grey with some silt and some fine roots	M	L / MD		TOPSOIL
				D				SC	CLAYEY SAND: fine grained, orange, with some low to medium plasticity clay clay content increasing with depth				RESIDUAL
				D		1		CH	SANDY SILTY CLAY: medium to high plasticity light grey, mottled orange & red with sand fine to medium grained	<Wp	H		
				D		2			clay begins to have a slightly fissured structure from 1.3m with a trace of former roots and red ironstaining				
						3			SANDY SILTY CLAY: medium plasticity light grey with sand fine grained				EXTREMELY WEATHERED ROCK
						4			Pit JTP7 Terminated at 2.40 m				

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools

SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress

WATER
D none observed
✕ not measured
▽ water level
▽ water outflow
▽ water inflow

SAMPLES TESTS ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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 Geosciences Pty Ltd
ACN 056 335 516

engineering log - excavation

COFFEY

pit no JTP8
sheet 1 of 1

office job no: G12023/1
pit commenced: 31-03-99
pit completed: 31-03-99
logged by: MF
checked by:

client: SHOALHAVEN CITY COUNCIL
principal:
project: EFFLUENT DISPOSAL STUDY
pit location: JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)

equipment type and model: BACKHOE
excavation dimensions: 4 m long 0.45 m wide orientation:

R L Surface: NOT MEASURED
datum:

method	penetration 1 2 3 4	support	water	samples, tests etc	R.L. depth metres	graphic log	classification SYMBOL	material: soil type: plasticity or particle characteristics; colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D			SC	CLAYEY SAND: fine grained, brown, with some silt and fine roots, breaks up in 50mm pedals	M	L		TOPSOIL
				D			SC			MD		
							CI	CLAYEY SAND: fine grained, orange, with a trace of silt and occasional medium to coarse angular and rounded quartz gravel	>Wp	VSt	×	RESIDUAL
				D			CI	SANDY SILTY CLAY: medium to high plasticity, orange with sand fine grained			×	
							CI	SANDY CLAY: medium plasticity, orange, with some angular sandstone gravel		St		
					1			Pit JTP8 Terminated at 0.60 m Backhoe refusal at 0.6m on moderately weathered sandstone				
					2							
					3							
					4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools

SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress

WATER
D none observed
✱ not measured
water level
water outflow
water inflow

SAMPLES TESTS ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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

COFEXCA VERSION B4. 18 / 5/99 12:34:11

Coffey Geosciences Pty Ltd
ACN 056 335 516

engineering log - excavation

COFFEY

pit no JTP9
sheet 1 of 1

office job no: G12023/1
pit commenced: 31-03-99
pit completed: 31-03-99
logged by: WS
checked by:

client: SHOALHAVEN CITY COUNCIL
principal:
project: EFFLUENT DISPOSAL STUDY
pit location: JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)

equipment type and model: BACKHOE
excavation dimensions: 4 m long 0.45 m wide orientation:

R.L. Surface: NOT MEASURED
datum: -

method	penetration 1 2 3 4	support	water	samples tests etc	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics; colour; secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D			SC	CLAYEY SAND: fine grained, light grey, with some fine roots	D M	L		TOPSOIL
							CH	SILTY CLAY: high plasticity, orange, with a trace of sand fine grained, massive structure	=Wp	H	X	RESIDUAL
				D						VSt		
									<Wp		X	
										H		
					1			SANDY SILTY CLAY: low to medium plasticity, orange with brown, layering sand fine to medium grained				EXTREMELY WEATHERED ROCK
				D								
								SANDSTONE: Highly weathered fine grained, orange-brown, with some extremely weathered bands				HIGHLY WEATHERED ROCK
				D	2							
								Pit JTP9 Terminated at 2.40 m				
					3							
					4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools
SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress

WATER
D none observed
¥ not measured
water level
water outflow
water inflow

SAMPLES, TESTS, ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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

COFEXCA VERSION B4. 18 / 5/99 12 :34 :29

Coffey Geosciences Pty Ltd
ACN 056 335 516

engineering log - excavation

COFFEY

pit no: JTP10
sheet 1 of 1

office job no: G12023/1

client:	SHOALHAVEN CITY COUNCIL	pit commenced:	31-03-99
principal:		pit completed:	31-03-99
project:	EFFLUENT DISPOSAL STUDY	logged by:	JWE
pit location:	JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)	checked by:	
equipment type and model:	BACKHOE	R L Surface:	NOT MEASURED
excavation dimensions:	4 m long 0.45 m wide	orientation: -	datum:

method	penetration 1 2 3 4	support	water	samples tests etc	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D				SC	CLAYEY SAND: fine grained, light grey with some silt and roots	D M	L MD		TOPSOIL
							CH	SILTY CLAY: medium to high plasticity, orange, with a trace to some sand fine grained with slight fissuring and a trace of roots	<Wp	H		RESIDUAL
					1			SANDY SILTY CLAY: light grey, mottled orange, some red fissured structure breaks up into 20-50mm pedals gravelly from 0 8-0 9m				EXTREMELY WEATHERED ROCK
					2			SANDSTONE: fine grained light grey mottled orange highly weathered				HIGHLY WEATHERED ROCK
								Pit JTP10 Terminated at 2 40 m Practical refusal with backhoe at 2 4m				
					3							
					4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools

SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress

WATER
D none observed
✱ not measured
water level
water outflow
water inflow

SAMPLES, TESTS, ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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

COFEXCA VERSION B4. 18 / 5/99 12 :16 :12

Coffey Geosciences Pty. Ltd
ACN 056 335 516

engineering log - excavation

COFFEY

pit no: JTP11
sheet 1 of 1

office job no: G12023/1

client: SHOALHAVEN CITY COUNCIL
principal:
project: EFFLUENT DISPOSAL STUDY
pit location: JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)

pit commenced: 31-03-99
pit completed: 31-03-99
logged by:
checked by:

equipment type and model: BACKHOE
excavation dimensions: 4 m long 0.45 m wide orientation:

R.L. Surface: NOT MEASURED
datum:

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L. / depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D			SC	CLAYEY SAND: fine grained, light grey, with some silt and roots	D M	L		TOPSOIL
							CH	SILTY CLAY: medium to high plasticity, orange, mottled red, with a trace to some sand fine grained		VSt/ H		RESIDUAL
				D				becoming light grey from 1 1m		H		
					1			SILTY CLAY: medium plasticity, light grey, fissured structure withsome sand fine grained				EXTREMELY WEATHERED ROCK
					2			SANDSTONE: fine grained, light grey-orange, highly weathered				HIGHLY WEATHERED ROCK
								Pit JTP11 Terminated at 2 20 m slow progress on highly to moderately weathered sandstone				
					3							
					4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools
SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress
WATER
D none observed
¥ not measured
water level
water outflow
water inflow

SAMPLES, TESTS, ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system
MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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 Geosciences Pty Ltd
ACN 056 335 516

engineering log - excavation

COFFEY

pit no JTP12
sheet 1 of 1

office job no: G12023/1
pit commenced: 31-03-99
pit completed: 31-03-99
logged by: MKP
checked by:

client: SHOALHAVEN CITY COUNCIL
principal:
project: EFFLUENT DISPOSAL STUDY
pit location: JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)

equipment type and model: BACKHOE
excavation dimensions: 4 m long 0.45 m wide orientation:

R.L. Surface: NOT MEASURED
datum:

method	penetration 1 2 3 4	support	water	samples, tests etc	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D			SC	CLAYEY SAND: fine grained, light grey with some silt and some fine roots breaks up in hard lumps up to 200mm from 0.1m depth	D M			TOPSOIL
					1		CH	SILTY CLAY: medium to high plasticity, orange-brown & red, with a trace of sand fine grained slight fissuring	<Wp	H		RESIDUAL
								SANDY SILTY CLAY: medium to high plasticity, light grey mottled orange, & red highly fissured breaks into pedals of 20-50mm with red ironstaining in some fine root hairs				EXTREMELY WEATHERED ROCK
					2			SANDSTONE: fine grained, light grey-orange with some extremely weathered sections				HIGHLY WEATHERED ROCK
								Pit JTP12 Terminated at 2.50 m				
					3							
					4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools
SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress

WATER
D none observed
✱ not measured
water level
water outflow
water inflow

SAMPLES, TESTS ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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 Geosciences Pty Ltd
ACN 056 335 516

engineering log - excavation

COFFEY

pit no: JTP13
sheet 1 of 1

office job no: G12023/1

client:	SHOALHAVEN CITY COUNCIL	pit commenced:	31-03-99
principal:		pit completed:	31-03-99
project:	EFFLUENT DISPOSAL STUDY	logged by:	ME
pit location:	JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)	checked by:	
equipment type and model:	BACKHOE	R L Surface:	NOT MEASURED
excavation dimensions:	4 m long 0.45 m wide	orientation:	datum:

method	penetration 1 2 3 4	support	water	samples tests etc	R.L. depth metres	graphic log	classification symbol	material: soil type: plasticity or particle characteristics; colour; secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D			SC	CLAYEY SAND: fine grained light grey with fine roots and a trace to some silt	M	L		TOPSOIL
							CI	SILTY CLAY: medium plasticity orange & light grey mottled		VSt		RESIDUAL
				D						H		
				D	1			SANDY SILTY CLAY: medium plasticity, light grey, mottled orange, with some red ironstaining highly fissured structure with fine root hairs				EXTREMELY WEATHERED ROCK
				D				SANDSTONE: fine grained, light grey-orange with some extremely weathered sections				HIGHLY WEATHERED ROCK
					2							
								Pit JTP13 Terminated at 2.60 m				
					3							
					4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools
SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress

WATER
D none observed
X not measured
water level
water outflow
water inflow

SAMPLES, TESTS, ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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

COFEXCA VERSION 84. 18 / 5/99 12 :20 :49

Coffey Geosciences Pty Ltd
ACN 056 335 516

engineering log - excavation

COFFEY

pit no: JTP14
sheet 1 of 1

office job no: G12023/1

client:	SHOALHAVEN CITY COUNCIL	pit commenced:	31-03-99
principal:		pit completed:	31-03-99
project:	EFFLUENT DISPOSAL STUDY	logged by:	JWF
pit location:	JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)	checked by:	
equipment type and model:	BACKHOE	R.L. Surface:	NOT MEASURED
excavation dimensions:	4 m long 0.45 m wide	orientation:	datum:

method	penetration 1 2 3 4	support	water	samples, tests, etc	R.L. / depth metres	graphic log	classification symbol	material: soil type; plasticity or particle characteristics; colour; secondary and minor components	moisture condition	consistency / density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D			SC	CLAYEY SAND: fine grained, light grey, with low plasticity clay with some silt and fine roots	M	L		TOPSOIL
				D			CI	SILTY CLAY: medium plasticity, orange, with a trace to some fine grained sand	>Wp	VSt		RESIDUAL
				D	1			SANDY SILTY CLAY: medium plasticity, light grey, some red ironstaining, fissured structure in places	<Wp			EXTREMELY WEATHERED ROCK, moist in places
				D	2			contains some highly weathered ironstone bands from 1.9m				
					3			Pit JTP14 Terminated at 2.70 m				
					4							

