

REPORT 20-1531R1
Revision 0

Aquaculture Project, Cudgen Noise Assessment

Prepared for
David McPhee & Associates
220 Priors Pocket Road
Moggill Qld 4070

2 September 2004

RICHARD HEGGIE
A S S O C I A T E S
ABN 29 001 584 612

Level 1, 240 Waterworks Road Ashgrove QLD 4060 Australia
Telephone 61 7 3858 4800 Facsimile 61 7 3858 4801 Email brisbane@heggies.com.au

DOCUMENT CONTROL

Aquaculture Project, Cudgen Noise Assessment



Richard Heggie Associates Pty Ltd operates under a Quality System which has been certified by Quality Assurance Services Pty Limited to comply with all the requirements of ISO 9001:2000 "Quality Systems - Model for Quality Assurance in Design, Development, Production, Installation and Servicing" (Licence No 3236).

This document has been prepared in accordance with the requirements of that System.

Richard Heggie Associates Pty Ltd is a Member Firm of the Association of Australian Acoustical Consultants.

Reference	Status	Date	Prepared	Checked	Authorised
20-1531R1	Revision 0	2 September 2004	Shane Elkin	Glenn Homes	Shane Elkin

TABLE OF CONTENTS

1	INTRODUCTION	4
2	SITE DESCRIPTION AND ACOUSTICAL ENVIRONMENT	5
3	NOISE ASSESSMENT PROCEDURES	7
3.1	Operational Intrusive Noise Criteria	7
3.2	Operational Amenity Goal	8
3.3	Construction Noise Guidelines	8
3.4	Modifying Factors	10
3.4.1	Tonal Noise	10
3.4.2	Low-frequency Noise	10
3.5	Project Specific Noise Limits	11
4	NOISE SOURCES	12
4.1	Operational	12
4.2	Construction	12
5	NOISE MODELLING METHODOLOGY	14
6	PREDICTIONS AND ASSESSMENT	16
6.1	Operational Noise	16
6.2	Construction Noise	17
7	CONCLUSION	18
Figure 1	Aerial Photograph of the Proposed Site and Surrounding Noise Sensitive Locations	6
Table 1	INP Recommended Amenity Criteria	8
Table 2	Recommended EPA Noise Goals for Construction Works	9
Table 3	Preferred EPA Daytime Construction Hours	9
Table 4	Modifying Factors - Tonal Noise	10
Table 5	Operation Equipment List	12
Table 6	Likely Construction Equipment	13
Table 7	Operational Noise Predictions and Assessment	16
Table 8	Construction Noise Predictions and Assessment	17

1 INTRODUCTION

Richard Heggie Associates Pty Ltd (Heggies) has been commissioned by David McPhee & Associates to assess operational and construction noise emissions from a proposed aquaculture project at Cudgen located adjacent to the Murwillumbah exit on the Pacific Highway at the nearest residential receivers. It is understood that this assessment will form part of the Development Application.

The assessment has been conducted in general accordance with the guidelines presented in the Department of Environment and Conservation (DEC), formerly the Environmental Protection Authority (EPA), Industrial Noise Policy and Environmental Noise Control Manual.

This report presents the results of the assessment study and an indication of the degree of impact on surrounding residences.

2 SITE DESCRIPTION AND ACOUSTICAL ENVIRONMENT

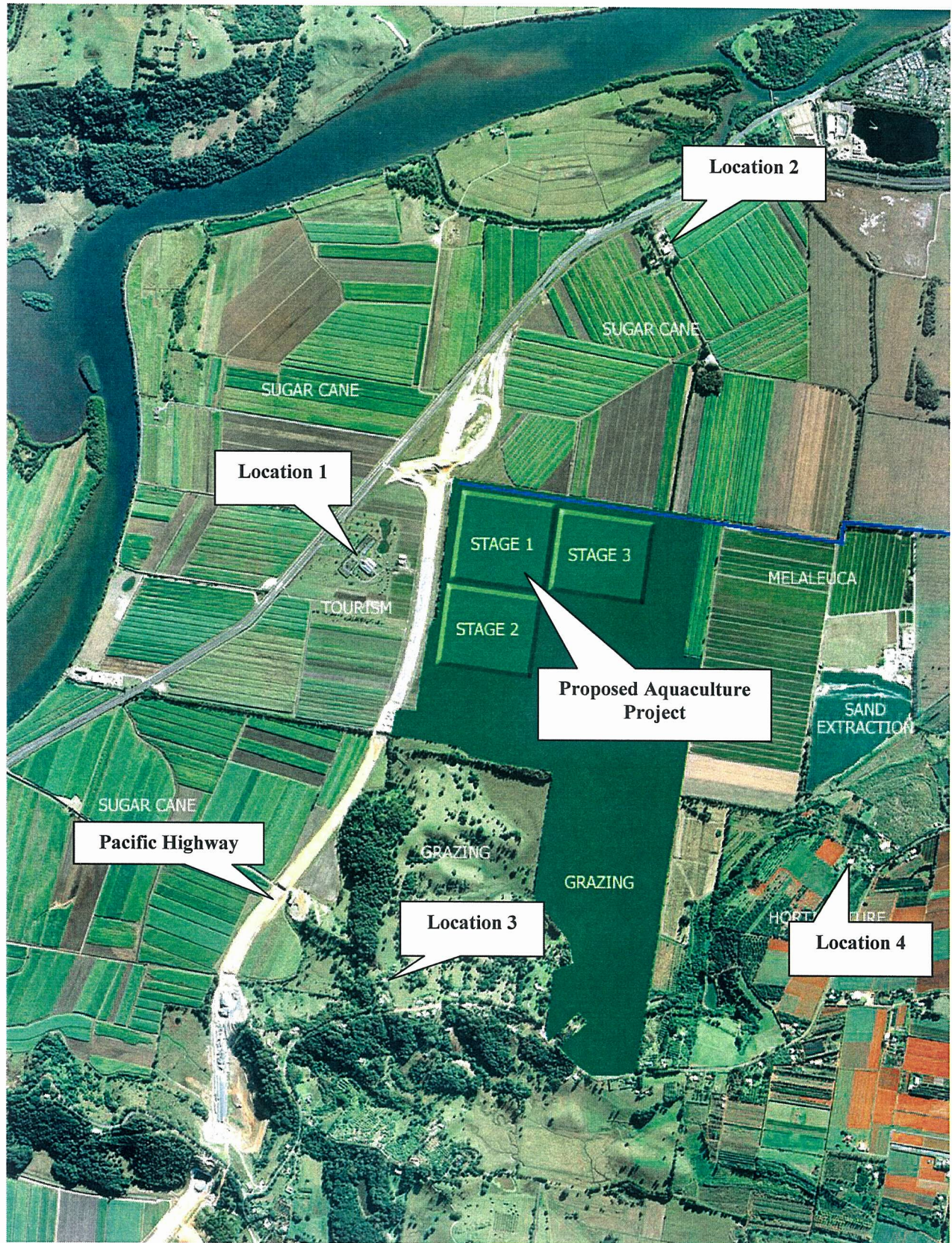
The proposed aquaculture project is located in a predominantly farming area.

Figure 1 contains an aerial photograph of the proposed site and surrounding noise sensitive locations. Based on this aerial photograph, the nearest noise sensitive locations are:

- Location 1 – Melaleuca Station (owner's residence) ~500 m
- Location 2 – Farmhouse ~1,260 m
- Location 3 – Residences (Cudgen Road) ~1,706 m
- Location 4 – Residences (Cudgen Road) ~1,780 m

The noise environment is typically rural with traffic noise from the Pacific Highway dominant at Locations 1 (particularly), 2 and 3 and audible at Location 4. During a night time visit, insects were also audible.

Figure 1 Aerial Photograph of the Proposed Site and Surrounding Noise Sensitive Locations



3 NOISE ASSESSMENT PROCEDURES

DEC's *Industrial Noise Policy* represents the New South Wales Government's guidelines and criteria in addressing the noise impacts of industry. It aims to balance the need for industrial activity with the desire for quiet within the community. The criteria selected are designed to protect at least 90 per cent of the population living in the vicinity of the industrial noise sources for at least 90 per cent of the time.

The *Industrial Noise Policy*'s objectives are:

- a. to establish noise criteria that would protect the community from excessive noise;
- b. to preserve the amenity for specific land uses;
- c. to use the criteria for deriving project specific land uses;
- d. to promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects.

Implementation is achieved by ensuring:

- a. that noise from any single source does not intrude greatly above the prevailing background noise level. This is known as the intrusive noise criteria;
- b. the background noise level does not exceed the level appropriate for the particular locality and land use. This is known as the amenity criteria.

In order to satisfy the above two requirements, an Amenity and an Intrusive noise criterion is recommended of which the lower of the two applies.

3.1 Operational Intrusive Noise Criteria

The intrusive noise criterion sets a limit of 5 decibels (dB) for the equivalent continuous (energy – average) noise level or $L_{Aeq}(15\text{minute})$ of the source (within any 15 minute period) above the background level. That is the $L_{Aeq}(15\text{minute})$ from industrial sources should not exceed the LA_{90} background noise level by more than 5 dB.

Where the LA90 background noise level is less than 30 dBA, the INP recommends that it be taken as 30 dBA for assessment purposes.

3.2 Operational Amenity Goal

The amenity assessment is based upon the noise criteria specific to land use and associated activities, and is expressed as an LAeq over the specified time periods day, evening and night.

The amenity criteria are set out in full in Table 2.1 of the *NSW Industrial Noise Policy*. The relevant rural category criteria are reproduced in **Table 1**.

The limiting amenity noise criterion is that which occurs during the limiting night-time period and is 40 dBA.

Table 1 INP Recommended Amenity Criteria

Type of Receiver	Indicative Noise Amenity Area	Time of Day	ANL (LAeq)
Residence	Suburban	Day	50
		Evening	45
		Night	40

3.3 Construction Noise Guidelines

When dealing with noise emanating from construction works, the NSW DEC (formerly EPA) recognises that higher levels of noise are likely to be tolerated by people in view of the relatively short duration of the works. As a result, the DEC's current guidelines for construction noise assessment are contained in its "*Environmental Noise Control Manual*" (ENCM).

Chapter 171-1 of the ENCM recommends the following approaches to mitigating adverse noise impacts from construction sites:

Noise Emission Objectives

The ENCM recommends that the LA10(15minute) noise levels arising from a construction site and measured within the curtilage of an occupied noise-sensitive premises (ie at boundary or within 30 m of dwelling, whichever is the lesser) should not exceed the levels indicated in **Table 2**. These noise goals are consistent with community reaction to construction noise.

Table 2 Recommended DEC Noise Goals for Construction Works

Period of Noise Exposure	LA10(15minute) Construction Noise Goal
Cumulative noise exposure period not exceeding 4 weeks	LA90(15minute) plus 20 dBA
Cumulative noise exposure period of between 4 weeks and 26 weeks	LA90(15minute) plus 10 dBA
Cumulative noise exposure period longer than 26 weeks	LA90(15minute) plus 5 dBA

Preferred Hours of Construction

The guidelines recommend confining permissible work times as outlined in **Table 3**.

Table 3 Preferred DEC Daytime Construction Hours

Day	Preferred Construction Hours
Monday to Friday	7.00 am to 6.00 pm
Saturdays	7.00 am to 1.00 pm (if inaudible at residences) Otherwise, 8.00 am to 1.00 pm.
Sundays or Public Holidays	No construction

Works Undertaken Outside of Preferred Construction Hours

Where it is necessary for construction works to be undertaken outside the preferred daytime construction hours, the condition normally applied is that:

- LA10(15minute) noise levels emitted by the works should not exceed the LA90 level during the relevant evening or night-time period by a margin of more than 5 dBA, *independent* of the duration of the construction activity.

Silencing

All practical measures should be used to silence construction equipment, particularly in instances where extended hours of operation are required.

3.4 Modifying Factors

A penalty of 5 dB is to be applied to the source level if the characteristic of the noise source is likely to increase annoyance. This includes noise of tonal, impulsive, intermittent or low frequency character.

3.4.1 Tonal Noise

Tonal noise is defined by the INP as containing a prominent frequency and characterised by a definite pitch. It is assessed in one-third octave bands or narrow band analysis.

Table 4 Modifying Factors - Tonal Noise

Level of one-third octave band exceeds the level of the adjacent bands on both sides by:	Centre Frequency	Penalty
5 dB	Above 400 Hz	5 dB
8 dB	160 to 400 Hz Inclusive	5 dB
15 dB	Below 160 Hz	5 dB

Taken from INP Table 4.1.

3.4.2 Low-frequency Noise

Low-frequency noise is defined as containing major components within the low frequency range (20 Hz to 250 Hz) of the frequency spectrum. C-weighted and A-weighted levels are measured over the same time period and modifying factor of 5 dB is to be applied if the difference between the two levels is 15 dB or more.

The INP states that only one 5 dB correction should be applied if the tone is in the low-frequency range, where a source emits tonal and low-frequency noise.

No impulsive, tonal or low-frequency noise is anticipated during operation of the aquaculture project therefore no modifying factors have been applied in this assessment.

3.5 Project Specific Noise Limits

No background noise measurements have been undertaken for this study.

Therefore, the following background noise assumptions have been made:

- **Daytime (7am to 6pm) – 40 dBA LA90**
based on Noise Area Category “R1” – Areas with negligible transport – from Australian Standards 1055.3-1977 *Acoustics – Description and measurement of environmental noise*.
- **Night-time (6pm to 7am) – 30 dBA LA90**
based on the fact that 30 dBA is recommended as the minimum background noise level in the DEC’s INP.

Particularly for Location 1, and to a lesser degree Locations 2 and 3, the above assumptions are considered conservative given the dominance of Pacific Highway traffic noise observed during the site visit.

Therefore, the project specific noise limits are:

Operational - **35 dBA LAeq** (based on night-time intrusive criterion of background +5 dBA)

Construction (daytime only)

- should be treated as one
∴ 50 should apply to all construction*
- **60 dBA LA10** – Earthworks (activities up to 4 weeks duration)
 - **50 dBA LA10** – Construction (activities up to 26 weeks duration)

4 NOISE SOURCES

4.1 Operational

Table 5 outlines the proposed plant for each stage (1, 2 & 3) of the aquaculture project as supplied by David McPhee and Associates. **Table 5** also lists the sound pressure levels (again supplied by David McPhee and Associates) that have been used to assess operational noise levels in this study.

Table 5 Operation Equipment List

Item	Number	Sound Pressure Level @ 1 m (of each item)
Pumps	24	64 dBA
	24	55 dBA
Fans	60	62 dBA
Fans	20	65 dBA
Refrigeration Plant	1	70 dBA ^①

^① Assumes Refrigeration Plant is housed within the processing building constructed of tilt up concrete walls and metal roof

An emergency diesel generator will also likely be located on-site. No acoustic data was supplied for this item of plant so a Sound Power Level (SWL) of 107 dBA was assumed based on Heggies in-house database. It should be noted that the emergency generator would only be operational during loss of electricity to the site which is hardly every anticipated.

4.2 Construction

Table 6 outlines the likely plant required during construction of each stage (1, 2 & 3) of the aquaculture project (as supplied by David McPhee and Associates). **Table 6** also lists the sound power levels associated with such plant. These sound power levels are based on Heggies database and are considered typical for such equipment.

Table 6 Likely Construction Equipment

Plant Item	L _{Amax} Sound Power Level
Earthworks	
Dozer	110 dBA
Vibratory Roller	110 dBA
30t Excavator	110 dBA
Bobcat	100 dBA
Grader	110 dBA
Construction	
Forklift	98 dBA
Crane	105 dBA
Concrete Truck	111 dBA

Note: Under normal operation, LA10 noise levels are typically 5 dBA less than maximum noise levels for mobile construction equipment.

Heggies has been advised that 'earthworks' for each stage are likely to occur for 3 to 4 weeks with 'construction' to take up to six months (26 weeks) for each stage. Furthermore, earthworks/construction activities are only proposed during the day (7am to 6pm) period.

→ Monday to Friday only?

5 NOISE MODELLING METHODOLOGY

In order to calculate noise emission levels at the various noise sensitive receiver locations, a SoundPLAN (Version 6) environmental computer model was used. SoundPLAN is a software package which enables compilation of a sophisticated computer model comprising a digitised ground map (containing ground contours), the location and acoustic sound power levels of potentially critical noise sources on site and the location of receivers for assessment purposes.

The computer model can generate noise emission levels taking into account factors such as source sound power levels and locations, distance attenuation, ground absorption, air absorption, and shielding attenuation, as well as meteorological conditions, including wind effects.

The CONCAWE prediction methodology was utilised within SoundPLAN. The statistical accuracy of environmental noise predictions using CONCAWE was investigated by Marsh (Applied Acoustics 15 - 1982). Marsh concluded that CONCAWE was accurate to ± 2 dB in any one octave band between 63 Hz and 4 kHz and ± 1 dBA overall.

The sound power levels documented in **Table 5** (operational) and **Table 6** (construction) were utilised for these predictions. The predictions were undertaken by summing the sound power associated with all items of plant for each stage and locating them in the centre of the appropriate (Stage 1, 2 or 3) area shown in **Figure 1**. For conservatism, no shielding has been modelled for the light-weight buildings covering the aquaculture facility.

Both “neutral” and “worst case” noise predictions were conducted for both the operational and construction noise predictions. The worst case weather conditions modelled were:

- 10°C
- 90% Humidity
- Pasquill Stability Category F
- 2 m/s Wind Speed

It should also be noted that the sound power levels documented in **Table 6** correspond to the maximum noise levels from the associated machinery. Experience has shown that the L₁₀ noise levels with mobile construction machinery in operation are typically 5 dBA lower than the maximum levels. Therefore the SoundPLAN predictions undertaken for the construction phase of the project utilise sound power levels 5 dBA less than those shown in **Table 6**.

6 PREDICTIONS AND ASSESSMENT

6.1 Operational Noise

Table 7 documents the “neutral” and “worst case” noise predictions for the operational phase (Stages 1, 2 and 3) of the proposed aquaculture project. **Table 7** also shows the applicable noise limits, as discussed in **Section 3** of this report and whether noise control measures will be required in order to achieve compliance with the appropriate limit.

Table 7 Operational Noise Predictions and Assessment

Location	Predicted Operational Noise Level dBA LAeq		Noise Limit	Noise Control Measures Required
	“Neutral” Weather Conditions	“Worst Case” Weather Conditions		
1	19	25	35	No
2	11	18	35	No
3	7	14	35	No
4	7	14	35	No

During operation of the emergency diesel generator, noise levels of 33 dBA (neutral weather) and 38 dBA (worst-case weather) are predicted at Location 1. The predictions at the other three locations are all (neutral and worst-case) less than 30 dBA. This would result in a minor exceedance (3 dBA) of the night-time criterion at Location 1 under worst case conditions only. Given the conservative night-time background noise assumption of 30 dBA at Location 1, due to its close proximity to the Pacific Highway, and the very infrequent use of the generator, this minor exceedance is considered acceptable.

agree.

Heggies has also been advised that submersible pumps are the preferred option in the vicinity of the police station adjacent to the ocean for pumping fresh seawater to the proposed aquaculture facility. As these pumps are submersible, no noise impacts are anticipated. However, if submersible pumps are not feasible, above ground pumps in this area may need to be housed in a suitably designed building to ensure acceptable noise levels. Such a building may include besser block walls, concrete slab roof and silenced air intake/outlet vents if warranted following a more detailed assessment.

6.2 Construction Noise

Table 8 documents the “neutral” and “worst case” noise predictions for the two construction phases – earthworks and construction - of each stage of the proposed aquaculture project. As construction for the three stages are not expected to run concurrently, these predictions are valid throughout the construction phase of all three stages of the project. **Table 8** also shows the applicable noise limits, as discussed in **Section 3** of this report and whether noise control measures will be required in order to achieve compliance with the appropriate limit.

Table 8 Construction Noise Predictions and Assessment

Location	Predicted Construction Noise Level dBA L10		Noise Limit	Noise Control Measures Required
	“Neutral” Weather Conditions	“Worst Case” Weather Conditions		
Earthworks				
1	37	42	60	No
2	27	34	60	No
3	24	31	60	No
4	23	30	60	No
Construction				
1	33	38	50	No
2	23	30	50	No
3	20	27	50	No
4	19	26	50	No

As shown in **Tables 7** and **8**, no exceedances of the operational or construction noise limits are predicted at the neighbouring noise sensitive locations for Stage 1 of the proposed aquaculture project.

Nb. Constr Noise in App not correct as
constr period will exceed 26wks (likely 48wks).
∴ should be Bgd + 5dB(A).
Nb. predictions < 42 dB,
constr only in day.
Don't know bground, but presumed in App
to be 40 dB ∴ limit 45, which predicted to meet.