METHOD
- N natural exposure
- X existing excavation
- BH backhoe bucket
- B bulldozer blade
- R bulldozer ripper
- E excavator
- HA hand auger
- HT hand tools

SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 — little resistance ranging to very slow progress

WATER
- D none observed
- ✱ not measured
- water level
- water outflow
- water inflow

SAMPLES TESTS ETC
- U undisturbed sample (mm)
- D disturbed sample
- Bs bulk sample
- E environmental sample
- VS vane shear
- DP dynamic penetrometer
- FD field density
- WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system

MOISTURE
- D dry
- M moist
- W wet
- Wp plastic limit
- Wl 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 Geosciences Pty. Ltd
ACN 056 335 516

engineering log - excavation

COFFEY

pit no: JTP15
sheet 1 of 1

office job no: G12023/1

client:	SHOALHAVEN CITY COUNCIL	pit commenced:	31-03-99
principal:		pit completed:	31-03-99
project:	EFFLUENT DISPOSAL STUDY	logged by:	
pit location:	JERBERRA ESTATE, ST GEORGES BASIN (REFER TO DRAWING)	checked by:	
equipment type and model:	BACKHOE	R.L. Surface:	NOT MEASURED
excavation dimensions:	4 m long 0.45 m wide	orientation:	datum:

method	penetration 1 2 3 4	support	water	samples tests etc	R.L. depth metres	graphic log	classification SYMBOL	material: soil type: plasticity or particle characteristics, colour, secondary and minor components	moisture condition	consistency/ density index	hand penetrometer kPa 100 200 300 400	structure and additional observations
E		Nil	D	D			CH	ORGANIC CLAY: medium plasticity, dark grey with fine roots and organic spongy material	>Wp			TOPSOIL
							CH	SILTY CLAY: high plasticity, grey-brown with fine roots slightly fissured structure	>Wp	St		ALLUVIUM
				D				becoming light grey brown mottled orange massive structure				
				D	1							
					2							
								Pit JTP15 Terminated at 2.60 m				
					3							
					4							

METHOD
N natural exposure
X existing excavation
BH backhoe bucket
B bulldozer blade
R bulldozer ripper
E excavator
HA hand auger
HT hand tools
SUPPORT
SH shoring SC shotcrete
Nil no support
RB rockbolts

PENETRATION
1 2 3 4 little resistance ranging to very slow progress
WATER
D none observed
¥ not measured
water level
water outflow
water inflow

SAMPLES TESTS ETC
U undisturbed sample (mm)
D disturbed sample
Bs bulk sample
E environmental sample
VS vane shear
DP dynamic penetrometer
FD field density
WS water sample

CLASSIFICATION SYMBOLS AND SOIL DESCRIPTION
based on unified classification system
MOISTURE
D dry
M moist
W wet
Wp plastic limit
Wl 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

COFEXCA VERSION B4. 18 / 5/99 12 :37 :54

APPENDIX B

Laboratory Reports

G12023/1-AD
27 January 2000

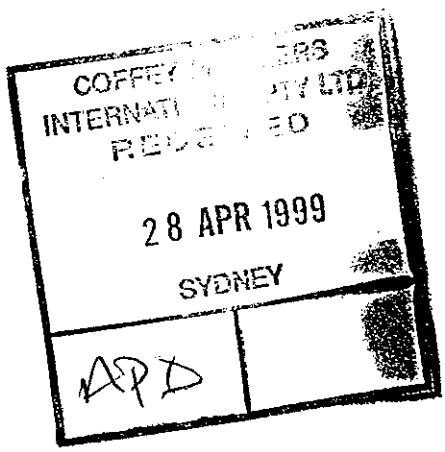
B2: Chemical Laboratory Reports

Coffey

SYDNEY ANALYTICAL LABORATORIES

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
NATA Reg. 1884



ANALYTICAL REPORT for:

COFFEY GEOSCIENCES PTY LTD

PO BOX 125
NORTH RYDE 2113

ATTN: ANDREW DAWKINS

JOB NO: SAL7628

CLIENT ORDER: G12023/1

DATE RECEIVED: 08/04/99

DATE COMPLETED: 16/04/99

TYPE OF SAMPLES: SOILS

NO OF SAMPLES: 4

National Association of Testing Authorities, Australia
NATA Endorsed Test Report

.....
Issued on 23/04/99
Lance Smith
(Chief Chemist)

SYDNEY
ANALYTICAL
LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL7628
CLIENT ORDER: G12023/1

	SAMPLES	*PHOSPHORUS SORPTION mg/kg	ESP %	CEC MEQ%
1	JTP4/0.6-0.7	600	2.0	8.0
2	JTP7/0.4-0.5	400	0.9	2.3
3	JTP11/0.4-0.5	550	2.9	7.5
4	JTP14/0.4-0.5	560	2.0	6.0
MDL		1	0.1	0.1
Method Code		S9	C35	S7
Preparation		P5	P5	P5

ANALYTICAL REPORT

JOB NO: SAL7628
CLIENT ORDER: G12023/1

	SAMPLES	EXCHANGEABLES Na MEQ%	K MEQ%	Ca MEQ%	Mg MEQ%	Mn MEQ%	Al MEQ%
1	JTP4/0.6-0.7	0.16	0.12	0.23	3.45	<0.01	3.8
2	JTP7/0.4-0.5	0.02	0.02	0.34	0.70	<0.01	1.0
3	JTP11/0.4-0.5	0.22	0.04	1.45	4.05	<0.01	2.1
4	JTP14/0.4-0.5	0.12	0.06	0.10	2.75	<0.01	2.7
	MDL	0.01	0.01	0.01	0.01	0.01	0.1
	Method Code	S7	S7	S7	S7	S7	S7
	Preparation	P5	P5	P5	P5	P5	P5

SYDNEY ANALYTICAL LABORATORIES

ANALYTICAL REPORT

JOB NO: SAL7628
CLIENT ORDER: G12023/1

	SAMPLES	SOLUBLES Na MEQ%	K MEQ%	Ca MEQ%	Mg MEQ%	Mn MEQ%	Al MEQ%
1	JTP4/0.6-0.7	0.32	0.03	<0.01	0.10	<0.01	<0.1
2	JTP7/0.4-0.5	0.10	0.06	0.01	0.17	<0.01	<0.1
3	JTP11/0.4-0.5	0.24	0.42	0.04	0.45	<0.01	<0.1
4	JTP14/0.4-0.5	0.22	0.17	<0.01	0.31	<0.01	<0.1
	MDL	0.01	0.01	0.01	0.01	0.01	0.1
	Method Code	S7	S7	S7	S7	S7	S7
	Preparation	P5	P5	P5	P5	P5	P5

RESULTS ON DRY BASIS

ANALYTICAL REPORT

JOB NO: SAL7628
CLIENT ORDER: G12023/1

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory.

P5	Sample dried, split and crushed to -150um
*S9	Phosphorus Sorption - Dept of Agriculture Standard Method Determined by APHA 4500F
C35	Exchangeable Sodium Percentage - Silver Thiourea Extract Determined by APHA 3500D
S7	Cation Exchange Capacity & Exchangeable/Soluble Cations Determined by Silver Thiourea Method

*The laboratory's NATA registration does not cover performance of this service

A preliminary report was faxed on 16/04/99

G12023/1-AD
27 January 2000

B1: Physical Laboratory Reports

Coffey

Coffey Geosciences Pty Ltd A.C.N. 056 335 516

Geotechnical Resources Environmental Technical Project Management
142 Wicks Road, North Ryde, NSW, 2113
Ph: (61 2) 9888 7444 Fax: (61 2) 9878 8155

Coffey

determination of emerson class number

client : *SHOALHAVEN CITY COUNCIL*
principal :
project : *EFFLUENT DISPOSAL STUDY*
location : *JERBERRA ESTATE, ST GEORGES BASIN*

job no : *G12023/1*
laboratory : *SYDNEY*
date : *15/04/99*
test report :

test procedure : *AS1289.3.8.1-1997*
sample identification: *JTP9 (0.4 - 0.5m)*
Sample supplied by CG-Wollongong on the 9/4/99.

test data

air dried crumbs

time start of test: *12/4/99 15:26*

time dispersion commences: *12/4/99 15:27*

time dispersion completed: *Not Observed*

remoulded material

time start of test: -

time dispersion commences: -

time dispersion completed: -

material description

(CI/CH) CLAY - medium to high plasticity,light brown.

type of water used: *Distilled*

water temperature: *20.5°*

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-BR1 Version 4.0

Authorised Signature
NATA No 431

16/4/99

Coffey Geosciences Pty Ltd A.C.N. 056 335 516

Geotechnical Resources Environmental Technical Project Management
142 Wicks Road, North Ryde, NSW, 2113
Ph: (61 2) 9888 7444, Fax: (61 2) 9878 8155

determination of emerson class number

client : *SHOALHAVEN CITY COUNCIL*
principal :
project : *EFFLUENT DISPOSAL STUDY*
location : *JERBERRA ESTATE, ST GEORGES BASIN*

job no : *G12023/1*
laboratory : *SYDNEY*
date : *15/04/99*
test report :

test procedure : *AS1289.3.8.1-1997*
sample identification: *JTP3 (0.5 - 0.6m)*
Sample supplied by CG-Wollongong on the 9/4/99.

test data

air dried crumbs

time start of test: *12/4/99 15:27*

time dispersion commences: -

time dispersion completed: -

remoulded material

time start of test: *13/4/99 11:50*

time dispersion commences: -

time dispersion completed: -

material description

(Cl) CLAY - medium plasticity,light brown orange.