7 CONCLUSION

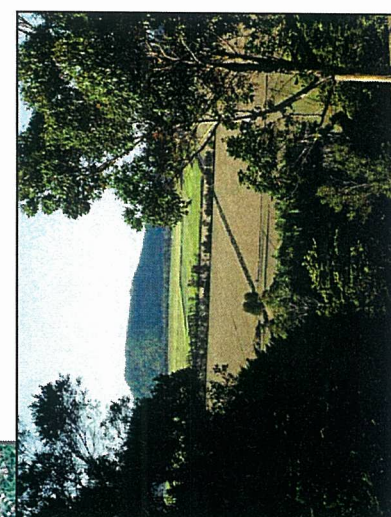
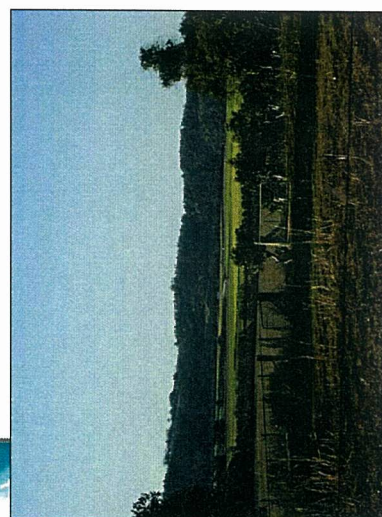
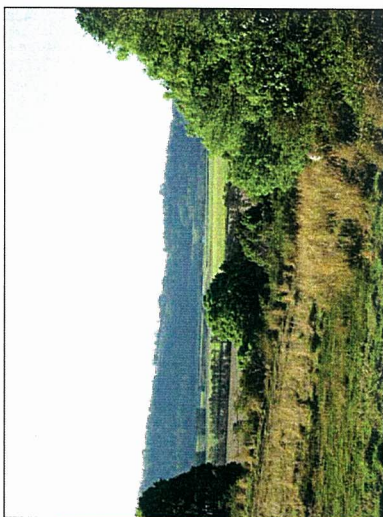
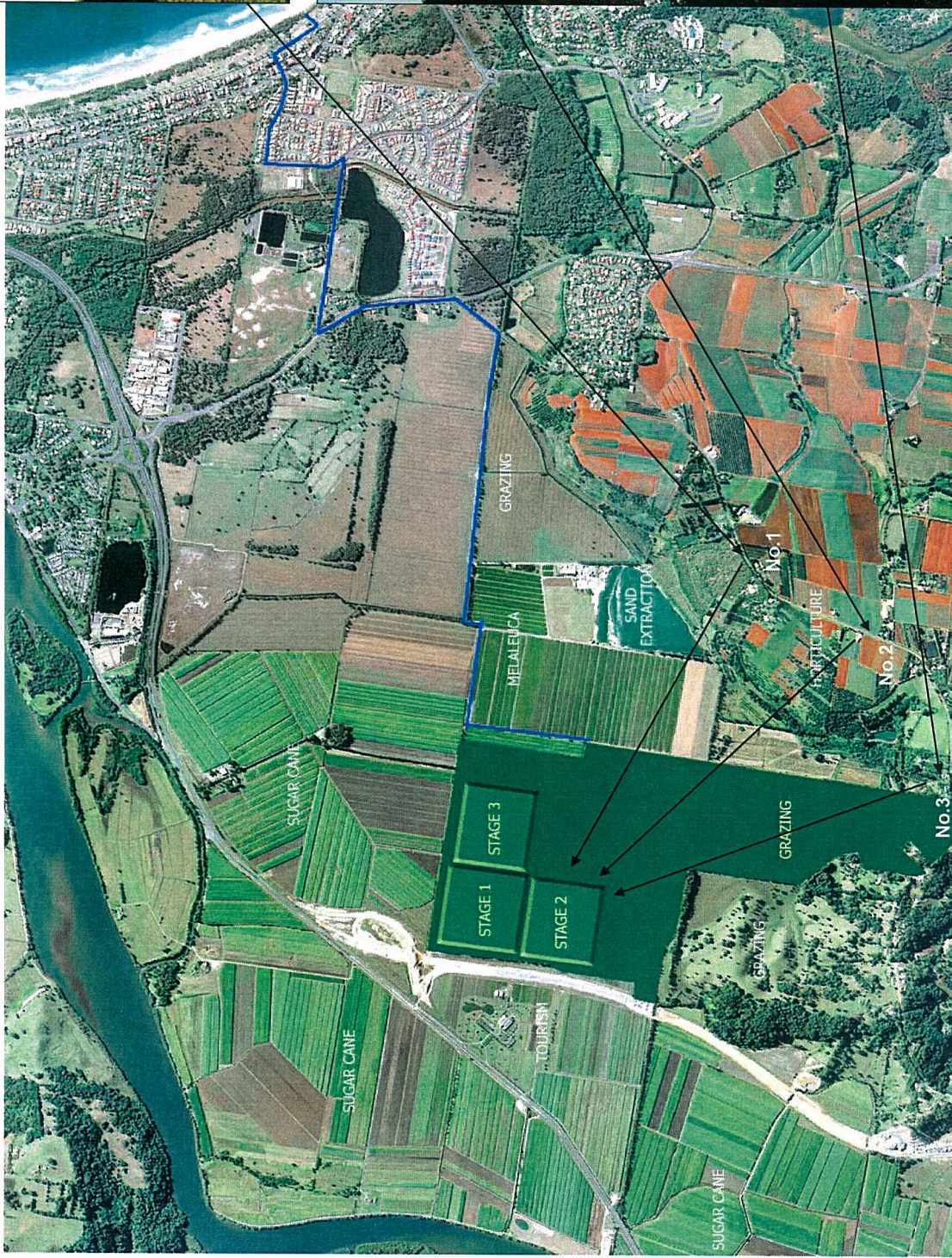
The level of noise emission from the proposed aquaculture project at Cudgen has been assessed based on the guidelines presented in the DEC's *NSW Industrial Noise Policy* and the *Environmental Noise Control Manual*.

Based on the investigations undertaken for this report it is concluded that:

- a. No specific noise control measures are required for the operation of the aquaculture project based on the advice that the refrigeration plant will be located within the processing building.
- b. No specific controls are required for the construction of Stages 1, 2 or 3 of the aquaculture project.

APPENDIX H

- **VISUAL ASSESSMENT SHEET 1**
- **VISUAL ASSESSMENT SHEET 2**
- **VISUAL ASSESSMENT SHEET 3**
- **LANDSCAPING BUFFER PLANTING PALETTE**



VISUAL IMPACT ASSESSMENT - SHEET No.1

Views from Cudgen Ridge



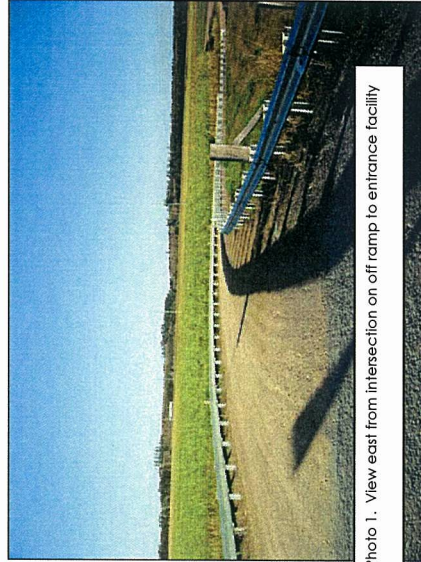
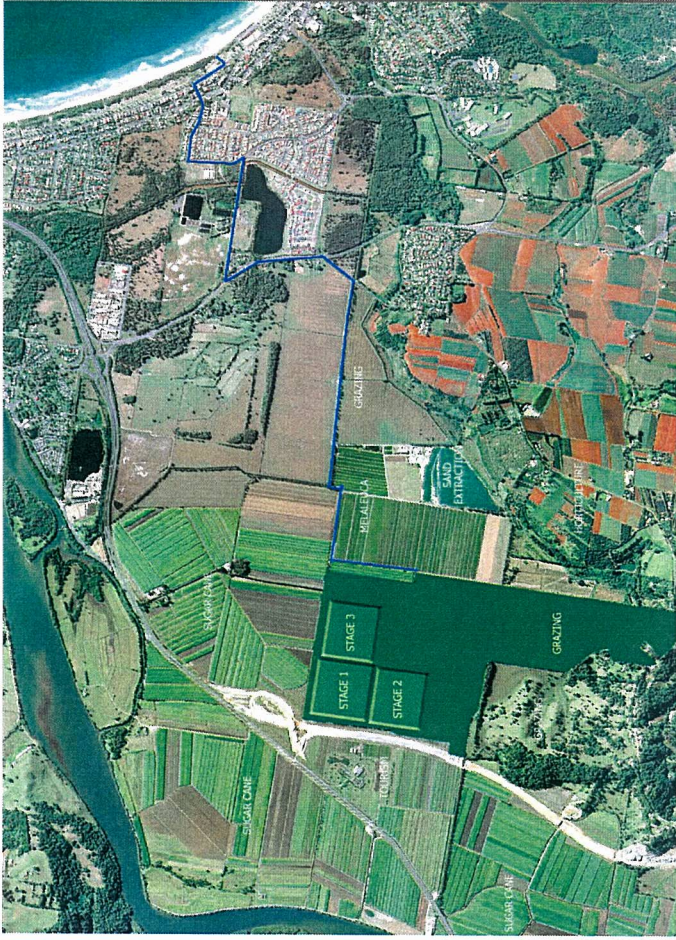


Photo 1. View east from intersection on off ramp to entrance facility

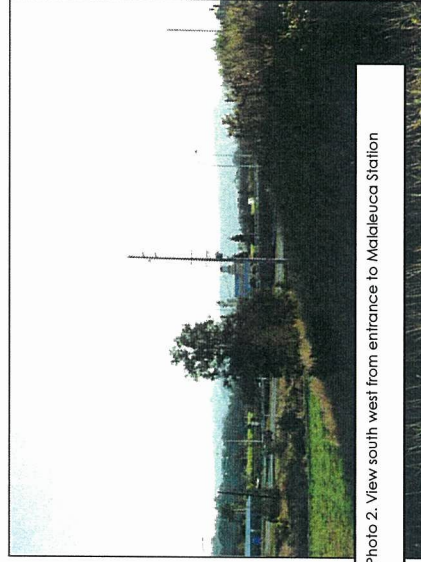


Photo 2. View south west from entrance to Matalauca Station

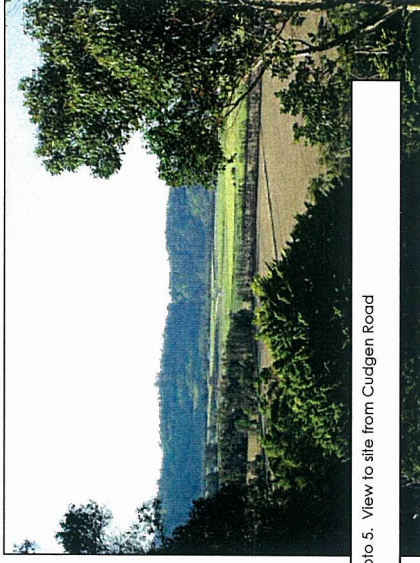


Photo 5. View to site from Cudgen Road

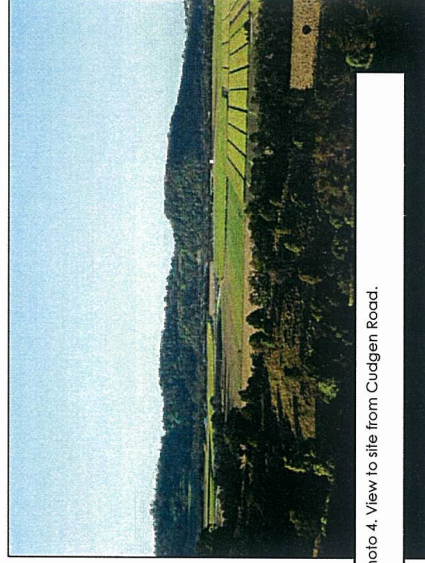


Photo 4. View to site from Cudgen Road.

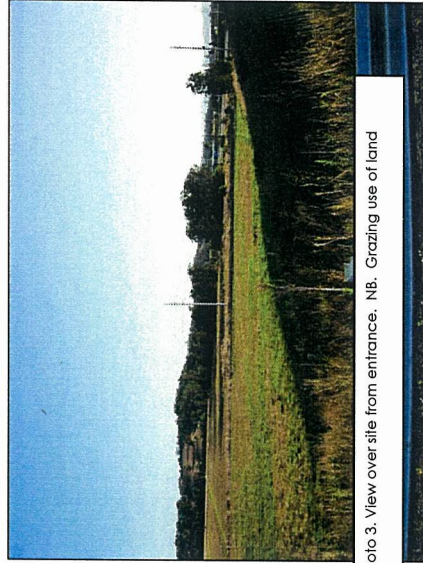
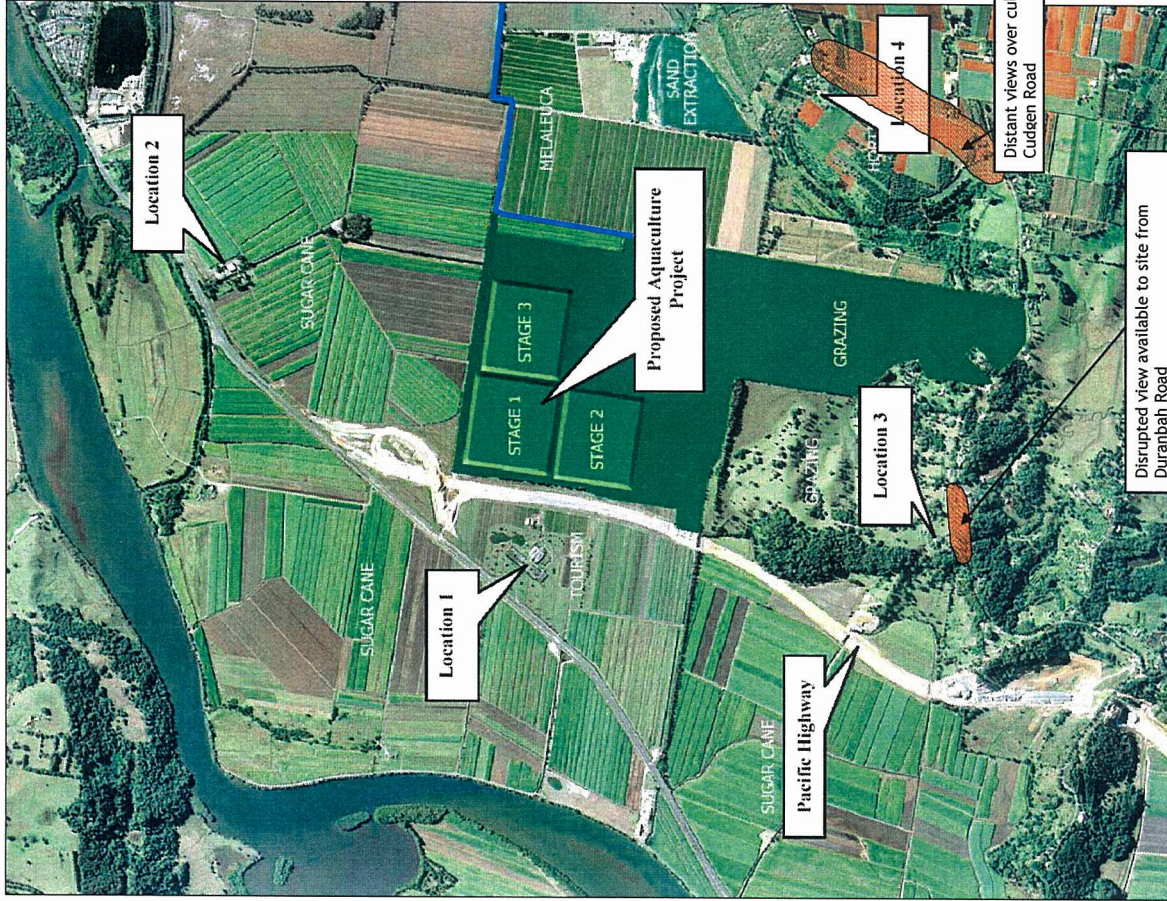


Photo 3. View over site from entrance. NB. Grazing use of land



- Location 1 - Melalucea Station (owner's residence) ~500 m
- Location 2 - Farmhouse ~1,260 m
- Location 3 - Residences (Cudgen Road) ~1,706 m
- Location 4 - Residences (Cudgen Road) ~1,780 m

VISUAL / LOCATIONAL CONTEXT - SHEET No.3



Buffer Planting Palette

Botanical Name		Common Name		Height	Spread	Notes
Type 1 (Vines)	Glycine clandestina	Twining Glycine / Twining Pea Vine	2.5m		Purple / pink hairy flowers	
	Pandorea jasminoides	Wonga Vine			Pale pink flowers , fruit eaten by wonga pigeons and other birds, also nesting for wrens, robins, fantails	
	Viola henderacea	Native Violet	5cm		White / mauve flowers	
Type 1 (Groundcovers)	Acrostichum speciosum	Mangrove fern				
	Actinotus helianthi	Flannel Flower	50 – 80cm	50cm	Silver grey foliage, creamy white daisy flower	
	Adiantum aethiopicum	Maiden hair fern				
	Adiantum hispidulum	Rough maiden hair	45cm		Young fronds are often pink and mature to green	
	Alpinia caerulea	Native ginger	2m		Clumping plant upright arching stems, having long fleshy green leaves. Small white flowers followed by blue fruits	

Botanical Name		Common Name	Height	Spread	Notes
Type 1 (Groundcovers)	Blechnum spp.	Fern	50cm		New foliage pink / red Species for use B. cartilagineum & indicum
	Dianella caerulea	Flax Lily	30cm	20cm	Clumping plant, flax like leaves, blue flowers followed by blue fruit
	Lomandra filiformis	Wattle Matrush	25cm		Stiff linear and tufting leaves, yellow globose wattle like flowers
	Lomandra hystrix	Creek Matrush	65cm		Dense heads of purple-flushed straw- yellow flowers Jul-Aug
	Lomandra longifolia	Common Mat rush	1m		Tussock forming, spiked flower spray
	Lomandra multiflora	Many flowered Matrush	75cm		Erect slender stems, branching sprays, flowers white / yellow
Botanical Name		Common Name	Height	Spread	Notes
Type 1 (Shrubs)	Acacia baueri		1m		Bright yellow flower clusters are globular small shrub for coastal areas
	Alectryon coriaceus	Beach Birds Eye	4 – 6m	2 – 3m	Glossy black seeds, in winter

Type 1 (Shrubs cont)				
Botanical Name	Common Name	Height	Spread	Notes
Baekea stenophylla	Weeping baeckea	1m	1m	
Banksia aemula	Wallum Banksia	3m		Robust large shrub, flowers usually cream or pale yellow
Banksia ericifolia var.ericifolia	Heath-leaved banksia	5m		Medium to large shrub, flowers orange in colour, good screen plant
Banksia oblongifolia	Dwarf Banksia	2m	1.5m	Recognised by the bright orange colour of new leaves, and later dense rusty hair that covers new growth.
Banksia robur	Swamp Banksia	2m	2m	Dense greenish-yellow flower heads
Banksia spinulosa var. collina		2m		Useful screen plant, flowers bright yellow which open in autumn and winter
Boronia falcifolia	Wallum boronia	75cm		Slender stems, flowers star-like appearance and are deep pink in colour and appear from spring through to mid summer

Type 1	Botanical Name		Common Name		Height	Spread	Notes
	Callistemon pachyphyllus		Wallum Bottlebrush		1 - 2m	1 - 2m	
(Shrubs cont)	Cordyline spp.		Palm Lily		5 –7m		Uncommon specie, red flowers in spring Cordyline congesta rare. Cordylines have deep, glossy green leaves, small white to purple flowers in winter and spring followed by red / purple berries
	Crinum pedunculatum		Swamp Lilly		2m	2m	Flowers, occurring from Spring – Autumn which are white
	Cyathea cooperi		Tree fern		10m		Large spreading leaves
	Hibiscus heterophyllus		Native Rosella		4 – 6m	2m	Large yellow white or pink flower
	Leptospermum flavescens		Wild May		3m	2m	Compact medium sized shrub, late spring early summer mass of white flowers
	Leptospermum petersonii		Lemon Scented Tea-tree		5m	2.5m	Masses of white flowers spring to summer
	Melaleuca thymifolia		Thyme-leaf Honey-myrtle		1m	1m	Pale purple flowers late spring to autumn, cultivars also suitable

Botanical Name		Common Name	Height	Spread	Notes
Type 1 (Shrubs cont)	<i>Myoporum floribundum</i>	Boobiala	3m	3m	Spring and summer masses of small white flowers
	<i>Omalthus natans</i>	Bleeding Heart	4m		Old leaves turn red, tiny green flowers, dwarf variety available
	<i>Photinia x fraseri</i>		3m		Exotic, new growth red, good hedge plant
	<i>Pittosporum revolutum</i>	Yellow Pittosporum	2.5m		Glossy leaves, yellow scented flowers in summer
	<i>Syzygium australe</i>		3 – 5m		
<i>Westringia fruticosa</i>		Native Rosemary	1 – 2m	1 – 2m	Dense foliage and sparse white flowers year-round
Botanical Name		Common Name	Height	Spread	Notes
Type 2 (Small to Medium Trees <10m	<i>Acmena smithii</i>	Creek Lilly Pilly	10m		New foliage is shiny dark red, grey-headed flying fox feeds on the blossoms and nectar and rose-crowned fruit dove are also attracted for food.
	<i>Acronychia littoralis</i>	Scented Acronychia	6m		Endangered, yellowish flowers during Winter to Summer, drupe, borne during Autumn to Winter.

Type 2 (Small to Medium Trees <10m)					Botanical Name	Common Name	Height	Spread	Notes
					<i>Banksia integrifolia</i>	Coast Banksia	8 m	3 – 4m	
					<i>Banksia serrata</i>	Saw Banksia	10m		
					<i>Callistemon salignus</i>	White Bottle Brush	5 – 10m		New growth pink, white to cream flowers
					<i>Diplogottis cunninghamii</i>	Native Tamarind	10m		Fruits eaten by birds (pigeon and orioles) and with fruit bats or flying foxes.
					<i>Elaeocarpus obovatus</i>	Hard Quandong	5 – 8m	3 – 5m	small bushy tree with white bell-shaped flowers and bird attracting blue fruit
					<i>Elaeocarpus reticulatus</i>	Blueberry Ash	4 – 6m	2 – 3m	Fragrant white or pink, lacy, bell-shaped flowers in profusion, followed by blue berries
					<i>Endiandra sieberi</i>	Corkwood	6 -10m	3 – 5m	Dense habit and ridged, corky bark, new growth deep red. large, glossy black fruits, attractive to birds.
					<i>Evodiella muelleri</i>	Little Evodia	5m		Attractive foliage and clusters of pink flowers
					<i>Guioa semiglauc</i>	Guioa	5 – 8m	3 – 4m	Yellow green flowers

Botanical Name		Common Name	Height	Spread	Notes
Type 2 (Small to Medium Trees <10m)	Hibiscus tiliaceus	Cottonwood	10m	8m	Large heart shaped leaves, flowers yellow with crimson center most of the year particularly summer
	Jagera pseudorhus	Foambark	8 m		Small tree, finely toothed leaflets
	Medicosma cunninghamii	Pinkheart	6 – 8m		Large creamy flowers, used by a variety of birds (eg scrub wrens, yellow robins) and bats (eg hoary bats, little bent wing bats) which forage for insects
	Synoum glandulosum	Scentless Rosewood	4 – 10m		Cream flowers, attracts insectivorous birds
	Syzygium luehmannii	Small leaved Lillypilly	7m		New growth pink / red
Botanical Name		Common Name	Height	Spread	Notes
Type 3 Medium to Large trees and palms > 10m	Acmena hemilampra	White Lilly Pilly / Blush Satinash	10 –15m		Fruits late winter spring, fruit eaten by Grey Flying fox
	Alphitonia excelsa	Red Ash	25m	5m	Cream flowers

Botanical Name		Common Name	Height	Spread	Notes
Type 3 Medium to Large trees and palms > 10m	<i>Araucaria cunninghamii</i>	Hoop Pine	20 – 50m		
	<i>Archontophoenix cunninghamiana</i>	Bangalow Palm	25m	3 – 6m	
	<i>Brachychiton discolor</i>	Lacebark	15 – 30m		Deciduous to part deciduous whilst flowering late spring to summer, large pink flowers
	<i>Casuarina glauca</i>	Swamp Oak	10 – 15m		
	<i>Callitris glaucophylla</i> (was <i>C. columellaris</i>)	Bribe Island Pine	20m		Dark furrowed bark, dark green foliage
	<i>Commersonia bartramia</i>	Brown Kurrajong	12m		Abundant creamy-white flowers in summer
	<i>Cryptocarya obovata</i>	White Wallnut	25 – 40m		Fruit eaten by frugivore bats and birds
	<i>Cryptocarya triplinervis</i>	Three Veined Laurel	12m		Dense crown of dark green leaves, flowers spring / summer
	<i>Cupaniopsis anacardioides</i>	Tuckeroo	15m		Autumn / winter flowers, fruit ripening summer
	<i>Gevillea robusta</i>	Silky Oak	25 – 35m		Orange yellow flowers conspicuous in mid spring

Botanical Name		Common Name	Height	Spread	Notes
Type 3 Medium to Large trees and palms > 10m	Glochidion spp	Cheese Tree	10 – 15m		Bushy trees with spreading crown of smooth shining leaves
	Harpullia pendula	Tulipwood	15 – 25m		Lavea of the cornelian butterfly feed on the seeds
	Gevillea robusta	Silky Oak	25 – 35m		Orange yellow flowers conspicuous in mid spring
	Livistonia australis	Cabbage Tree Palm	25m		
	Lophostemon confertus	Brush box	25m	5 – 15m	Good shade tree, flowers, white flowers in summer
	Melaleuca quinquervia	Broad leaf Paperbark	20m		White / cream flowers late summer to early winter, flowers attract insects, birds and bats
	Melicope elleryana	Pink Euodia	12 – 20m	10 – 15m	Mass pale pink flowers in summer
	Stenocarpus sinuatus	Firewheel tree	10 –20m		Attractive tree, up to 10yrs to flower
	Syzygium luehmannii	Small leaved Lillypilly	7m		New growth pink / red
	Tristaniopsis laurina	Water gum	10 –15m		Yellow flowers summer
Eucalytus robusta	Swamp Mahogany	30m			
Lophostemon suaveolens	Swamp Turpentine	15-36m			

Planting Densities

The following densities are proposed for a typical 10m x10m (100m²) planting module:

Type 1 - 1 per 1m²

Pot size at time of planting 140mm - 200mm

Type 2 - 1 per 10m²

Pot size at time of planting 25L - 45 L

Type 3 - 1 per 30 m²

Pot size at time of planting 45 - 100L

A variety of species are proposed to provide variety/diversity in the buffer.

APPENDIX I

- SOCIO ECONOMIC CHECKLIST

TWEED SHIRE COUNCIL - ASSESSMENT OF SOCIAL AND ECONOMIC IMPACT OF DEVELOPMENTS
CHECKLIST OF SOCIAL AND ECONOMIC ISSUES

	ECONOMIC IMPACT	CRITERIA	EFFECT			
			POSITIVE	UNCERTAIN/NEUTRAL	NEGATIVE	NET TOTAL
1	Economic Impacts	Increases or decreases retail and other services within the local area Increases or decreases facilities within the local area Better uses or makes redundant existing infrastructure Impact on existing economic land uses (commercial, tourism etc) Improves or reduces access to employment Increases or decreases long term jobs (temporary or permanent) Impact on skills/education Safeguards or threatens existing jobs	Yes			
2	Employment	Improves or reduces access to employment Increases or decreases long term jobs (temporary or permanent) Impact on skills/education Safeguards or threatens existing jobs	Yes			
3	Additional Information for Industrial, Commercial or Retail developments	Jobs created directly from the development • Construction Phase • Ongoing Operation Investment in the development • Construction (excluding land value) • Local Investment	Yes - 70 jobs in stage 1 through to 200 at stage 3. Approx 30 jobs during construction.			
	SOCIAL IMPACT	CRITERIA	EFFECT			
			POSITIVE	UNCERTAIN/NEUTRAL	NEGATIVE	NET TOTAL
4	Community Networks	Provides or reduces facilities or opportunities for social interaction Improves or reduces community identity and cohesion Improves or reduces existing residential amenity Creates or removes physical barriers between homes and community facilities Impacts on disadvantaged social groups Benefits or displaces disadvantaged groups Consolidates or dislocates existing social or cultural networks	Yes			

5	Public Realm	Safeguards or threatens heritage sites or buildings, or archaeological sites Makes available/enhances or detrimental to public places/open space Provides or displaces public facilities Avoids or exhibits overdevelopment/large scale buildings Significant positive or negative public response in submissions/ meetings Increases or decreases housing stock Increases or decreases stock of low income housing, or its affordability Increases or decreases housing rental averages Increases or decreases choice in housing Increases or decreases provision of special needs housing Increases or decreases the social mix of residents in the area	Yes				
6	Housing		Yes				
	COMMUNITY INFRASTRUCTURE	CRITERIA	EFFECT				
			POSITIVE	UNCERTAIN/NEUTRAL	NEGATIVE	NET TOTAL	
7	Human Service Facilities	Increases or decreases supply of: - community support/welfare services - child care, health or educational services - special services for high need/disadvantaged groups Decreases or increases demand for: - community support/welfare services - child care, health or educational services - special services for high need/disadvantaged groups Increases or decreases in the choice of local shopping facilities Increases or decreases local recreation or leisure facilities		Yes			
8	Access	Decreases or increases distance from homes to local community facilities and services Improves or reduces public transport services or access to such services Improves or reduces disabled access to local facilities Improves or reduces access by cycle to local facilities Improves or reduces pedestrian access to local facilities		Yes			
			Total	Total	Total	Net Total	

APPENDIX J

- GEOTECHNICAL REPORT



Douglas Partners

Geotechnics • Environment • Groundwater

**REPORT on
PRELIMINARY GEOTECHNICAL AND
ACID SULFATE SOILS INVESTIGATION**

**PROPOSED BAY LOBSTER AQUACULTURE PROJECT
355 CUDGEN ROAD, CUDGEN, NSW**

prepared for
AUSTRALIAN FRESH CORPORATION PTY LTD

**Project 33579
3 September 2004**

Douglas Partners Pty Ltd
ABN 75 053 980 117

439 Montague Road
West End Qld 4101
Australia

Phone (07) 3237 8900
Fax: (07) 3237 8999
brisbane@douglaspartners.com.au



TABLE OF CONTENTS

	<u>Page No.</u>
1.0 INTRODUCTION	1
2.0 SITE DESCRIPTION	1
3.0 GEOLOGY	2
4.0 FIELD WORK METHODS	2
5.0 FIELD WORK RESULTS	2
6.0 LABORATORY TESTING	3
6.1 Geotechnical Laboratory Tests	3
6.2 ASS Testing	4
7.0 PROPOSED DEVELOPMENT	6
8.0 COMMENTS	7
8.1 Appreciation of Ground Conditions	7
8.2 Pond Excavation	7
8.3 Acid Sulfate Soils	7
8.3.1 Criteria for Evaluation of Test Data	7
8.3.2 Presence of ASS	8
8.4 Filling Procedures	9
8.5 Flood Retention	9
8.6 Upper Level Footings and Settlement Estimates	10
8.7 Ground Improvement	11
8.8 Pavements	11

Attachments

Drawing 1 – Test Location Plan

Appendix A – Test Bore Report Sheets (Nos. 1 to 10)

 Cone Penetration Test Report Sheets (CPTs 11 to 14)

 Notes Relating to This Report

Appendix B – Laboratory Report Sheets

 Chain of Custody Documentation

REPORT ON
PRELIMINARY GEOTECHNICAL AND ACID SULFATE SOILS INVESTIGATION
PROPOSED BAY LOBSTER AQUACULTURE PROJECT
355 CUDGEN ROAD, CUDGEN, NSW

1.0 INTRODUCTION

This report details the results of a preliminary geotechnical and acid sulfate soils (ASS) investigation carried out for the proposed 'Bay Lobster Aquaculture Project' to be located at 355 Cudgen Road, Cudgen. The work was performed for Australian Fresh Corporation Pty Ltd, at the request of David McPhee and Associates, consulting engineers for the project.

The scope of work comprised four static cone penetration tests (CPTs), the drilling of ten test bores, logging and sampling, followed by analytical and geotechnical laboratory testing, engineering evaluation, analysis and reporting.

The objective of the work was to provide the following information as set out in the revised Douglas Partners Pty Ltd (DP) proposal P206.04 dated 28 July 2004 to Australian Fresh Corporation:

- subsurface conditions encountered, including groundwater observations;
- indicative presence or otherwise of ASS;
- suitability of excavated material for re-use as fill;
- indicative settlements;
- suitable ground improvement options (if required); and
- suitable foundation type(s).

2.0 SITE DESCRIPTION

The site is located at 355 Cudgen Road, Cudgen and comprises Lots 706, 708 to 710 on DP1000580, Lot 1 on DP267742 and Lot 1 on DP578963 in the Parish of Cudgen. The site is bounded to the north, east, south and south-west by other rural farm land, and to the north-west by a melaleuca station (refer Drawing 1). The Pacific Highway/Murwillumbah overpass exit is located immediately north-west of the site boundary. The site has a plan area of approximately 120 hectares, and at the time of the field work, was covered with mature sugarcane crops and cleared cane fields.

Ground surface levels, as indicated on the survey plan supplied by the client, vary between approximately 0.4m and 1.4m AHD. At the time of the field work, the variation in ground surface levels was not obvious due to the presence of the sugarcane.

3.0 GEOLOGY

Reference to the Geological Survey of Queensland's 1:250,000 Tweed Heads Sheet indicates the site may be underlain by Quaternary Alluvium typically comprising "*river gravels, alluvium, sand and clay*".

Reference to the Soil Conservation Service of New South Wales' Acid Sulphate Risk Maps, Cudgen and Tweed Heads, indicates the site to be located within an area of high probability of occurrence of ASS material within the soil profile and in an environment where deposition has been suitable for the formation of ASS materials.

4.0 FIELD WORK METHODS

The field work was undertaken between 11 and 25 August 2004 and comprised the drilling of ten test bores (designated Bores 1 to 10) and four CPTs (designated CPTs 11 to 14). The test locations are indicated on Drawing 1 attached and were measured using a hand-held Garmin GPS72.

The test bores were undertaken using a trailer-mounted drilling rig with 100mm diameter solid flight augers. The bores were drilled to maximum depths of 4m with disturbed samples generally recovered at 0.5m depth intervals for visual and tactile assessment, ASS screening tests and for geotechnical testing. Samples intended for ASS testing were double-wrapped in zip-lock bags and plastic, and kept on ice for transfer to the laboratory.

In the CPT test, a 35mm diameter cone with a following 135mm long friction sleeve is attached to rods of the same diameter and pushed continuously into the soil by hydraulic thrust provided by DP's specialist in-house ballasted cone truck. Strain gauges in the cone and sleeve measure resistance to penetration, and the results are displayed on a digital monitor and stored on computer disk for later plotting.

All field work was undertaken in the presence of an experienced geotechnical engineer who set out the test locations, supervised the drilling and testing, recovered disturbed samples, prepared descriptive logs of the materials encountered, operated the CPT computer, processed the test results (including inferred strata descriptions), dipped the test holes on completion, and conducted the field screening tests.

5.0 FIELD WORK RESULTS

The subsurface conditions encountered in the bores and inferred in the CPTs are described in the test report sheets in Appendix A together with general notes which define the descriptive terms and classification methods used.

In summary, the subsurface conditions comprised '**sand, silty sand, and gravelly sand**' underlain by '**clayey silt/silty clay**' at depth, as further described below:

- **Sand and Silty Sand** – Encountered from ground level in all bores and inferred in all CPTs, the sand and silty sand was observed to be fine to medium grained and brown and grey. This was inferred from the CPTs to be loose to medium dense near the surface, grading to loose and very loose below 0.3m to 0.75m depth. The very loose to loose sand was inferred to increase in relative density to medium dense below 3.5m to 5.3m depth, and gradually increasing to dense or interbedded medium dense and dense.
- **Gravelly Sand** – Underlying the sand and silty sand, gravelly sand was generally inferred in the CPTs below depths of approximately 8.5m to 9.5m. The gravelly sand was inferred to be dense and very dense, locally medium dense, and was inferred to depths of between approximately 16.6m and 18.5m depth in CPTs 12 to 14. CPT 11 refused in the gravelly sand at a depth of 11.02m.
- **Clayey Silt/Silty Clay** – Inferred beneath the gravelly sand in CPTs 12 to 14, clayey silt/silty clay was encountered to the termination depths of CPTs 12 to 14 at between 20m and 25m depth. The clayey silt/silty clay was inferred to be of firm to stiff strength consistency.

Free groundwater was encountered in all the test bores on completion of drilling and in CPT 14 on withdrawal of the rods at depths of between 0.8m and 1.05m corresponding to RL 0.0m to RL -0.3m. It should be noted, however, that groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

6.0 LABORATORY TESTING

Laboratory testing comprised particle size distribution tests, ASS field screening tests and analytical Chromium Suite tests. Detailed report sheets are attached in Appendix B and the results are summarised and discussed in the following subsections.

6.1 Geotechnical Laboratory Tests

Geotechnical laboratory testing comprised particle size distribution tests, by wet sieve analysis, on eight samples of sand recovered from the test bores. The results are summarised in Table 1 below:

Table 1 – Summary of Particle Size Distribution

Bore Location	Depth (m)	Description	Gravel Fraction (2mm to 60mm)	Sand Fraction (60µm to 2mm)	Fines (<60µm)
1	0.4-0.5	Silty sand	0	58	42
1	1.4-1.5	Slightly silty sand	0	84	16
4	0.9-1.0	Slightly silty sand	0	84	16
4	2.9-3.0	Sand with some silt	0	94	6
6	0.4-0.5	Sand with some silt	0	90	10
6	2.4-2.5	Sand with a trace of silt	0	96	4
9	0.9-1.0	Sand with some silt	0	90	10
9	1.9-2.0	Sand with some silt	0	93	7

The results indicate the samples tested to be predominantly sand with varying silt content.

6.2 ASS Testing

Soil testing for ASS was carried out with reference to the QASSIT Guidelines¹. Initially eighty samples from the bores were screened by measurement of pH after the addition of distilled water (pH_F) and peroxide (pH_{FOX}). Based on the results of the screening tests, selected samples were subjected to more rigorous Chromium Suite analytical testing.

The results of the screening tests (pH_F and pH_{FOX}) are presented in Table 2 below, along with a summary of the results of Chromium Suite testing. The complete analytical results are attached in Appendix B, together with 'Chain of Custody Documentation'.

Table 2 – Results of Field Screening and Chemical Laboratory Testing

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH _F	pH _{FOX}	ΔpH	Reaction (1,2,3,4) * F **	Chromium Reducible Sulfur (S _{CR})	Total Actual Acidity (TAA)	Retained Acidity (NASS)	Calculated Acid Neutralising Capacity (ANC)	Net Acidity
Bore 1										
0.4-0.5	Sand	6.8	3.3	3.5	1	-	-	-	-	-
0.9-1.0	Sand	6.2	4.0	2.2	1	-	-	-	-	-
1.4-1.5	Sand	6.1	2.2	3.9	3F	-	-	-	-	-
1.9-2.0	Sand	6.7	1.9	4.8	3F	-	-	-	-	-
2.4-2.5	Sand	7.5	2.0	5.5	3F	-	-	-	-	-
2.9-3.0	Sand	6.7	2.0	4.7	3F	-	-	-	-	-
3.4-3.5	Sand	7.0	2.1	4.9	3F	-	-	-	-	-
3.9-4.0	Sand	5.9	2.1	3.8	3F	-	-	-	-	-
Bore 2										
0.4-0.5	Silty Sand	6.7	4.2	2.5	1	-	-	-	-	-
0.9-1.0	Silty Sand	7.3	2.3	5.0	2F	-	-	-	-	-
1.4-1.5	Silty Sand	7.0	2.1	4.9	3F	-	-	-	-	-
1.9-2.0	Silty Sand	8.3	2.0	6.3	3F	-	-	-	-	-
2.4-2.5	Silty Sand	8.8	2.0	6.3	3F	-	-	-	-	-
2.9-3.0	Silty Sand	7.1	2.0	5.1	3F	-	-	-	-	-
3.4-3.5	Silty Sand	9.0	2.0	7.0	3F	-	-	-	-	-
3.9-4.0	Silty Sand	9.0	2.1	6.9	3F	-	-	-	-	-
Bore 3										
0.4-0.5	Silty Sand	4.6	2.5	2.1	2F	0.10	0.05	ND	ND	0.15
0.9-1.0	Silty Sand	4.1	2.1	2.0	2F	-	-	-	-	-
1.4-1.5	Silty Sand	5.6	2.2	3.4	3F	-	-	-	-	-
1.9-2.0	Silty Sand	4.9	2.4	2.5	4F	-	-	-	-	-
2.4-2.5	Silty Sand	6.7	2.1	4.6	4F	-	-	-	-	-
2.9-3.0	Silty Sand	6.6	2.0	4.6	3F	-	-	-	-	-
3.4-3.5	Silty Sand	7.4	2.1	5.3	4F	-	-	-	-	-
3.9-4.0	Silty Sand	7.8	2.1	5.7	4F	-	-	-	-	-

¹ Ahern, C R, Ahern, M R, and Powell, B, "Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998", QASSIT, Department of Natural Resources, Resources Sciences Centre, Indooroopilly, October 1998.