type of water used: *Distilled*

water temperature: *20.5°*

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

J. RUSSELL 16/4/99
Authorised Signature
NATA No 431

Coffey Geosciences Pty Ltd A.C.N. 056 335 516

Geotechnical Resources Environmental Technical Project Management
142 Wicks Road, North Ryde, NSW, 2113
Ph: (61 2) 9888 7444, Fax: (61 2) 9878 8155

determination of emerson class number

client : *SHOALHAVEN CITY COUNCIL*
principal :
project : *EFFLUENT DISPOSAL STUDY*
location : *JERBERRA ESTATE, ST GEORGES BASIN*

job no : *G12023/1*
laboratory : *SYDNEY*
date : *15/04/99*
test report :

test procedure : *AS1289.3.8.1-1997*
sample identification: *JTP10 (0.4 - 0.5m)*
Sample supplied by CG-Wollongong on the 9/4/99

test data

air dried crumbs

time start of test: *12/4/99 15:25*
time dispersion commences: -
time dispersion completed: -

remoulded material

time start of test: *13/4/99 11:45*
time dispersion commences: -
time dispersion completed: -

material description

(CI) CLAY - medium plasticity,orange brown, some fine to medium sand

type of water used: *Distilled*
water temperature: *20.5°*

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)
  - calcite or gypsum absent ☒
    - vigorous shaking disperses ☒ (5)
    - vigorous shaking flocculates ☐ (6)

Emerson class number 5

J. RUSSELL 16/4/99
Authorised Signature
NATA No 431

Coffey Geosciences Pty Ltd A.C.N 056 335 516

Geotechnical Resources Environmental Technical Project Management
142 Wicks Road, North Ryde, NSW, 2113
Ph: (61 2) 9888 7444, Fax: (61 2) 9878 8155

determination of emerson class number

client : *SHOALHAVEN CITY COUNCIL*
principal :
project : *EFFLUENT DISPOSAL STUDY*
location : *JERBERRA ESTATE, ST GEORGES BASIN*

job no : *G12023/1*
laboratory : *SYDNEY*
date : *15/04/99*
test report :

test procedure : *AS1289.3.8.1-1997*
sample identification: *JTP12 (0.4 - 0.5m)*
Sample supplied by CG-Wollongong on the 9/4/99.

test data

air dried crumbs

time start of test: *12/4/99 15:28*
time dispersion commences: -
time dispersion completed: -

remoulded material

time start of test: *13/4/99 11:52*
time dispersion commences: -
time dispersion completed: -

material description

(CI) CLAY - medium plasticity,red brown,trace of fine sand.

type of water used: *Distilled*
water temperature: *20.5°*

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: 6

J. RUSSELL 16/4/99
Authorised Signature
NATA No 431

Coffey Geosciences Pty Ltd A.C.N. 056 335 516

Geotechnical Resources Environmental Technical Project Management

142 Wicks Road, North Ryde, NSW, 2113
Ph: (61 2) 9888 7444. Fax: (61 2) 9878 8155

Coffey

test results

client : *SHOALHAVEN CITY COUNCIL*
principal :
project : *EFFLUENT DISPOSAL STUDY*
location : *JERBERRA ESTATE, ST GEORGES BASIN*

job no : *G12023/1*
laboratory : *SYDNEY*
date : *15/04/99*
test report :

test procedure : *AS1289 4.3.1*
test date : *13/4/99*

Sample Identification	pH Units
JTP3 (0.5 - 0.6m)	*5.2*
JTP9 (0.4 - 0.5m)	*5.1*
JTP10 (0.4 - 0.5m)	*5.3*
JTP12 (0.4 - 0.5m)	*4.7*

remarks : *Samples supplied by CG-Wollongong on the 9/4/99.*

This laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with the terms of accreditation. This document shall not be reproduced except in full without the prior approval of the laboratory.

J RUSSELL 16/4/99
Authorised Signature
NATA No 431

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test results

client : *SHOALHAVEN CITY COUNCIL*
principal :
project : *EFFLUENT DISPOSAL STUDY*
location : *JERBERRA ESTATE, ST GEORGES BASIN*

job no : *G12023/1*
laboratory : *SYDNEY*
date : *15/04/99*
test report :

test procedure : ***Prepared in accordance with AS1289 4.3.1 test method***
test date : *13/4/99*

Sample Identification	Electrical Conductivity Units us/cm
JTP3 (0.5 - 0.6m)	*0.07*
JTP9 (0.4 - 0.5m)	*0.56*
JTP10 (0.4 - 0.5m)	*0.03*
JTP12 (0.4 - 0.5m)	*0.04*

remarks : *Samples supplied by CG-Wollongong on the 9/4/99.*

Form Number L1.0R1 Version 4.0

Coffey

APPENDIX C

Preliminary Water Balance Calculations

JERBERRA ESTATE ST GEORGES BASIN
EFFLUENT STUDY
PRELIMINARY WATER BALANCE

Design Water Flow	1000	Q
Design percolation Rate	5	R

Parameter	Symbol	Formula	Units	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Days in Month	D		days	31	28	31	30	31	30	31	31	30	31	30	31	
Precipitation	P		mm/month	88	71	80	52	72	62	41	38	48	72	84	70	777
Evaporation	E		mm/month	195	160	146	120	96.1	87	96.1	127	150	177	180	214	1748
Crop Factor	C			0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	
Inputs																
Precipitation	P		mm/month	88	71	80	52	72	62	41	38	48	72	84	70	777
Possible Effluent Irrigation	W	(ET + B) - P	mm/month	90	77	59	65	27	29	58	86	94	92	81	123	H = 881
Actual Effluent Production	I	H/12	mm/month	73	73	73	73	73	73	73	73	73	73	73	73	
Inputs		(P + I)	mm/month	162	144	153	126	146	136	114	111	121	145	158	143	1669
Outputs																
Evapotranspiration	ET	E X C	mm/month	156	128	117	96	77	70	77	102	120	141	144	171	1398
Percolation	B	(R / 7) X D	mm/month	22	20	22	21	22	21	22	22	21	22	21	22	
Outputs		ET + B	mm/month	178	148	139	117	99	91	99	124	141	164	165	193	1659
Storage	S	(P + I) - (ET + B)	mm/month	-17	-3	14	8	47	45	15	-13	-20	-18	-8	-50	
Cumulative Strorage	M		mm	0	-3	11	20	66	111	126	113	93	75	67	17	