Table 2 – Results of Field Screening and Chemical Laboratory Testing (cont)

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH _F	pH _{FOX}	ΔpH	Reaction (1,2,3,4) * F **	Chromium Reducible Sulfur (S _{CR})	Total Actual Acidity (TAA)	Retained Acidity (NASS)	Calculated Acid Neutralising Capacity (ANC)	Net Acidity
Bore 4										
0.4-0.5	Sand	4.7	3.2	2.5	2F	-	-	-	-	-
0.9-1.0	Sand	5.4	2.4	3.0	2F	-	-	-	-	-
1.4-1.5	Sand	6.5	1.9	4.6	4F	-	-	-	-	-
1.9-2.0	Sand	6.2	1.9	4.3	3F	0.25	<0.02	ND	ND	0.25
2.4-2.5	Sand	7.0	1.9	5.1	4F	0.25	<0.02	ND	ND	0.25
2.9-3.0	Sand	6.8	1.9	4.9	4F	-	-	-	-	-
3.4-3.5	Sand	7.2	2.0	5.2	3F	-	-	-	-	-
3.9-4.0	Sand	7.1	2.0	5.1	3F	0.14	<0.02	ND	ND	0.14
Bore 5										
0.4-0.5	Silty Sand	5.3	2.8	2.5	1F	-	-	-	-	-
0.9-1.0	Silty Sand	6.4	1.8	3.6	2F	0.03	<0.02	ND	ND	0.27
1.4-1.5	Silty Sand	6.2	2.1	4.1	3F	-	-	-	-	-
1.9-2.0	Silty Sand	6.2	2.1	4.1	3F	-	-	-	-	-
2.4-2.5	Silty Sand	6.8	2.0	4.8	4F	-	-	-	-	-
2.9-3.0	Silty Sand	6.7	2.0	4.7	3F	-	-	-	-	-
3.4-3.5	Silty Sand	6.7	2.0	4.7	4F	-	-	-	-	-
3.9-4.0	Silty Sand	7.2	2.3	4.9	4F	-	-	-	-	-
Bore 6										
0.4-0.5	Sand	6.8	3.9	2.9	1F	-	-	-	-	-
0.9-1.0	Sand	6.6	2.5	4.1	1F	-	-	-	-	-
1.4-1.5	Sand	6.8	2.0	4.8	1F	-	-	-	-	-
1.9-2.0	Sand	7.8	2.1	5.7	2F	-	-	-	-	-
2.4-2.5	Sand	7.5	2.4	5.1	3F	-	-	-	-	-
2.9-3.0	Sand	7.6	2.3	5.3	4F	-	-	-	-	-
3.4-3.5	Sand	7.4	2.8	4.6	4F	-	-	-	-	-
3.9-4.0	Sand	7.9	2.7	5.2	4F	-	-	-	-	-
Bore 7										
0.4-0.5	Silty Sand	5.7	2.5	3.2	1	-	-	-	-	-
0.9-1.0	Silty Sand	6.4	2.6	3.8	4F	-	-	-	-	-
1.4-1.5	Silty Sand	6.6	1.8	4.8	3F	0.25	0.02	ND	ND	0.27
1.9-2.0	Silty Sand	6.6	2.0	4.6	4F	-	-	-	-	-
2.4-2.5	Silty Sand	6.8	2.0	4.8	2F	-	-	-	-	-
2.9-3.0	Silty Sand	7.2	1.9	5.3	3F	0.20	<0.02	ND	ND	0.20
3.4-3.5	Silty Sand	7.0	2.0	5.0	4F	-	-	-	-	-
3.9-4.0	Silty Sand	6.8	2.0	4.8	4F	-	-	-	-	-
Bore 8										
0.4-0.5	Silty Sand	5.6	3.3	2.9	1	-	-	-	-	-
0.9-1.0	Silty Sand	5.6	3.1	2.5	1	-	-	-	-	-
1.4-1.5	Silty Sand	5.8	1.9	3.9	2F	-	-	-	-	-
1.9-2.0	Silty Sand	6.2	2.0	4.2	2F	-	-	-	-	-
2.4-2.5	Silty Sand	6.2	2.1	4.1	3F	-	-	-	-	-
2.9-3.0	Silty Sand	6.5	2.1	4.4	4F	-	-	-	-	-
3.4-3.5	Silty Sand	6.3	2.1	4.2	4F	-	-	-	-	-
3.9-4.0	Silty Sand	6.2	2.1	4.1	4F	-	-	-	-	-

Table 2 – Results of Field Screening and Chemical Laboratory Testing (cont)

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH _F	pH _{FOX}	ΔpH	Reaction (1,2,3,4) * F **	Chromium Reducible Sulfur (S _{CR})	Total Actual Acidity (TAA)	Retained Acidity (NASS)	Calculated Acid Neutralising Capacity (ANC)	Net Acidity
Bore 9										
0.4-0.5	Sand	5.4	2.9	2.5	1F	-	-	-	-	-
0.9-1.0	Sand	5.9	2.2	3.7	2F	-	-	-	-	-
1.4-1.5	Sand	4.4	1.9	2.5	3F	-	-	-	-	-
1.9-2.0	Sand	6.1	2.1	3.5	4F	-	-	-	-	-
2.4-2.5	Sand	6.3	2.0	4.3	4F	-	-	-	-	-
2.9-3.0	Sand	4.0	2.2	1.8	4F	-	-	-	-	-
3.4-3.5	Sand	6.2	2.0	4.2	4F	0.15	<0.02	ND	ND	0.15
3.9-4.0	Sand	6.5	2.0	4.5	4F	-	-	-	-	-
Bore 10										
0.4-0.5	Silty Sand	6.3	2.6	3.7	1F	<0.02	<0.02	ND	ND	<0.02
0.9-1.0	Silty Sand	6.5	1.8	4.7	3F	0.18	<0.02	ND	ND	0.18
1.4-1.5	Silty Sand	6.6	1.8	4.8	4F	-	-	-	-	-
1.9-2.0	Silty Sand	6.5	2.0	4.5	3F	-	-	-	-	-
2.4-2.5	Silty Sand	6.9	2.0	4.9	4F	-	-	-	-	-
2.9-3.0	Silty Sand	6.7	2.0	4.7	4F	-	-	-	-	-
3.4-3.5	Silty Sand	8.0	2.6	5.4	2F	-	-	-	-	-
3.9-4.0	Silty Sand	7.2	2.7	4.5	4F	-	-	-	-	-

Notes:

* 1 – denotes slight effervescence; 2 – denotes moderate reaction; 3 – denotes vigorous reaction; 4 – denotes very strong effervescence accompanied by escape of gas/heat

** F – indicates a bubbly/frothy reaction (organics)

ND – not determined

7.0 PROPOSED DEVELOPMENT

At the time of reporting, it was understood that the proposed layout of the development had not been finalised and that an additional two stages may be undertaken. It was also understood from the client's brief that Stage 1 of the aquaculture facility site may comprise:

- 75,000 square metres of greenhouse style buildings;
- a 2,000 square metre processing building of possible concrete tilt panel construction;
- a small office building and amenities block; and
- internal roads and carparking pavements.

It is understood that filling is required to raise the site for flood reasons, with the construction of an additional perimeter flood bund to RL 3.7m. It is further understood that the filling is proposed to be won from site by excavating subsurface materials in the vicinity of the test bores (refer Drawing 1).

No structural loadings were provided at the time of reporting.

8.0 COMMENTS

8.1 Appreciation of Ground Conditions

The results of the preliminary geotechnical and ASS investigation indicate the subsurface conditions to generally comprise sandy soils which are very loose to loose in approximately the upper 3.5m to 5.5m and contain ASS. The groundwater was encountered at approximately 0.8m to 1.05m depth below present ground surface levels (ie. RL 0.0 m to RL -0.2m).

These conditions pose the following potential problems for development at this site:

- Potential for upper level footings to undergo excessively high settlement in the very loose to loose sands.
- The predominantly sand material may unravel during trafficking and may require the use of track-mounted equipment or an imported coarse granular bridging layer.
- The presence of very loose sands at shallow depth close to and below the water table would make trafficability and support of heavy equipment difficult within excavations unless drag-line equipment or equivalent was utilised.
- The predominantly sandy material proposed to be used in bund construction is relatively permeable.
- The presence of ASS, which when exposed by excavation, will require treatment prior to disposal off-site or re-use as engineered filling on site.

The above points are discussed in the sections below.

8.2 Pond Excavation

It is understood that excavation is proposed to an average depth of RL -2.5m AHD at the mid-eastern side of the site, to win material for engineered filling beneath the proposed aquaculture facility. Excavation of the generally sandy materials should be readily achieved using hydraulic equipment; however, the presence of a shallow groundwater table may cause trafficability problems, requiring the use of tracked vehicles or a dragline. The groundwater table may need to be locally drawn down in order to facilitate excavation. On completion of pond excavation, due to the sandy nature of the soils, the groundwater would be anticipated to return to equilibrium levels quite quickly.

8.3 Acid Sulfate Soils

8.3.1 Criteria for Evaluation of Test Data

The criteria on which the results of screening tests (pH_F and pH_{FOX}) were assessed as indicative of possible actual acid sulphate soils (AASS) or potential acid sulphate soils (PASS) were based on the QASSIT Guidelines as follows:

- $\text{pH}_F < 4$ indicates oxidation has occurred in the past and that AASS is present. The screening test results were at or above pH 4.0.
- $\text{pH}_{\text{FOX}} < 3$, plus a pH_{FOX} reading at least one pH unit below pH_F , plus a strong reaction with peroxide, strongly indicates the presence of PASS. This condition was encountered in seventy-three of the eighty samples, generally at or below approximately 0.5m depth.

The above criteria were used to select samples for quantitative laboratory analysis of ASS by the Chromium Suite of tests. In addition, samples with the lowest pH_{FOX} were generally selected for analytical testing.

The action criterion from the Chromium Suite of tests which triggers a requirement for ASS disturbance to be managed, was derived from the Soil Management Guidelines² and the Laboratory Methods Guidelines 2003³ as follows:

- net acidity = (SCR + TAA + NASS – ANC) of greater than or equal to 0.03% Sulfur for sand and clay soils.

The above threshold is for greater than 1,000 tonnes of soil to be disturbed.

The action criterion was exceeded in nine out of the ten samples submitted for Chromium Suite testing. It is thus concluded that a management plan is required to reduce the risk of environmental impact from oxidation of PASS during excavation and placement of filling for raising the site and flood mitigation works.

8.3.2 Presence of ASS

presumably being determined from this

The results of limited Chromium Suite testing and comparison with the action plan criteria indicate that AASS are present at the site. The results of the tests indicate a variation in net acidity from $<0.02\%$ to 0.27% Sulfur. Based on limited tests conducted at random depths within the top 4m of sand, it is suggested that spoil excavated from the site and sand batters exposed on cuts above the water table, will require to be neutralised at a rate of 12kg of lime per tonne. Assuming an overall placed density of approximately 1.5 to 1.7 tonnes/ m^3 , this equates to a lime application rate of up to approximately 18 to 21 kg/ m^3 . ✓

It should be noted that the ASS investigation is preliminary and that further sampling, screening and testing is required (with reference to QASSIT Guidelines) to confirm liming rates and management procedures.

² Dear, S E, Moore, N G, Dobos, S K, Watling, K M, and Ahern, C R, "Soil Management Guidelines" in "Queensland Acid Sulfate Soil Technical Manual", Department of Natural Resources and Mines, Indooroopilly, November 2002.

³ Ahern, C R, Sullivan, L A, and McElnea, A E "Laboratory Methods Guidelines 2003 – Acid Sulfate Soils" in "Queensland Acid Sulfate Soil Technical Manual", Department of Natural Resources and Mines, Indooroopilly, August 2003.

8.4 Filling Procedures

It is understood that the ground surface level beneath the propose aquaculture facility is to be raised from the existing variable level (RL 0.6m to RL 1.0m) to approximately RL2.6m AHD. Thus the existing surface is to be raised by up to 2m using sand won from site.

Approved sand filling from the borrow area should be placed in layers not exceeding 300mm 'loose' thickness, with each layer compacted to a minimum density index of at least 75% to 80%. This is in order to minimise settlement of the filling during subsequent loading from structures and footings.

It is recommended that full-time 'Level 1' testing supervision be provided for all filling, in accordance with AS 3798-1996⁴, where the filling is to be subjected to shallow footing loads.

Due to the presence of loose sands beneath the site, it should be recognised that some settlement will be induced in the foundation soil due to placement of filling and again once structural loads are placed on the filling. If the amount of such settlement is not tolerable, then either the subgrade ground should be densified (refer Section 8.7 below) or else the structures supported on piles bearing below the loose sands on medium dense or dense sands.

It is recommended that the base of any pad or strip footing excavation be finished by hand tools and compacted by either rammer, plate vibrator or other appropriate hand-guided equipment to negate the loosening and unravelling effects of the earthmoving machinery, such as excavator/backhoe bucket teeth.

Any additional filling brought on site to raise levels and supplement the existing reworked filling should be inspected by a geotechnical engineer for consistency with the assumptions made in this report. Any imported filling must also be sampled and tested to verify the presence of any ASS and requirements for additional liming (if required).

8.5 Flood Retention

It is understood that flood retention bunds are proposed to be constructed around the aquaculture facility to prevent inundation under flood conditions. Information relating to potential flood levels and flood regression rates, was not provided for the preparation of this preliminary report.

It is therefore difficult to be quantitative about bund seepage. It should be recognised, however, that the on-site sand soils (both borrow and foundation soils) are likely to exhibit relatively high permeability of approximately 10^{-3} m/s to 10^{-5} m/s. This is based on a very approximate empirical approach based on particle size distributions. For the optimistic (lowest) permeability of this estimated range, a 1m high bund with a 1m wide crest would be anticipated to have a full head of flood water seep through in only a day or so. Similarly, for a 3m head and 3m wide crest, the seepage time would increase to about 10 days. These times would decrease one hundred fold, however, for permeabilities at the highest end of the estimated range.

⁴ Australian Standard AS 3798-1996 "Guidelines on Earthworks for Commercial and Residential Developments", Standards Association of Australia.

It follows that, for a protective bund built of such sand, the crest width would have to be very large to withstand seepage from even a short duration and low flood head against it.

If a suitable bund wall is to be constructed to retain flooding, it would probably be more cost effective to import clay from elsewhere, for either complete bund construction or to use as a central clay cut-off zone. A relatively deep clay cut-off trench, however, would also require to be included, in order to prevent water from seeping beneath the bund.

As an alternative to constructing a surrounding perimeter bund, it is suggested that consideration be given to raising the complete work area to RL 3.7m.

8.6 Upper Level Footings and Settlement Estimates

It is understood that proposed footings being considered for the facility are lightly loaded pad and/or strip footings and on grade slabs founded in the engineered fill. The choice of footing option will depend upon what is considered to be acceptable in terms of settlements due to the applied working loads and the depth and varying density of the foundation soils.

On the basis of the above comments, it is suggested that maximum allowable bearing pressures for upper level footings founded in engineered filling placed under 'Level 1' testing and supervision be designed for the following:

- 150kPa for strips, pads and thickened edge beams or slab thickenings; and
- 20kPa for slab panels.

The above is subject to site preparation being undertaken in accordance with Section 8.4 above and the settlement estimates discussed below being acceptable.

Elastic settlement estimates were calculated using an in-house program, *T-REX*, which models flexible loadings on a fully flexible multi-layered foundation. Subsequent adjustment for fully rigid load applications were performed (where appropriate) by hand calculations using standard theory, generally based on 80% of the flexible load at the centre of the footing.

It should be noted that settlement estimates for footings founded in filling are highly dependent on the quality of the filling materials and any variation in compaction within the filling with respect to depth and areal extent. It is strongly recommended that full-time 'Level 1' testing and supervision be undertaken during fill placement (in accordance with AS 3798-1996), in order to minimise the risk of differential settlement occurring over and above that generally estimated.

Due to the variability in thickness of the very loose to loose sand beneath the proposed fill platform (from approximately 3.5m thick to 5.3m thick), there is a potential for differential and tilting settlements.

The results of total settlement estimates are summarised in Table 3 below for rigid pads and flexible strip and flexible slab panels, for founding in 'controlled' engineered filling under various loadings, and assuming the very loose to loose sands are left in their present state of density. Some

settlement will, of course, be incurred due to loading imposed by placement of filling, but this occurs relatively quickly and is complete prior to footing construction.

Table 3 – Summary of Elastic Settlement Estimates

Load Application	Total Settlement (mm)
Slab Panel (20m by 5m), loaded to 20kPa	5 to 10
Long strip footing, 0.5m wide, loaded to 150kPa (ie. 75kN/m)	10 to 15
Long strip footing, 0.5m wide, loaded to 10kPa (ie. 5kN/m)	< 5
Long strip footing, 0.5m wide, loaded to 20kPa (ie. 10kN/m)	5 to 10
Rigid pad, 1m by 1m, loaded to 150kPa (ie. 150kN column load)	10 to 15
Rigid pad, 2m by 2m, loaded to 150kPa (ie. 600kN column load)	25 to 30

8.7 Ground Improvement

Should the settlement estimates in Section 8.6 above prove unfavourable, then options for reducing settlement of the underlying very loose to loose sands may include the following:

- pre-loading the foundation soils by placement of additional temporary fill at least equivalent in load to the applied load from the structures;
- compaction of the foundation soils by dynamic impact roller;
- dynamic consolidation of the foundation soils by application of a heavy weight dropped from a crane in a series of grids across the site.

Of these, the most cost effective may prove to be the use of an impact or “square” roller, provided by specialist contractors such as Broons or Landpac. As this is specialist equipment, the suppliers should be approached directly for applicability and performance at this site. It is claimed, however, by such suppliers, that significant improvement can be obtained in loose sands to depths of “at least 2m”.

8.8 Pavements

It is understood that filling at the site will be undertaken under ‘Level 1’ testing and supervision, and at this stage, the proposed filling material is to be sand won from site. Based on experience and published data, soaked subgrade California bearing ratio (CBR) values for sand are likely to be in excess of 10%. For preliminary design purposes, it is therefore suggested that a subgrade CBR value of 10% be adopted. This suggested design value is dependent upon the provision and maintenance of adequate surface and subsurface drainage, particularly where pavements abut irrigated landscaped or garden areas.

DOUGLAS PARTNERS PTY LTD

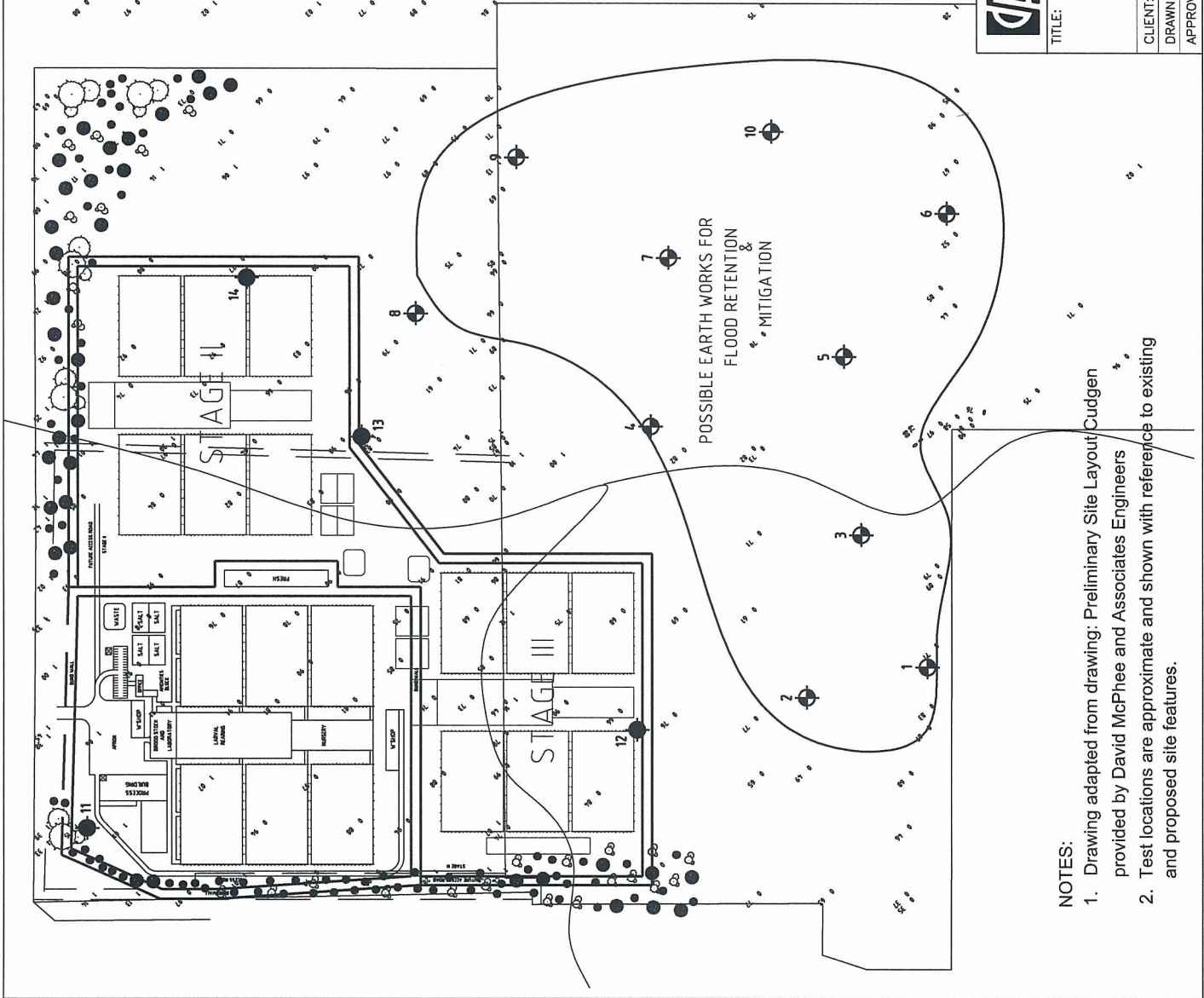
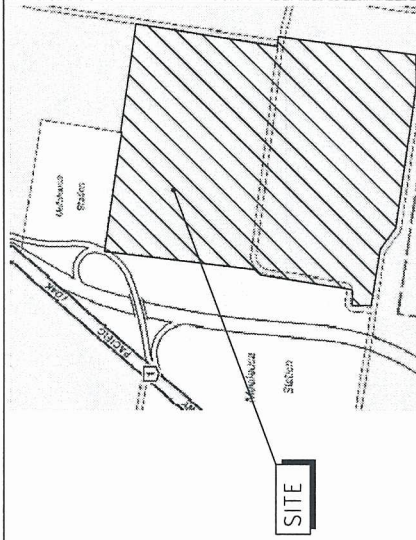


Chris Bell
Associate

Reviewed by:



Ken Boddie
Principal



NOTES:

1. Drawing adapted from drawing: Preliminary Site Layout/Cudgen provided by David McPhee and Associates Engineers
2. Test locations are approximate and shown with reference to existing and proposed site features.



Douglas Partners

Geotechnics Environment Groundwater

Sydney, Newcastle,
Brisbane, Melbourne,
Perth, Darwin

Townsville, Cairns
Wyong, Campbelltown,
Wollongong

TITLE: TEST LOCATION PLAN

PROPOSED BAY LOBSTER AQUACULTURE PROJECT
355 CUDGEN ROAD, CUDGEN

CUSTOMER:	AUSTRALIAN FRESH CORPORATION PTY LTD	OFFICE:	BRISBANE
DRAWN BY:	VTE	PROJECT NO:	33579
APPROVED BY:		DATE:	AUGUST 2004

APPENDIX A

***Test Bore Report Sheets (Nos. 1 to 10)
Cone Penetration Test Report Sheets (CPTs 11 to 14)
Notes Relating to This Report***

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 1
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.15	TOPSOIL - relatively loose, brown, silty, fine grained sand				
	SAND - relatively loose, light brown, slightly silty, fine grained sand				
		A	0.4		
			0.5		
1	- becoming grey	A	0.9		
			1.0		
		A	1.4		
			1.5		
2		A	2.0		
		A	2.4		
			2.5		
3		A	2.9		
			3.0		
		A	3.4		
			3.5		
4		A	3.9		
4.0	TEST BORE DISCONTINUED AT 4.0m		4.0		

RIG: Gemco HS7 **DRILLER:** Mapstone **LOGGED:** SAR **CASING:** not used
TYPE OF BORING: 100mm dia. solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 0.9m depth
REMARKS: 551938E, 6873072N

SAMPLING & IN SITU TESTING LEGEND

A Auger sample	PL Point load strength Is(50) MPa
B Bulk sample	S Standard penetration test
C Core drilling	U _x Tube sample (x mm dia.)
pp Pocket penetrometer (kPa)	V Shear vane (kPa)

CHECKED

Initials:

Date:



Douglas Partners
 Geotechnics • Environment • Groundwater

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.7m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 2
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
1	SILTY SAND - relatively loose, light yellow-brown and grey-brown silty, fine grained sand with a trace of clay				
		A	0.4 0.5		
		A	0.9 1.0		
2	SILTY SAND - relatively loose, grey, silty, fine grained sand				
		A	1.4 1.5		
		A	1.9 2.0		
3					
		A	2.4 2.5		
		A	2.9 3.0		
4					
		A	3.4 3.5		
		A	3.9 4.0		
	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7 **DRILLER:** Mapstone **LOGGED:** SAR **CASING:** not used
TYPE OF BORING: 100mm dia. solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 1.0m depth
REMARKS: 551926E, 6873216N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _x	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



Douglas Partners
Geotechnics • Environment • Groundwater

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 3
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: –

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
1	SILTY SAND - relatively loose, yellow-brown and grey-brown, silty, fine grained sand with a trace of clay				
		A	0.4 0.5		
		A	0.9 1.0		
1.1	SILTY SAND - relatively loose, grey-brown, silty, fine grained sand with some clay				
2		A	1.4 1.5		
		A	1.9 2.0		
3		A	2.4 2.5		
		A	2.9 3.0		
4		A	3.4 3.5		
		A	3.9 4.0		
4.0	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7 **DRILLER:** Mapstone **LOGGED:** SAR **CASING:** not used
TYPE OF BORING: 100mm dia. solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 0.9m depth.
REMARKS: 552101E, 6873123N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _s	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



Douglas Partners
 Geotechnics • Environment • Groundwater

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.9m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 4
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.2	TOPSOIL - relatively loose, brown, silty, fine grained sand				
	SAND - relatively loose, yellow-brown with orange-brown mottling, slightly silty, fine grained sand	A	0.4 0.5		
1.0	SAND - grey-brown, fine grained sand with some silt	A	0.9 1.0		
		A	1.4 1.5		
2.0		A	1.9 2.0		
		A	2.4 2.5		
3.0		A	2.9 3.0		
		A	3.4 3.5		
4.0	TEST BORE DISCONTINUED AT 4.0m	A	3.9 4.0		

RIG: Gemco HS7 **DRILLER:** Mapstone **LOGGED:** SAR **CASING:** not used
TYPE OF BORING: 100mm dia. solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 0.9m depth.
REMARKS: 552438E, 6873590N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength ls(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _x	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



Douglas Partners
Geotechnics • Environment • Groundwater

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 5
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
1	SILTY SAND - relatively loose, yellow-brown and grey-brown, silty, fine grained sand with some clay - becoming grey-brown with a trace to some clay				
		A	0.4		
			0.5		
		A	0.9		
			1.0		
		A	1.4		
			1.5		
2		A	1.9		
			2.0		
		A	2.4		
3			2.5		
		A	2.9		
			3.0		
		A	3.4		
4	TEST BORE DISCONTINUED AT 4.0m		3.5		
		A	3.9		
4.0			4.0		

RIG: Gemco HS7 **DRILLER:** Mapstone **LOGGED:** SAR **CASING:** not used
TYPE OF BORING: 100mm dia. solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 1.0m depth
REMARKS: 552308E, 6873109N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _x	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



Douglas Partners
Geotechnics • Environment • Groundwater

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.6m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 6
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.9	SAND - relatively loose, yellow-brown with orange-brown mottling, fine grained sand with some silt	A	0.4		
			0.5		
1	SAND - relatively loose, grey-brown, fine grained sand with a trace of silt	A	0.9		
			1.0		
		A	1.4		
			1.5		
2		A	1.9		
			2.0		
		A	2.4		
			2.5		
3		A	2.9		
			3.0		
		A	3.4		
			3.5		
4	TEST BORE DISCONTINUED AT 4.0m	A	3.9		
			4.0		

RIG: Gemco HS7 **DRILLER:** Mapstone **LOGGED:** SAR **CASING:** not used
TYPE OF BORING: 100mm dia. solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 0.8m depth
REMARKS: 552452E, 6872964N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _x	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



Douglas Partners
 Geotechnics • Environment • Groundwater

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 7
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.15	TOPSOIL - relatively loose, brown, silty, fine grained sand				
	SILTY SAND - relatively loose, yellow-brown with slight orange-brown mottling, silty, fine grained sand				
		A	0.4 0.5		
	- becoming grey-brown				
1		A	0.9 1.0		
		A	1.4 1.5		
2		A	1.9 2.0		
		A	2.4 2.5		
3		A	2.9 3.0		
		A	3.4 3.5		
4		A	3.9 4.0		
4.0	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7 **DRILLER:** Mapstone **LOGGED:** SAR **CASING:** not used
TYPE OF BORING: 100mm dia. solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 0.8m depth
REMARKS: 552454E, 6873291N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _x	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



Douglas Partners
Geotechnics • Environment • Groundwater

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 8
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.2	TOPSOIL - relatively loose, brown, silty, fine grained sand				
	SILTY SAND - relatively loose, yellow-brown with slight orange-brown mottling, silty, fine grained sand				
1	- becoming grey-brown	A	0.4		
			0.5		
		A	0.9		
			1.0		
2		A	1.4		
			1.5		
		A	1.9		
			2.0		
3		A	2.4		
			2.5		
		A	2.9		
			3.0		
4		A	3.4		
			3.5		
		A	3.9		
			4.0		
4.0	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7 **DRILLER:** Mapstone **LOGGED:** SAR **CASING:** not used
TYPE OF BORING: 100mm dia. solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 0.8m depth
REMARKS: 552438E, 6873590N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _x	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



Douglas Partners
 Geotechnics • Environment • Groundwater

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 1.0m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 9
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.15	TOPSOIL - relatively loose, brown, silty, fine grained sand				
	SAND - relatively loose, yellow-brown with orange-brown mottling, fine grained sand with some silt				
		A	0.4 0.5		
	- becoming grey-brown				
1		A	0.9 1.0		
		A	1.4 1.5		
2		A	1.9 2.0		
		A	2.4 2.5		
3		A	2.9 3.0		
		A	3.4 3.5		
4	TEST BORE DISCONTINUED AT 4.0m	A	3.9 4.0		

RIG: Gemco HS7 **DRILLER:** Mapstone **LOGGED:** SAR **CASING:** not used
TYPE OF BORING: 100mm dia. solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 0.8m depth
REMARKS: 552597E, 6873446N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _s	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



Douglas Partners
Geotechnics • Environment • Groundwater

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD
PROJECT: BAY LOBSTER AQUACULTURE PROJECT
LOCATION: 355 CUDGEN ROAD, CUDGEN

PROJECT No: 33579
SURFACE LEVEL: 0.8m*
DIP OF HOLE: 90°

BORE No: 10
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.3	TOPSOIL - relatively loose, brown and orange-brown, silty, fine grained sand				
	SILTY SAND - relatively loose, grey, silty, fine grained sand	A	0.4 0.5		
1		A	0.9 1.0		
		A	1.4 1.5		
2		A	1.9 2.0		
		A	2.4 2.5		
3		A	2.9 3.0		
		A	3.4 3.5		
4		A	3.9 4.0		
	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7 **DRILLER:** Mapstone **LOGGED:** SARq **CASING:** not used
TYPE OF BORING: 100mm dia. solid flight auger
WATER OBSERVATIONS: Free groundwater observed at 0.9m depth
REMARKS: 552578E, 6873150N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _s	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



Douglas Partners
 Geotechnics • Environment • Groundwater

CONE PENETRATION TEST

CLIENT: Australian Fresh Corporation Pty Ltd

PROJECT: Proposed Bay Lobster Aquaculture Project

LOCATION: 355 Cudgen Road, Cudgen

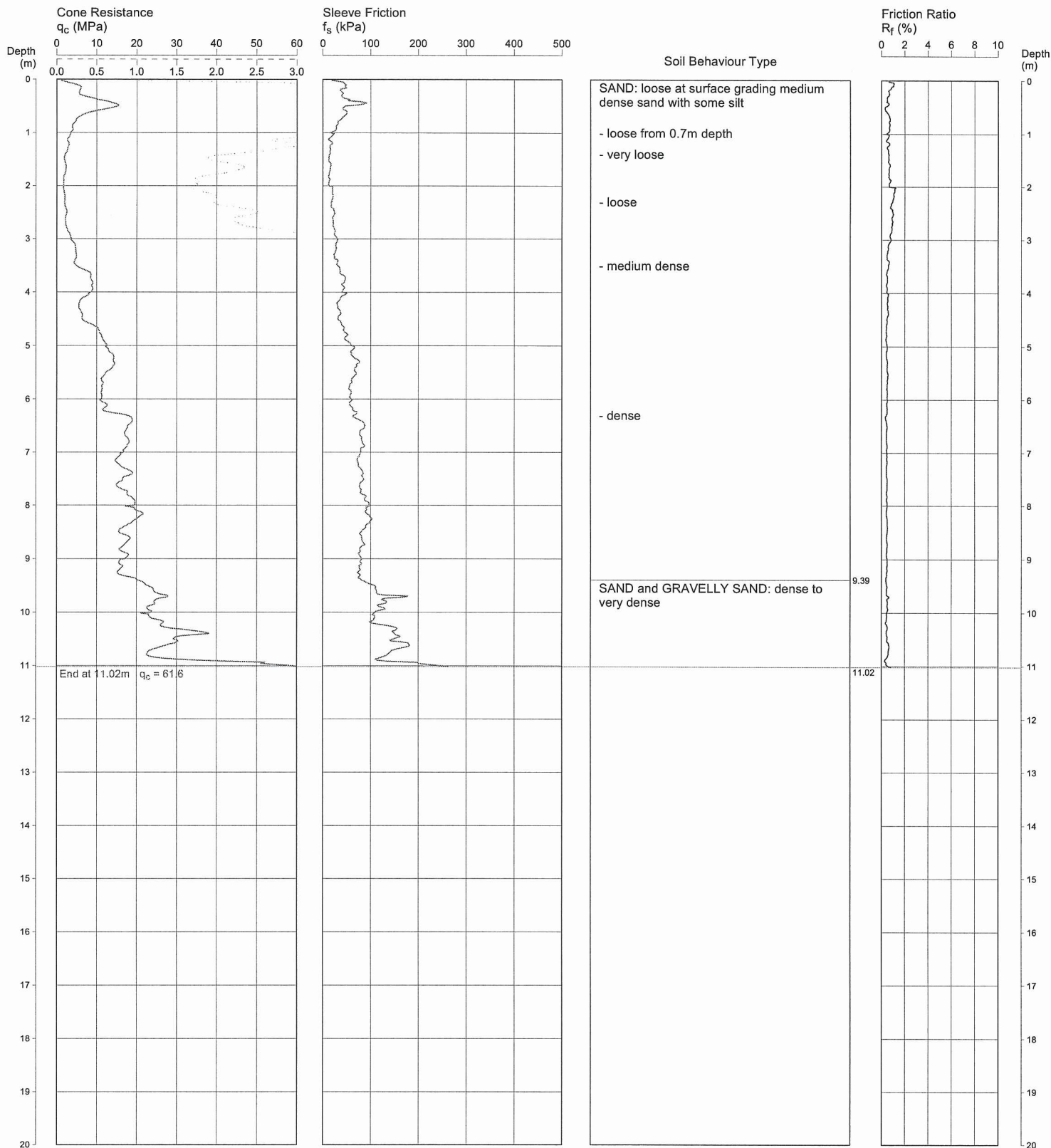
PROJECT No: 33579

CPT 11

Page 1 of 1

DATE 25/08/04

SURFACE RL: 1.1m*



REMARKS: E551913m, N6874062m.
Hole collapse at 0.85m depth, unable to record water level.* Level interpolated from client supplied drawing

Date
Plotted
Checked

File: O:\Geotech projects\33579 KINGSCLIFF\Field\33579-11.CP5
Cone ID: 402 Type: 2 Standard
ConePlot Version 5.8.0
© 2003 Douglas Partners Pty Ltd



Douglas Partners
Geotechnics • Environment • Groundwater

CONE PENETRATION TEST

CLIENT: Australian Fresh Corporation Pty Ltd

PROJECT: Proposed Bay Lobster Aquaculture Project

LOCATION: 355 Cudgen Road, Cudgen

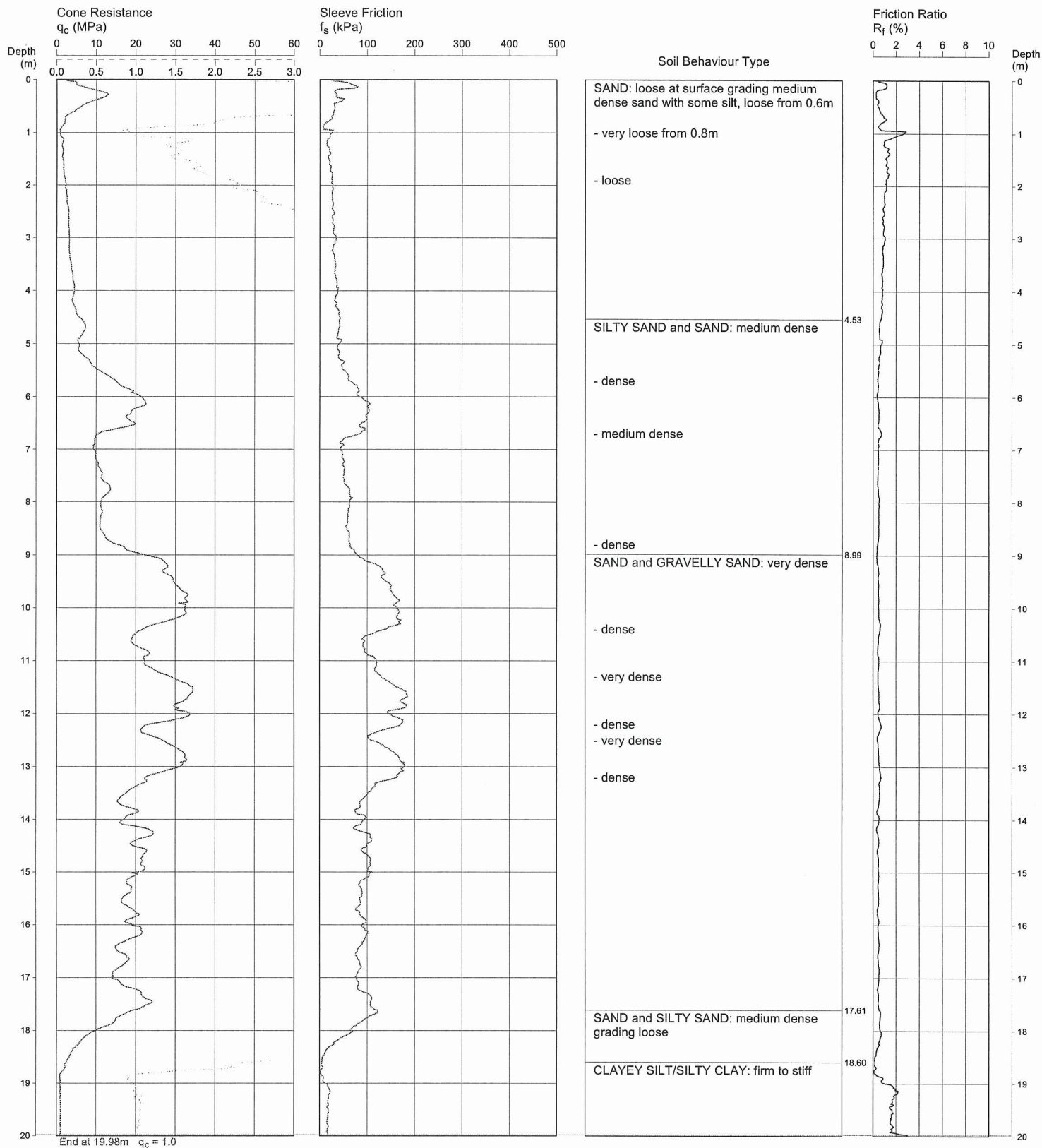
PROJECT No: 33579

CPT 12

Page 1 of 1

DATE 25/08/04

SURFACE RL: 0.7m*



REMARKS: E551921m, N6873416m.
Hole collapse at 1.15m depth, unable to record water level.* Level interpolated from client supplied drawing

Date
Plotted
Checked

File: O:\Geotech projects\33579 KINGSCLIFF\Field\33579-12.CP5
Cone ID: 402 Type: 2 Standard
ConePlot Version 5.8.0
© 2003 Douglas Partners Pty Ltd