Irrigation Area	L	365 X Q / H	m2	414

Storage	V	Largest M	mm	129
		(V X L)/1000 m3		53

Water Balance Calculations

① NUTRIENT BALANCE

$$A = \frac{C \times Q}{L_s}$$

A = land area m^2
C = nutrient conc. (mg/L)
Q = wastewater flow rate
L_x = critical loading rate

A phosphorus (average)

527.5 mg/kg assume 1500 kg soil/m^3

0.7913 g/m^3

7912 kg/ha/m of soil

Assumptions:

- total phosphorus conc (TP) in wastewater = 12 mg/L
- critical loading rate (L_p) = 3 mg/m^2/day
- phosphorus sorbtion capacity = 7900 kg/ha

① Amount of phosphorus that can be absorbed without leaching over 50 years

$P_{absorbed}$ = 7900 × 1/3

= 2631 kg/ha/m

= 0.26 kg/m^2

② Determine amount of vegetation uptake over 50 years

P_{uptake} = 3 × 365 × 50

= 54,750 mg/m^2

= 0.055 kg/m^2

③ Determine amount of phosphorus generated in 50 years

= 12 × 1000 × 365 × 50

= 219 kg

Irrigation area = $\frac{P_{generated}}{P_{absorbed} + P_{uptake}}$

$= \frac{219}{0.26 + 0.055}$

$= 695 m^2$

B NITROGEN

Assumptions (based on Table 14 of E&H 1999 Guidelines)

- 37 mg/l nitrogen concentration in wastewater
- 25 mg/m²/d critical loading rate

$A = \frac{C \times Q}{L_x}$

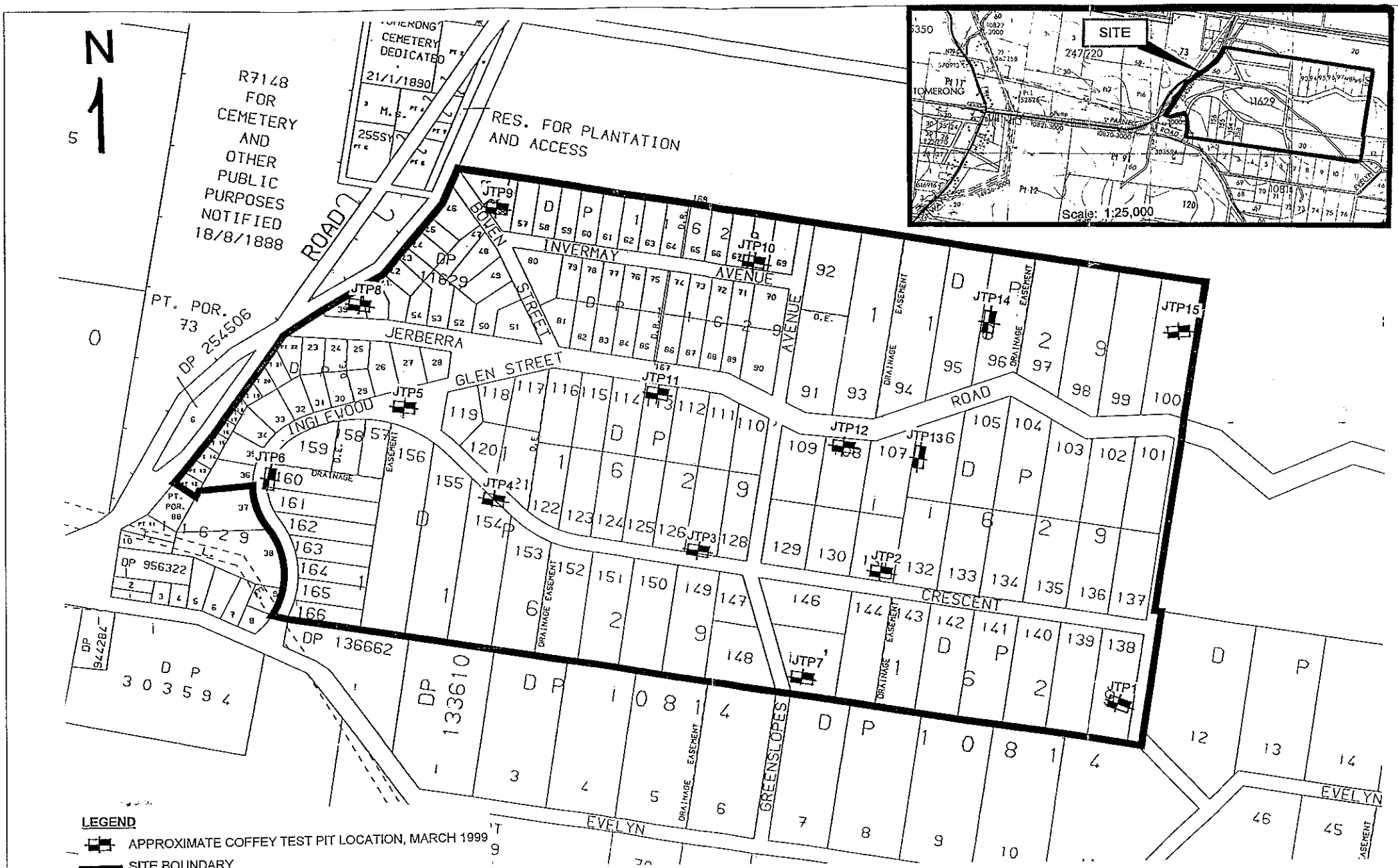
where A = irrigation area in m²
C = concentration of nutrient
Q = wastewater flow rate
L_x = critical loading rate