CONE PENETRATION TEST

CLIENT: Australian Fresh Corporation Pty Ltd

PROJECT: Proposed Bay Lobster Aquaculture Project

LOCATION: 355 Cudgen Road, Cudgen

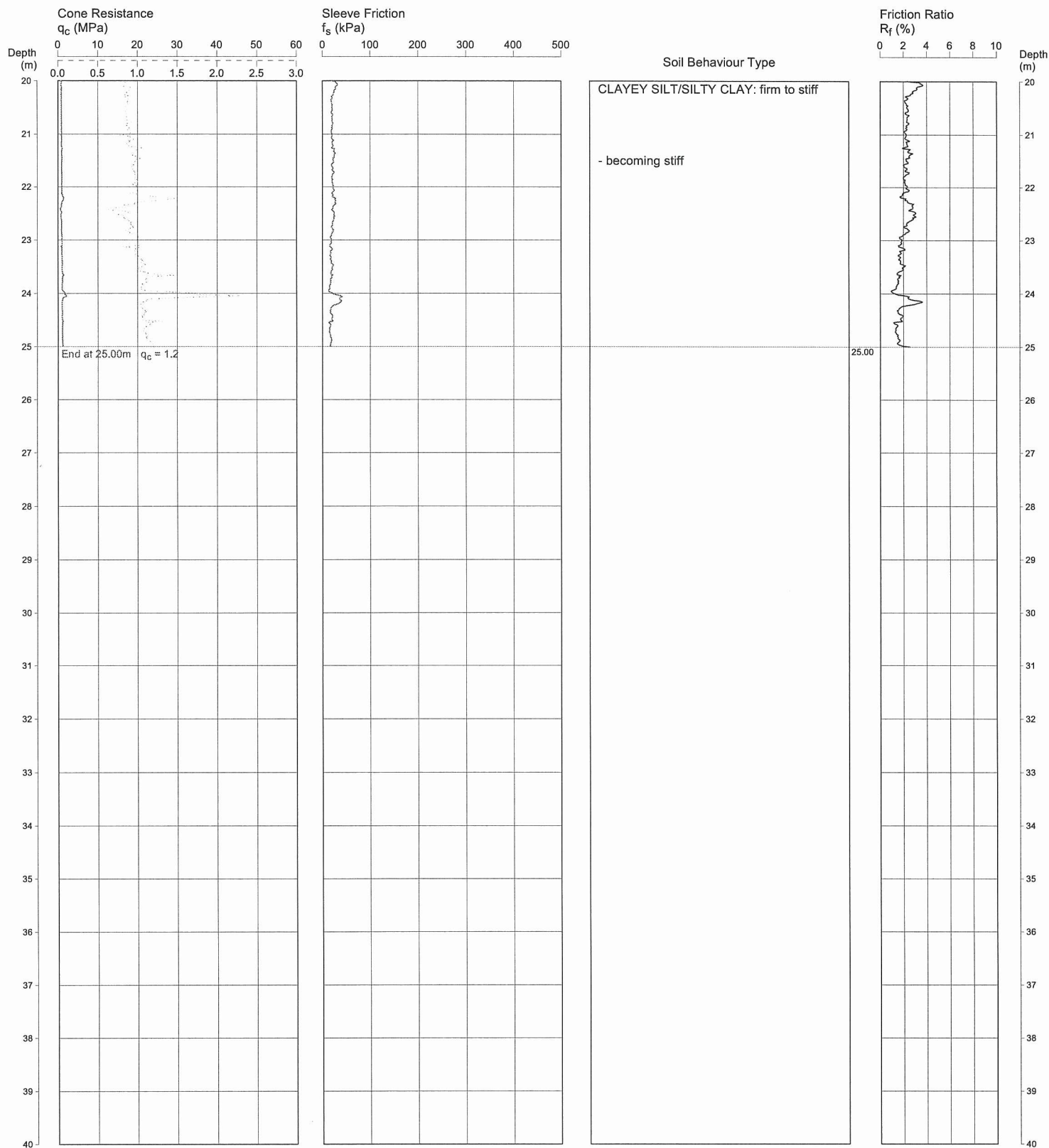
PROJECT No: 33579

CPT 13

Page 2 of 2

DATE 25/08/04

SURFACE RL: 1.0m*



REMARKS: E552308m, N6873675m.
Hole collapse at 1.1m depth, unable to record water level.* Level interpolated from client supplied drawing

Date
Plotted
Checked

File: O:\Geotech projects\33579 KINGSClIFF\field\33579-13.CP5
Cone ID: 402 Type: 2 Standard

ConePlot Version 5.8.0
© 2003 Douglas Partners Pty Ltd



Douglas Partners
Geotechnics • Environment • Groundwater

CONE PENETRATION TEST

CLIENT: David McPhee & Associates

PROJECT: Proposed Bay Lobster Aquaculture Project

LOCATION: 355 Cudgen Road, Cudgen

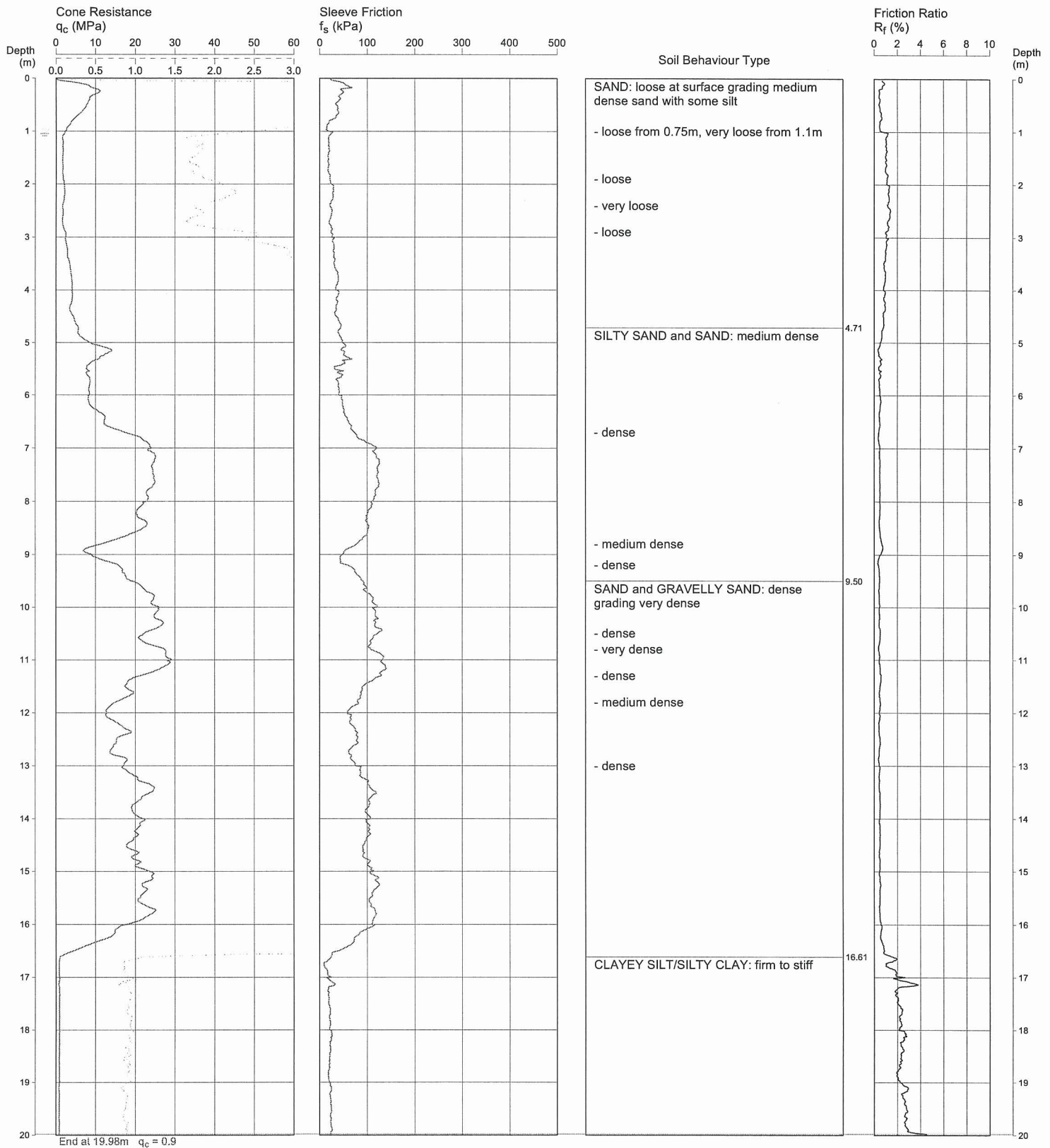
PROJECT No: 33579

CPT 14

Page 1 of 1

DATE 25/08/04

SURFACE RL: 0.8m*



REMARKS: E552511m, N6873776m.
Water level measured at 1.05m depth on withdrawal of rods.* Level interpolated from client supplied drawing

Date
Plotted
Checked

File: O:\Geotech projects\33579 KINGSCLIFF\Field\33579-14.CP5
Cone ID: 402 Type: 2 Standard

ConePlot Version 5.8.0
© 2003 Douglas Partners Pty Ltd



Douglas Partners
Geotechnics • Environment • Groundwater



Douglas Partners

Geotechnics • Environment • Groundwater

NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigations Code. In general, descriptions cover the following properties - strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12—25
Firm	25—50
Stiff	50—100
Very stiff	100—200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5—10	2—5
Medium dense	10—30	5—15
Dense	30—50	15—25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing with a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling are given in the report.

Drilling Methods.

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole is advanced using 90—115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical

means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" — Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7
as 4, 6, 7
N = 13
- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm
as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In

such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0—5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0—50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%—2% are commonly encountered in sands and very soft clays rising to 4%—10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6) N \text{ (blows per 300 mm)}$$

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

$$q_c = (12 \text{ to } 18) c_u$$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on

soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. Normally, there is a depth limitation of 1.2 m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

Bore Logs

The bore logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variations between the boreholes.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.

- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report.

- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

If these occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is

recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

Copyright © 1998 Douglas Partners Pty Ltd

APPENDIX B

**Laboratory Report Sheets
Chain of Custody Documentation**



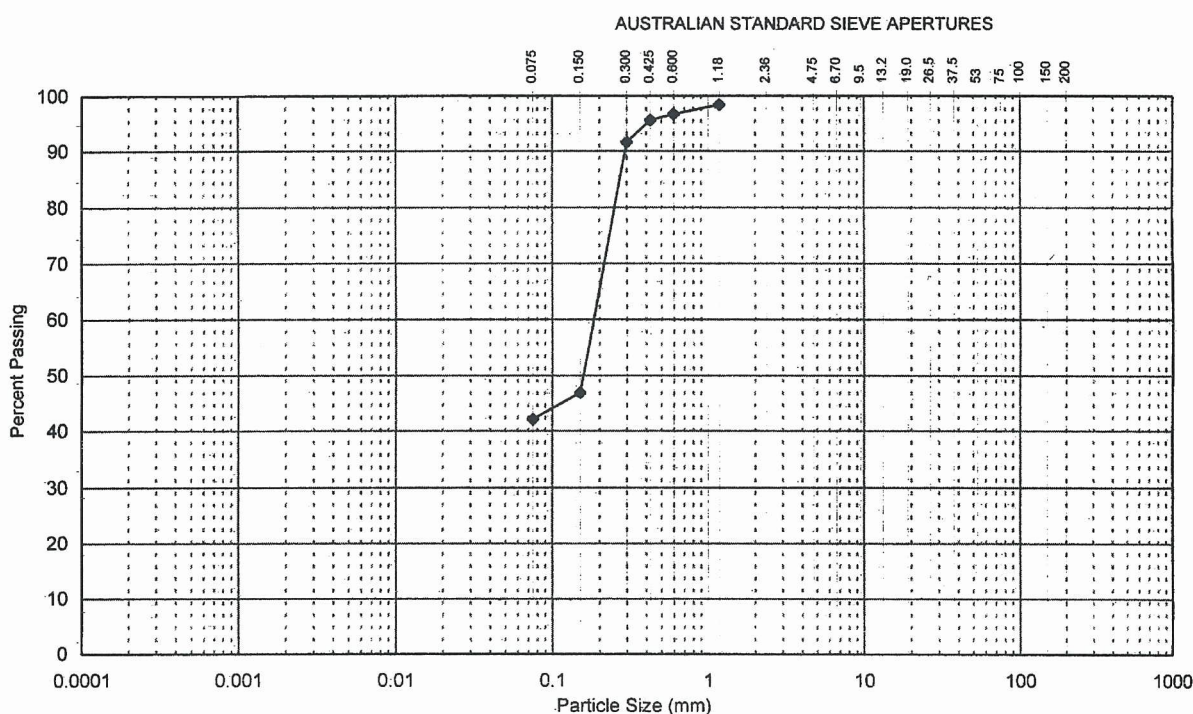
Douglas Partners
Geotechnics • Environment • Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
439 Montague Road
West End QLD 4101
Australia

439 Montague Road
West End QLD 4101
Phone (07) 3237 8900
Fax: (07) 3237 8999
dpbris@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 246
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 1	Date Sampled:	11/08/2004
Depth / Layer :	0.4 - 0.5	Date of Test:	31/08/2004
		Page:	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60

Description: Silty SAND - Light brown, fine to medium grained.

Test Method(s): AS 1289.3.6.1-1995.

Sampling Method(s): By Client

Method of Dispersion:

Remarks:

Form R004 Rev3 Feb 2004



NATA Accredited Laboratory No 1289
This Laboratory is accredited by the National Association of
Testing Authorities, Australia. The test(s) reported herein have
been performed in accordance with its terms of accreditation.
This document shall not be reproduced except in full.

Approved Signatory:

Tested:	LS
Checked:	AJM

Anthony J. McKenna
Laboratory Manager



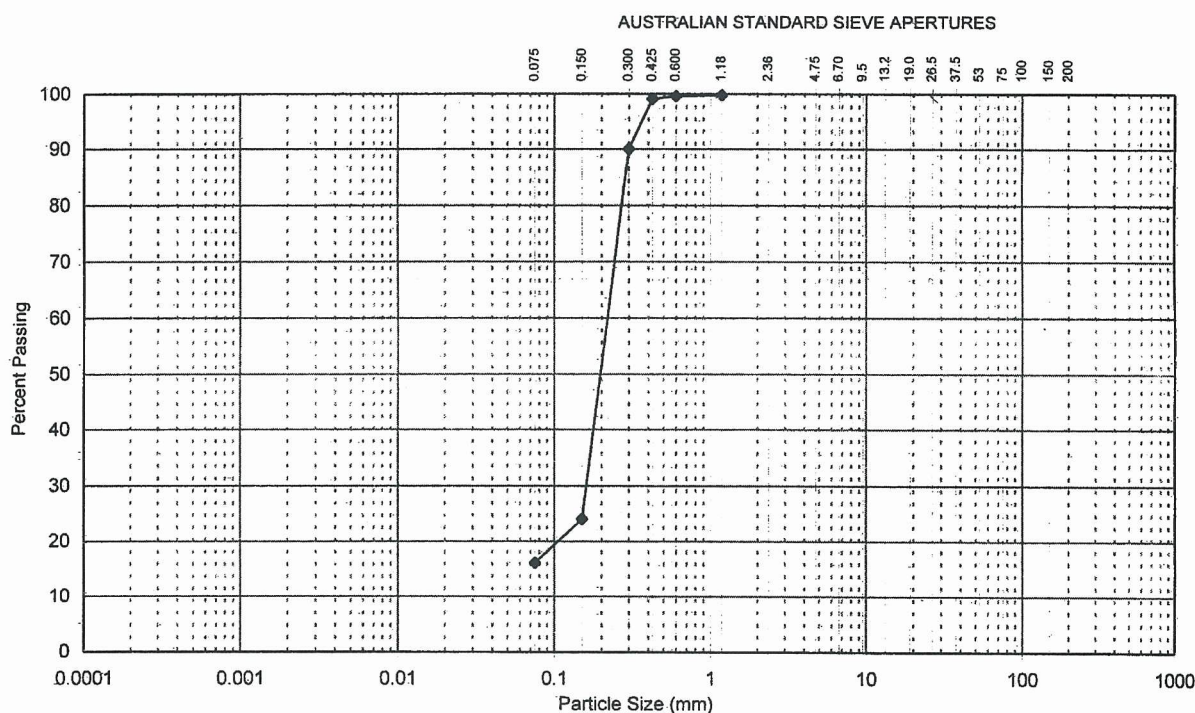
Douglas Partners
Geotechnics • Environment • Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
439 Montague Road
West End QLD 4101
Australia

439 Montague Road
West End QLD 4101
Phone (07) 3237 8900
Fax: (07) 3237 8999
dpbris@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 247
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 1	Date Sampled:	11/08/2004
Depth / Layer :	1.4 - 1.5	Date of Test:	31/08/2004
		Page:	1 of 1



CLAY FRACTION		SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
		Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
		0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60

Description: SAND - slightly silty, grey, fine to medium grained.

Test Method(s): AS 1289.3.6.1-1995.

Sampling Method(s): By Client

Method of Dispersion:

Remarks:

Form R304 Rev3 Feb 2004



NATA Accredited Laboratory No 1289
This Laboratory is accredited by the National Association of
Testing Authorities, Australia. The test(s) reported herein have
been performed in accordance with its terms of accreditation.
This document shall not be reproduced except in full

Approved Signatory:

Tested:	LS
Checked:	AJM

Anthony J. McKenna
Laboratory Manager



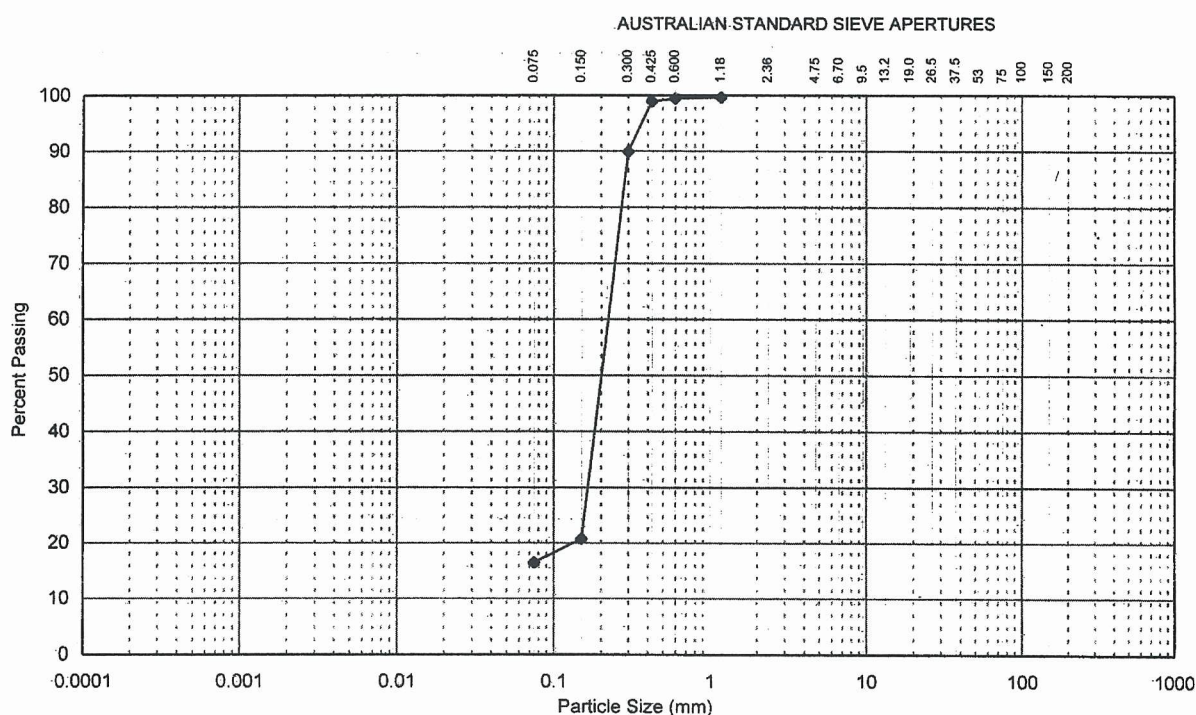
Douglas Partners
Geotechnics • Environment • Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
439 Montague Road
West End QLD 4101
Australia

439 Montague Road
West End QLD 4101
Phone (07) 3237 8900
Fax: (07) 3237 8999
dpbris@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 248
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 4	Date Sampled:	11/08/2004
Depth / Layer :	0.9 - 1.0	Date of Test:	31/08/2004
		Page:	1 of 1



CLAY FRACTION		SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
		Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
		0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60

Description: SAND - Slightly silty, light brown, fine to medium grained

Test Method(s): AS 1289.3.6.1-1995.

Sampling Method(s): By Client

Method of Dispersion:

Remarks:



NATA Accredited Laboratory No 1289
This Laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of accreditation. This document shall not be reproduced except in full

Approved Signatory:

Tested:	LS
Checked:	AJM

Anthony J. McKenna
Laboratory Manager



Douglas Partners
Geotechnics • Environment • Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117

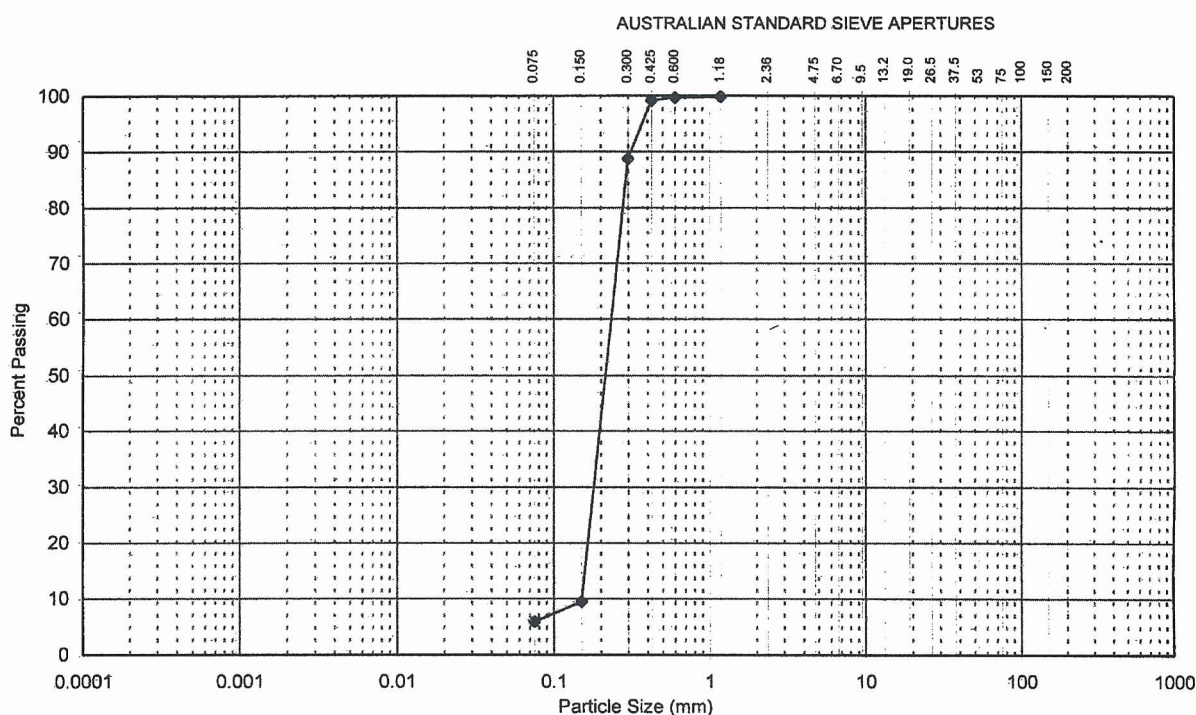
439 Montague Road
West End QLD 4101
Australia

439 Montague Road
West End QLD 4101

Phone (07) 3237 8900
Fax: (07) 3237 8999
dpbris@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 249
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 4	Date Sampled:	11/08/2004
Depth / Layer :	2.9 - 3.0	Date of Test:	31/08/2004
		Page:	1 of 1



CLAY FRACTION		SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
		Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
		0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60

Description: SAND - Grey, medium grained with some silt.