$A = \frac{37 \times 1000}{25}$

$= 1480 m^2$

APPENDIX D

Drawings



Coffey

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50 0 50 100 150 200 250

Scale (metres) 1:5000

Revision	Description	Drawn	Approved	Date

Drawn	JMF
Checked	LPT
Date	13-04-99

SHOALHAVEN CITY COUNCIL
EFFLUENT DISPOSAL STUDY
JERBERRA ESTATE, ST GEORGES BASIN
APPROXIMATE SAMPLING LOCATIONS

Drawing no: G12023/1-1

Job no: G12023/1

Coffey

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25 0 25 50 75 100 125

Scale (metres)
1:25,000 (at A3)

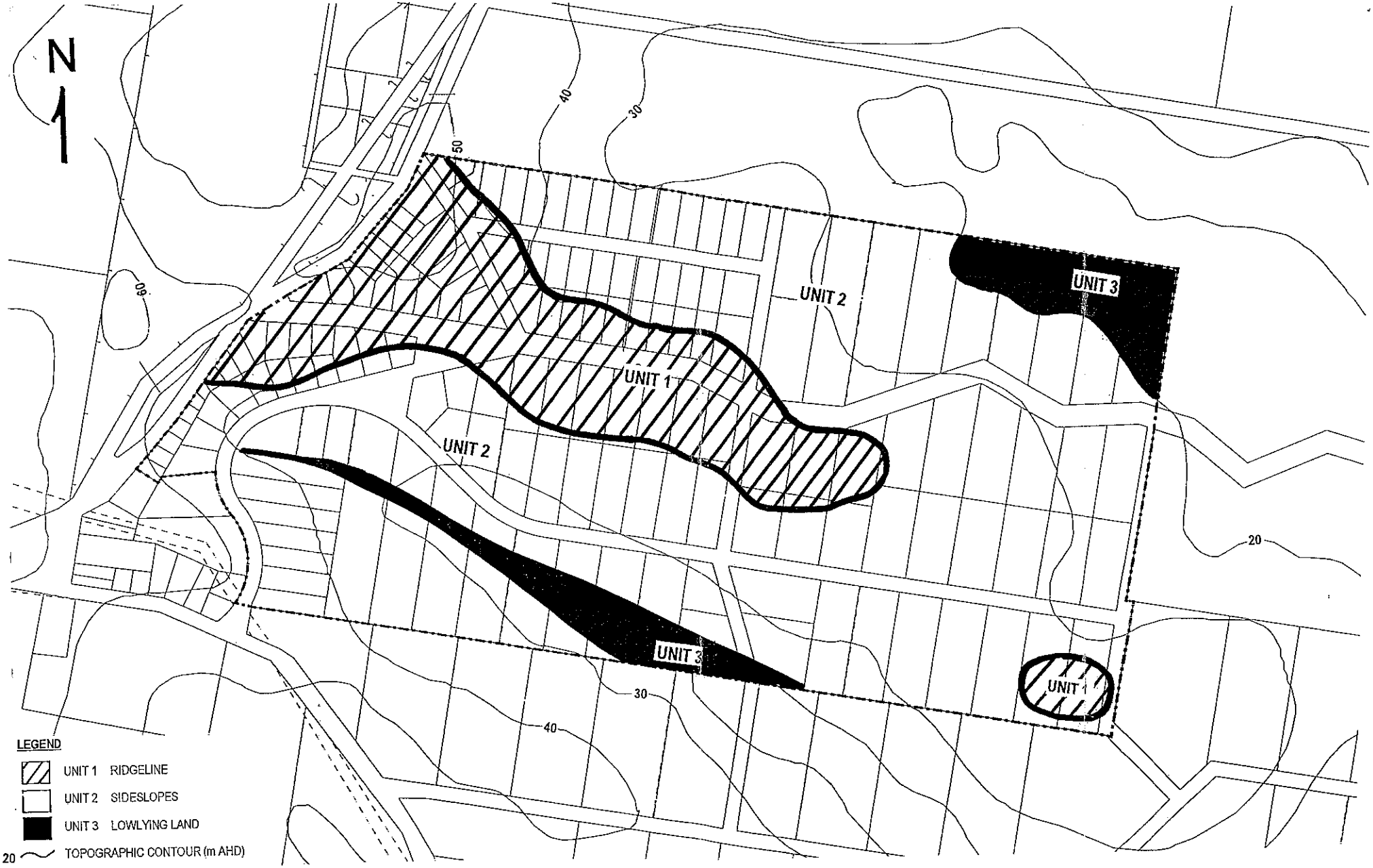
Revision	Description	Drawn	Approved	Date