Test Method(s): AS 1289.3.6.1-1995.

Sampling Method(s): By Client

Method of Dispersion:

Remarks:



NATA Accredited Laboratory No 1289
This Laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of accreditation. This document shall not be reproduced except in full

Approved Signatory:

Tested:	LS
Checked:	AJM

Anthony J. McKenna
Laboratory Manager



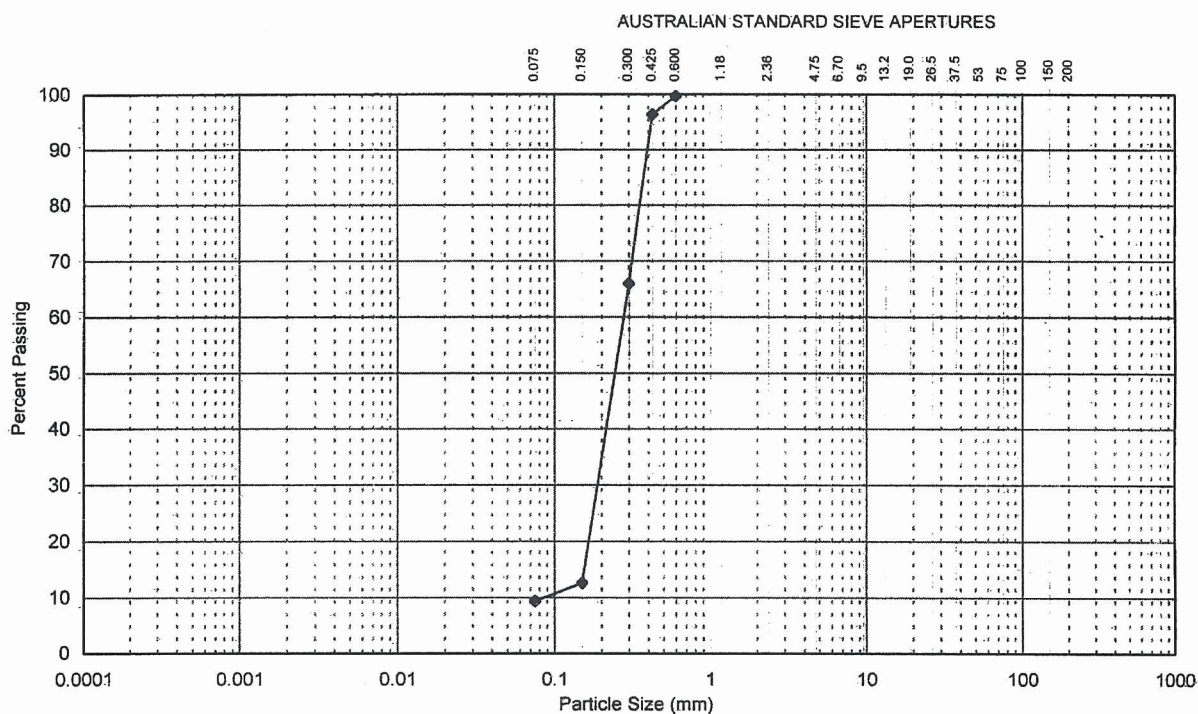
Douglas Partners
Geotechnics • Environment • Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
439 Montague Road
West End QLD 4101
Australia

439 Montague Road
West End QLD 4101
Phone (07) 3237 8900
Fax: (07) 3237 8999
dpbris@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 250
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 6	Date Sampled:	11/08/2004
Depth / Layer :	0.4 - 0.5	Date of Test:	31/08/2004
		Page:	1 of 1



CLAY FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.06	0.2	0.6	2.0	6.0	20	60

Description: SAND - Light Brown, medium grained with some silt.

Test Method(s): AS 1289.3.6.1-1995.

Sampling Method(s): By Client

Method of Dispersion:

Remarks:



NATA Accredited Laboratory No 1289
This Laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of accreditation. This document shall not be reproduced except in full

Approved Signatory:

Tested:	LS
Checked:	AJM

Anthony J. McKenna
Laboratory Manager



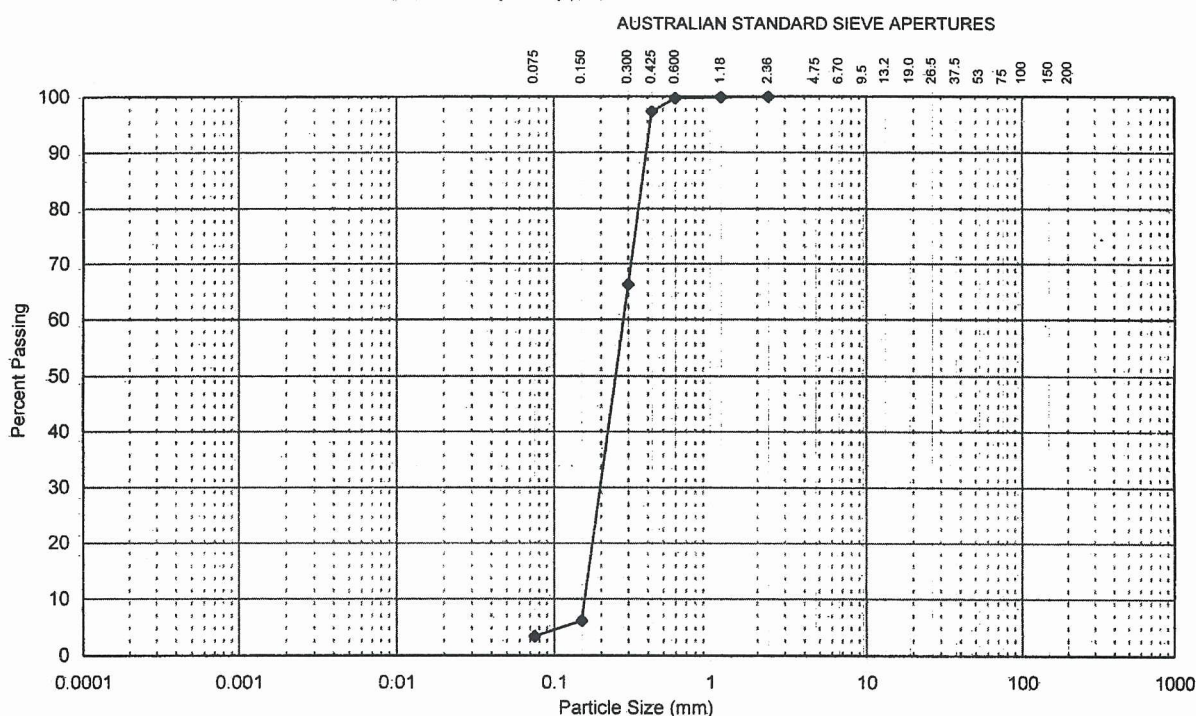
Douglas Partners
Geotechnics • Environment • Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
439 Montague Road
West End QLD 4101
Australia

439 Montague Road
West End QLD 4101
Phone (07) 3237 8900
Fax: (07) 3237 8999
dpbris@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUA CULTURE PROJECT	Report No. :	B04 - 251
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 6	Date Sampled:	11/08/2004
Depth / Layer :	2.4 - 2.5	Date of Test:	31/08/2004
		Page:	1 of 1



CLAY FRACTION		SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
		Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
		0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60

Description: SAND - Grey, medium grained with a trace of silt.

Test Method(s): AS 1289.3.6.1-1995

Sampling Method(s): By Client

Method of Dispersion:

Remarks:



NATA Accredited Laboratory No 1289
This Laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of accreditation. This document shall not be reproduced except in full.

Approved Signatory:

Tested:	LS
Checked:	AJM

Anthony J. McKenna
Laboratory Manager



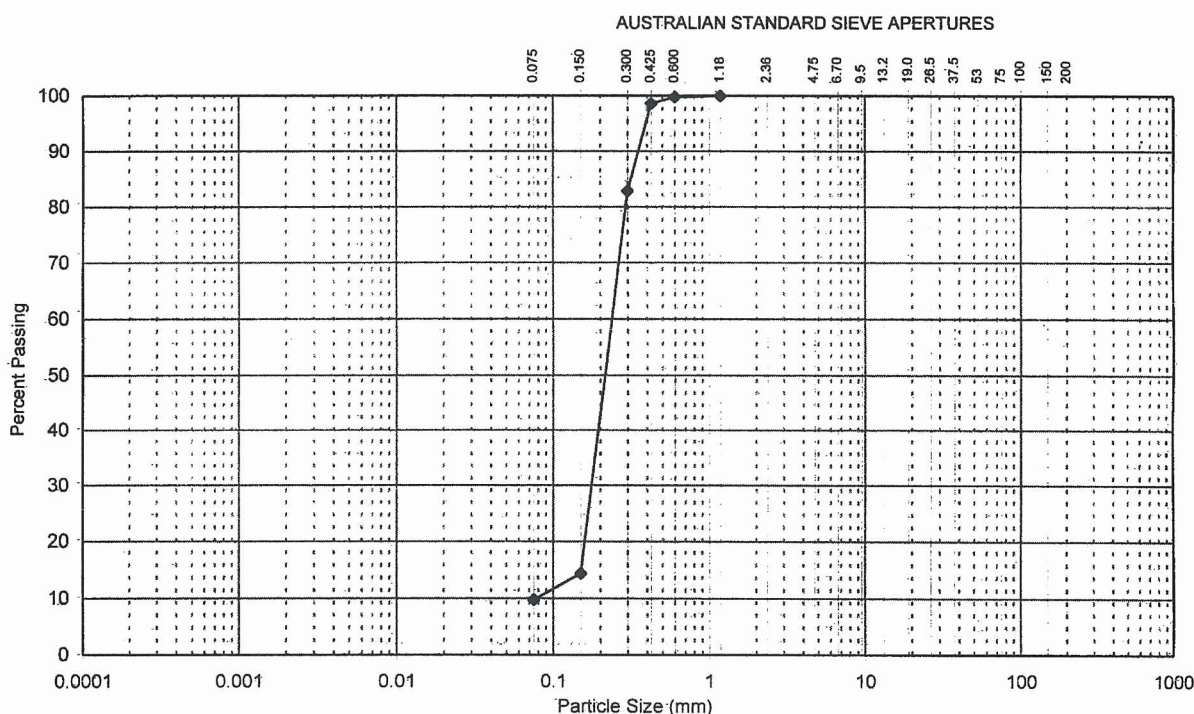
Douglas Partners
Geotechnics • Environment • Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
439 Montague Road
West End QLD 4101
Australia

439 Montague Road
West End QLD 4101
Phone (07) 3237 8900
Fax: (07) 3237 8999
dpbris@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 252
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 9	Date Sampled:	11/08/2004
Depth / Layer :	0.9 - 1.0	Date of Test:	31/08/2004
		Page:	1 of 1





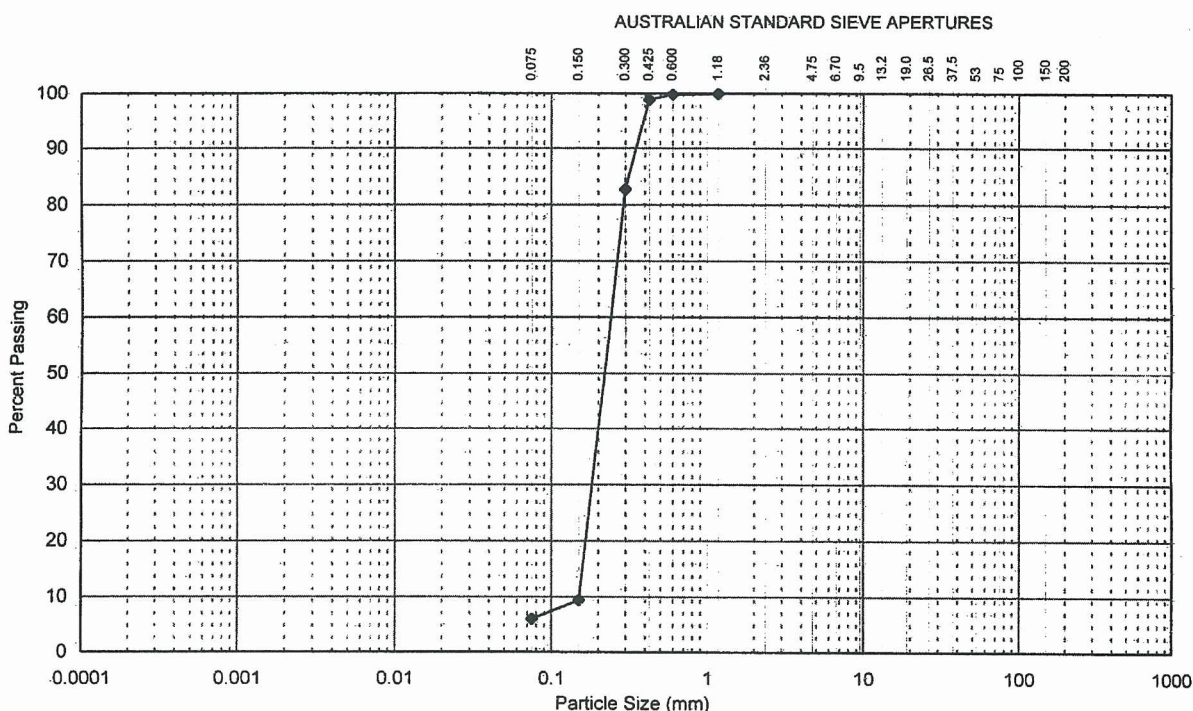
Douglas Partners
Geotechnics • Environment • Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
439 Montague Road
West End QLD 4101
Australia

439 Montague Road
West End QLD 4101
Phone (07) 3237 8900
Fax: (07) 3237 8999
dpbris@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 253
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 9	Date Sampled:	11/08/2004
Depth / Layer :	1.9 - 2.0	Date of Test:	31/08/2004
		Page:	1 of 1



CLAY-FRACTION	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
	0.002	0.006	0.02	0.6	0.2	0.6	2.0	6.0	20	60

Description: SAND - Grey, medium grained with some silt.

Test Method(s): AS 1289.3.6.1-1995.

Sampling Method(s): By Client

Method of Dispersion:

Remarks:

Form R004 Rev3 Feb 2004



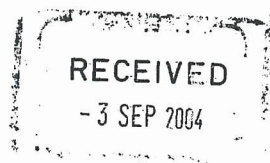
NATA Accredited Laboratory No 1289
This Laboratory is accredited by the National Association of Testing Authorities, Australia. The test(s) reported herein have been performed in accordance with its terms of accreditation. This document shall not be reproduced except in full

Approved Signatory:

Tested:	LS
Checked:	AJM

Anthony J. McKenna
Laboratory Manager

ALS Environmental



CERTIFICATE OF ANALYSIS

CONTACT: MR CHRIS BELL
CLIENT: DOUGLAS PARTNERS PTY LTD
ADDRESS:
439 MONTAGUE ROAD
WEST END QLD 4101
ORDER No.: 48547
PROJECT: 33579

BATCH: AEB63472
SUB BATCH: 0
LABORATORY: BRISBANE
DATE RECEIVED: 18/08/2004
DATE COMPLETED: 01/09/2004
SAMPLE TYPE: SOIL
No. of SAMPLES: 10

COMMENTS

Results apply to sample(s) as submitted. CHROMIUM SUITE as per Method of Qld Dept of Natural Resources & Mines. Acid Base Accounting incorporates a minimum safety factor of 1.5. This report supersedes EB63472.

NOTES

This is the Final Report and supersedes any preliminary reports with this batch number. All pages of this report have been checked and approved for release.

ISSUING LABORATORY: BRISBANE

Address
32 Shand Street
Stafford QLD 4053
Australia
Signatory

Phone: 61-7-3243 7222
Fax: 61-7-3243 7218
Email: michael.heery@alsenviro.com

K. Melie

Reports signed by signatories as required

LABORATORIES

AUSTRALASIA

Brisbane
Melbourne
Sydney
Newcastle
Auckland
Hong Kong
Singapore
Kuala Lumpur
Bogor
Mumbai

AMERICAS

Vancouver
Santiago
Antofagasta
Lima



NATA Accredited Laboratory Number 825
Site: BRISBANE

This laboratory is accredited by the National Association of Testing Authorities, Australia. The tests reported herein have been performed in accordance with its scope of accreditation. This document shall not be reproduced, except in full.

Batch:

AEB63472

Sub Batch:

0

Date of Issue:

01/09/2004

Client:

DOUGLAS PARTNERS PTY LTD

Client Reference:

33579

CERTIFICATE OF ANALYSIS



			SAMPLE IDENTIFICATION											
			Laboratory I.D.		1	2	3	4	5	6	7	8	9	10
			Date Sampled											
METHOD	ANALYSIS DESCRIPTION	UNIT	LOR	Bore 3 0.4-0.5	Bore 4 1.9-2.0	Bore 4 2.4-2.5	Bore 4 3.9-4.0	Bore 5 0.9-1.0	Bore 7 1.4-1.5	Bore 7 2.9-3.0	Bore 9 3.4-3.5	Bore 10 0.4-0.5	Bore 10 0.9-1.0	
EA-033-A	ACTUAL ACIDITY													
EA-033-A	pH KCl (23A)	0.1		4.6	5.4	5.6	5.9	5.4	5.1	5.5	5.4	5.4	5.4	
EA-033-A	Titratable Actual Acidity (23F)	mole/tonne		31	5	<2	2	4	10	<2	4	5	9	
EA-033-A	sulfidic-Titratable Act. Acidity (s-23F)	% S	0.02	0.05	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	
EA-033-B	POTENTIAL ACIDITY													
EA-033-B	Chromium Reducible Sulfur (22B)	% S	0.02	0.10	0.25	0.25	0.14	0.03	0.25	0.20	0.15	<0.02	0.18	
EA-033-B	acidity-Chromium Reducible Sulfur(a-22B)	mole/tonne	10	62	156	156	87	19	156	125	94	<10	112	
EA-033-C	ACID NEUTRALISING CAPACITY													
EA-033-C	Acid Neutralising Capacity (19A1)	% CaCO3	0.01	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	
EA-033-C	acidity-Acid Neutralising Cap. (a-19A1)	mole/tonne	10	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	
EA-033-C	sulfidic-Acid Neutralising Cap. (s-19A1)	% S	0.01	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	
EA-033-D	RETAINED ACIDITY													
EA-033-D	Net Acid Soluble Sulfur (20J)e	% S	0.02	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	
EA-033-D	acidity-Net Acid Soluble Sulfur (a-20J)	mole/tonne	10	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	
EA-033-D	sulfidic-Net Acid Soluble Sulfur (s-20J)	% pyrite S	0.02	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	
EA-033-E	ACID BASE ACCOUNTING													
EA-033-E	ANC Fineness Factor	% S	0.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	
EA-033-E	Net Acidity (sulfur units)	% S	0.02	0.15	0.25	0.25	0.14	0.03	0.27	0.20	0.15	<0.02	0.18	
EA-033-E	Net Acidity (acidity units)	mole/tonne	10	93	161	156	89	23	166	125	94	<10	121	
EA-033-E	Limiting Rate	kg CaCO3/ht	1	7	12	12	7	2	12	9	7	<1	9	

Batch: AEB63472
 Sub Batch: 0
 Date of Issue: 01/09/2004
 Client: DOUGLAS PARTNERS PTY LTD
 Client Reference: 33579