Drawn	JMF
Checked	LP4
Date	18-05-99

SHOALHAVEN CITY COUNCIL
EFFLUENT DISPOSAL STUDY
JERBERRA ESTATE, ST GEORGES BASIN
CATCHMENT CONFIGURATION

Drawing no: G12023/1-2

Job no: G12023/1



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1:5000

Scale (metres)

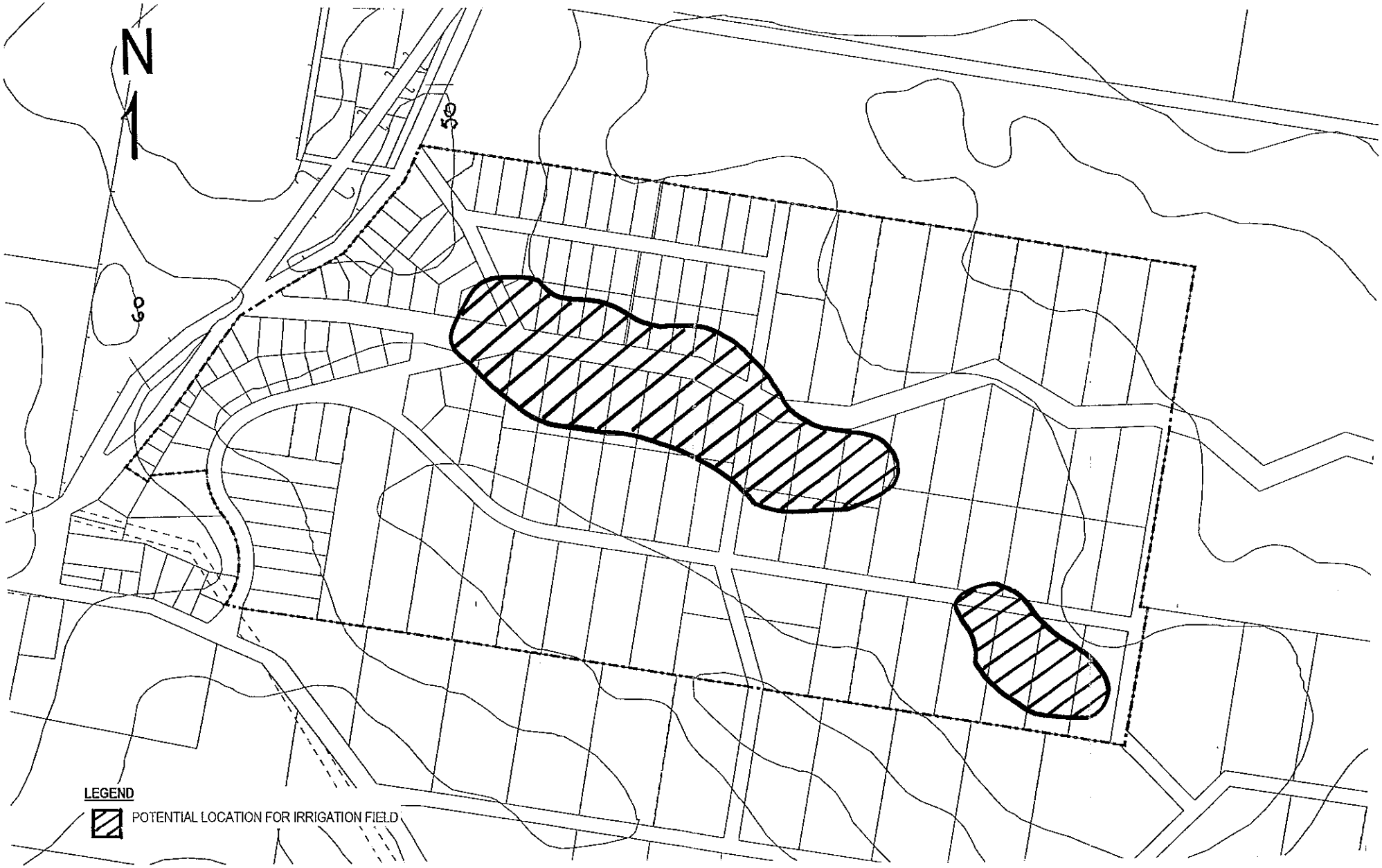
Revision	Description	Drawn	Approved	Date

Drawn	JMF
Checked	LDT
Date	30-04-99

SHOALHAVEN CITY COUNCIL
EFFLUENT DISPOSAL STUDY
JERBERRA ESTATE, ST GEORGES BASIN
TERRAIN UNITS

Drawing no: G12023/1-3

Job no: G12023/1



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1:5,000

Scale (metres)

Revision	Description	Drawn	Approved	Date

Drawn	JMF
Checked	LPF
Date	23-09-99

SHOALHAVEN CITY COUNCIL
EFFLUENT DISPOSAL STUDY
JERBERRA ESTATE, ST GEORGES BASIN
POTENTIAL LOCATION FOR IRRIGATION FIELD

Drawing no: G12023/1-4

Job no: G12023/1