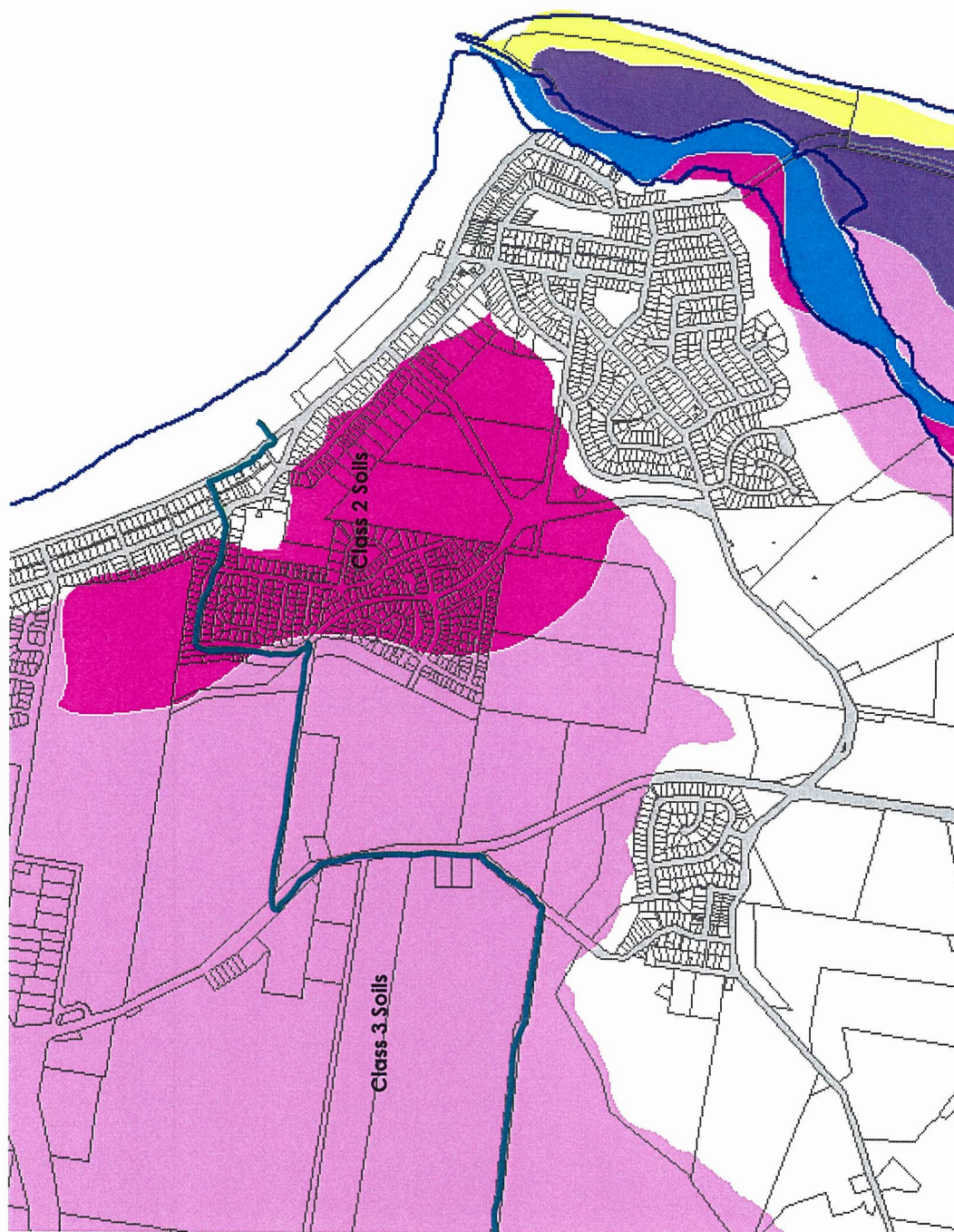
QUALITY CONTROL REPORT



METHOD		ANALYSIS DESCRIPTION	Laboratory I.D.		SAMPLE IDENTIFICATION						
			Date Sampled	200							
			UNIT	LOR	Method Blank 1						
			CHECKS AND SPIKES								
EA-033-A	ACTUAL ACIDITY										
EA-033-A	pH KCl (23A)		mole/tonne	0.1	---						
EA-033-A	Titratable Actual Acidity (23F)		% S	2	<2						
EA-033-A	sulfidic-Titratable Act. Acidity (s-23F)		% S	0.02	<0.02						
EA-033-B	POTENTIAL ACIDITY										
EA-033-B	Chromium Reducible Sulfur (22B)		% S	0.02	<0.02						
EA-033-B	acidity-Chromium Reducible Sulfur(a-22B)		mole/tonne	10	<10						
EA-033-C	ACID NEUTRALISING CAPACITY										
EA-033-C	Acid Neutralising Capacity (19A1)		% CaCO3	0.01	Not Det'd						
EA-033-C	acidity-Acid Neutralising Cap. (a-19A1)		mole/tonne	10	Not Det'd						
EA-033-C	sulfidic-Acid Neutralising Cap. (s-19A1)		% S	0.01	Not Det'd						
EA-033-D	RETAINED ACIDITY										
EA-033-D	Net Acid Soluble Sulfur (20Je)		% S	0.02	Not Det'd						
EA-033-D	acidity-Net Acid Soluble Sulfur (a-20J)		mole/tonne	10	Not Det'd						
EA-033-D	sulfidic-Net Acid Soluble Sulfur (s-20J)		% pyrite S	0.02	Not Det'd						
EA-033-E	ACID BASE ACCOUNTING										
EA-033-E	ANC Fineness Factor		% S	0.5	---						
EA-033-E	Net Acidity (sulfur units)		% S	0.02	---						
EA-033-E	Net Acidity (acidity units)		mole/tonne	10	---						
EA-033-E	Limiting Rate		kg CaCO3/t	1	---						

APPENDIX K

- ACID SULFATE SOILS CLASS MAP - BEACH END
- ACID SULFATE SOILS CLASS MAP - SITE END

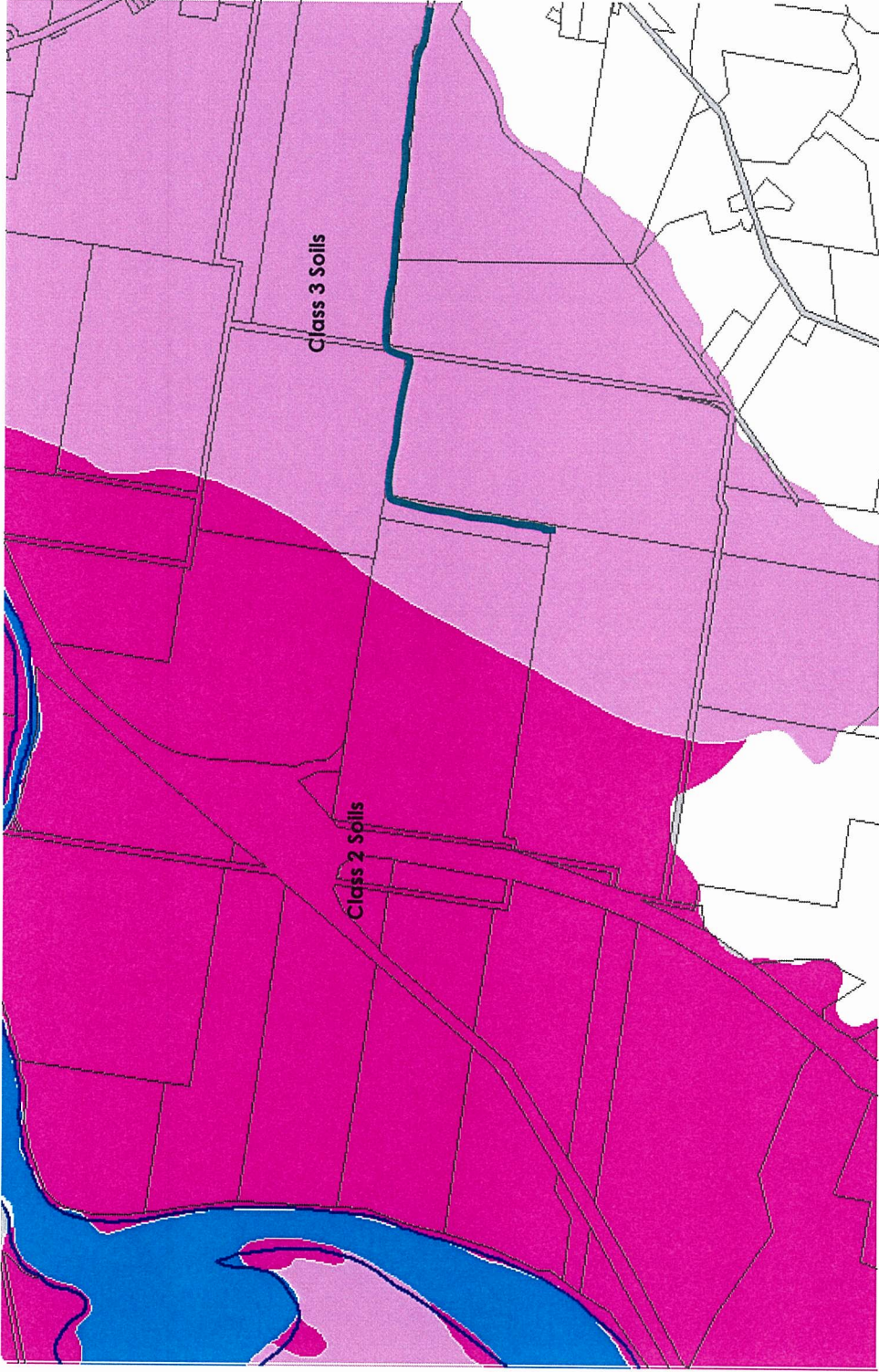


PIPELINE ROUTE - ACID SULFATE SOIL CLASSES

— Pipeline Route



CONSULTING



PIPELINE ROUTE - ACID SULFATE SOIL CLASSES

— Pipeline Route

APPENDIX L

- TWEED RIVER WATER QUALITY DATA

Tweed Shire Council Water Quality Data

TOTAL NITROGEN mg/l

Date	Sampling location													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
13.11.96	0.3	0.2	0.2	0.2	0.2	0.4								
8.01.97	0.35	0.28	0.35	0.21	0.14	0.14								
6.03.97	0.4	0.6	0.5	0.4	0.3	0.4								
14.05.97	0.4	0.6	0.4	0.4	0.7	1.4								
9.07.97	0.7	0.8	0.8	0.8	0.8	0.8								
10.9.97	0.9	0.9	1.2	1.1	0.4	0.5								
30.10.97	0.8	0.8	0.3	0.6	0.3	0.6								
15.12.97	0.2	0.2	0.9	0.6	0.2	0.5								
18.02.98	0.5	0.4	0.6	0.6	0.8	1.4								
30.4.98	0.4	0.3	0.6	0.2	0.2	0.2								
24.06.98	0.3	0.4	0.3	0.2	0.2	0.2								
22.10.98	0.3	0.1	0.1	0.1	0.8	0.1								
22.12.98	0.8	0.7	0.8	0.8	0.7	0.5								
18.02.99	0.9	0.9	0.8	0.9	0.9	1.1								
22.04.99	0.3	0.4	0.3	0.4	0.4	0.2								
10.06.99	0.6	0.9	0.8	0.8	0.6	0.8								
10.08.99	0.3	0.3	0.3	0.3	0.4	0.3								
21.10.99	0.6	0.7	0.7	0.8	0.7	0.7								
23-Feb-00	0.4	0.2	0.2	0.3	0.3	0.3								
18-Apr-00	0.6	0.8	0.4	0.7	0.5	0.5								
12-Jul-00	0.4	1	1	0.4	0.4	0.7								
16-Aug-00	0.6	0.9	0.6	0.7	0.5	0.5								
4-Oct-00	0.2	0.2	0.3	0.2	0.2	0.2								
13-Dec-00	0.4	0.4	0.5	0.6	0.5	0.6								
20-Mar-01	0.6	0.4	0.8	0.8	0.9	0.2								
27-Jun-01	0.2	0.2	0.2	0.2	0.2	0.2								
15-Aug-01	0.2	0.3	0.4	0.2	0.4	0.4								
17-Oct-01	0.4	0.4	0.3	0.2	0.4	0.4								
12-Dec-01	0.4	0.2	0.3	0.4	0.3	0.2								
23-Apr-02	0.3	0.5	0.4	0.4	0.4	0.4								
20-Jun-02	0.5	0.3	0.7	0.3	0.5	0.6								
21-Aug-02	0.4	0.4	0.4	0.4	0.4	0.3								
23-Oct-02	0.3	0.3	0.2	0.2	0.3	0.2								
13-Mar-03	0.3	0.6	0.4	0.7	0.4	0.9								
9-Apr-03	0.6	0.4	0.3	0.5	0.3	0.3								
29-May-03	0.2	1	0.2	0.2	0.3	0.2								
24-Jul-03	0.2	0.2	0.2	0.2	0.2	2.1								
17-Sep-03	0.6	0.3	0.2	0.2	0.2	0.2								
5-Nov-03	0.6	0.2	0.8	0.2	0.2	0.2								
7-Jan-04	0.2	0.3	0.4	1.7	0.2	0.2								
3-Mar-04	1.4	0.9	1.1	0.9	1.9	0.8								
4-May-04	0.7	0.4	0.5	0.5	0.4	0.6								
30-Jun-04	0.2	0.2	0.2	0.2	0.2	0.4								
20.05.92											11			1.75
1.07.92							0.21	0.27	0.05	0.08	0.29	0.45	1	0.5
6.08.92							0.1	0.35	0.1	0.1	0.1	0.5	0.2	1.25
13.10.92							0.5	2.3	0.5	0.5	0.5	1.34	0.5	0.1
11.12.92							0.2	0.6	0.55	0.52	2.17	0.1	0.4	1.1
17.2.93							0.1	0.1	0.1	0.1	0.1	0.8	0.2	0.2
12.05.93							0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.3
22.07.93							0.25	0.2	0.8	0.2	0.2	0.2	0.2	0.7
30.09.93							0.2	0.6	0.6	0.3	0.3	0.2	0.2	0.5
26.11.93							0.2	0.2	0.2	0.2	0.2	0.6	0.2	0.2
12.01.94							0.2	0.2	0.2	0.2	0.3	0.6	0.4	0.2
11.03.94							0.2	0.3	0.4	0.2	0.4	1.1	0.2	0.2
11.05.94							0.2	0.2	0.2	0.2	0.6	0.2	0.4	0.3
13.07.94							0.3	0.3	1	0.7	0.2	0.2	0.4	0.4
27.09.94							0.2	0.2	0.6	0.2	0.2	0.2	0.1	0.2
7.12.94							0.2	0.2	0.5	0.2	0.2	0.4	0.2	0.6
17.02.95							0.3	0.3	0.7	0.3	0.5	0.2	0.4	0.1

Tweed Shire Council Water Quality Data

TOTAL NITROGEN mg/l

Date	Sampling location													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
5.04.95							0.4	0.2	0.2	0.4	0.2	0.2	0.6	0.1
5.07.95							0.2	0.3	0.2	0.2	0.2	0.4	0.2	0.4
13.09.95							0.4	0.4	0.6	0.4	0.4	0.8	0.2	0.4
12.12.95							0.5	0.6	0.8	0.6	0.5	0.3	0.6	0.3
1.02.96							0.2	0.3	0.4	0.3	0.3	0.4	0.2	0.4
17.04.96							0.4	0.2	0.2	0.2	0.2	0.3	3.5	0.4
19.06.96							0.5	0.2	0.2	0.2	0.2	0.2	1.3	0.2
20.08.96							0.2	0.2	0.2	0.2	0.2	0.5	0.8	3.6
30.10.96							0.4	0.2	0.2	0.4	0.3	0.3	0.4	0.4
11.12.96							0.2	0.2	0.6	0.4	0.2	0.4	0.3	1.2
12.02.97							0.2	0.1	0.6	0.4	0.2	0.6	0.3	0.3
9.04.97							0.4	0.4	0.4	0.5	0.5	0.3	0.4	0.2
11.06.97							0.4	0.7	0.5	0.4	0.5	0.5	0.5	0.4
6.08.97							0.7	0.3	0.1	0.1	0.5	0.2	0.3	0.5
1.10.97							0.4	0.8	0.1	0.6	0.3	1.1	0.4	0.3
19.11.97							1.1	0.5	0.5	1	0.7	0.3	1	0.5
21.01.98							0.3	0.2	0.6	0.4	0.4	0.4	0.2	0.4
7.04.98							0.8	0.3	0.2	0.7	0.4	0.2	0.4	0.7
29.04.98							0.3	0.4	0.2	0.5	0.2	0.2	0.4	0.6
17.06.98							0.2	0.6	0.2	0.2	0.2	0.5	0.4	0.6
19.08.98							0.4	0.4	0.6	0.2	0.3	2.7	0.5	0.5
15.10.98							0.5	1	0.6	0.8	1.9	1.2	0.2	0.4
8.12.98							<0.2	0.4	0.3	0.6	1	1.5	0.2	0.4
11.02.99							1.1	0.9	0.3	0.6	0.6	0.2	0.3	0.2
20.04.99							0.2	<0.2	0.4	0.2	0.2	0.4	0.2	0.3
3.06.99							0.2	0.2	0.5	0.6	0.5	0.2	0.4	0.2
3.08.99							0.3	0.2	0.2	0.1	0.1	0.2	0.4	0.2
15.09.99							0.3	0.3	0.2	0.2	0.2	0.4	0.4	0.4
11.11.99							0.5	0.5	0.4	0.4	0.3	0.2	0.4	0.5
6/01/2000							1	1	0.2	0.2	0.2	0.6	0.2	0.3
22/02/2000							0.4	0.5	0.3	0.5	0.6	1	0.2	0.3
17/05/2000							0.4	0.2	0.7	0.8	0.6	0.8	0.2	0.2
5/07/2000							0.6	0.4	2.4	0.6	0.4	0.4	0.4	0.2
30/08/2000							0.3	0.6	0.8	0.4	0.4	0.4	0.2	0.2
15/11/2000							0.6	0.6	0.5	0.6	0.6	0.4	0.4	0.9
10/01/2001							0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.2
22/03/2001							0.5	0.3	0.4	0.4	0.4	0.2	0.2	0.3
23/05/2001							0.2	0.2	0.4	0.3	0.2	0.3	0.2	0.5
11/07/2001							0.2	0.3	0.3	0.4	0.2	0.2	0.2	0.2
19/09/2001							0.3	0.6	0.2	0.4	0.2	0.2	0.7	0.2
22/11/2001							0.5	0.2	0.2	0.4	0.2	0.4	0.8	0.2
30/01/2002							0.3	0.2	0.4	0.3	0.4	0.4	0.2	0.7
20/03/2002							0.6	0.6	0.4	0.4	0.4	0.4	0.2	1.2
1/05/2002							0.3	0.2	0.2	0.6	0.4	0.4		0.2
29/05/2002							0.4	0.2	0.4	0.4	0.4	0.2		0.5
10/07/2002							0.2	0.2	0.2	0.2	0.2	1.1		
25/09/2002							0.2	1	4	0.4	1.1	0.2		
25/11/2002							0.4	0.4	0.4	0.4	0.3	0.8		
15/01/2003							0.6	0.4	0.2	0.4	0.8	0.4		
18/02/2003							0.4	0.4	0.4	0.4	0.2	0.4		
15/04/2003							0.4	0.7	0.2		0.8	0.6		
19/06/2003							0.3	0.3	0.6	0.2	0.6	0.2		
12/08/2003							0.2	0.2	0.4	0.2	0.2	0.2		
1/10/2003							0.6	0.6	0.2	0.7	0.5	0.2		
3/12/2003							1.6	0.4	0.6	0.2	0.3	0.6		
21/01/2004							0.6	0.5	0.3	1	0.5	1.2		
31/03/2004							1.3	0.8	0.2	0.8	1.4	0.3		
18/05/2004							0.2	0.2	1.1	0.2	0.2	0.7		
21/07/2004							0.2	0.2	0.2	0.7	0.6			

Tweed Shire Council Water Quality Data

TOTAL PHOSPHORUS mg/l

Date	Sampling location						7	8	9	10	11	12	13	14
	1	2	3	4	5	6								
13.11.96	0.11	0.28	0.03	0.05	0.04	0.04								
8.01.97	0.046	0.054	0.05	0.04	0.04	0.054								
6.03.97	0.15	0.4	0.11	0.14	0.11	0.1								
14.05.97	0.14	0.19	0.14	0.23	0.26	0.27								
9.07.97	0.03	0.04	0.18	0.06	0.04	0.05								
10.9.97	0.04	0.06	0.04	0.20	0.16	0.02								
30.10.97	0.03	0.05	0.02	0.08	0.04	0.02								
15.12.97	0.01	0.02	0.08	0.02	0.03	0.03								
18.02.98	0.1	0.07	0.12	0.06	0.11	0.08								
30.4.98	0.04	0.03	0.05	0.04	0.01	0.04								
24.06.98	0.05	0.05	0.17	0.05	0.05	0.04								
22.10.98	0.06	0.06	0.06	0.06	0.06	0.06								
22.12.98	0.03	0.02	0.03	0.02	0.02	0.02								
18.02.99	0.02	0.02	0.01	0.01	0.01	0.01								
22.04.99	0.01	0.01	0.04	0.05	0.05	0.05								
10.06.99	0.13	0.25	0.08	0.09	0.12	0.2								
10.08.99	0.04	0.04	0.04	0.04	0.04	0.03								
21.10.99	0.08	0.08	0.08	0.08	0.07	0.06								
23-Feb-00	0.08	0.09	0.08	0.27	0.05	0.07								
18-Apr-00	0.05	0.06	0.07	0.06	0.06	0.05								
12-Jul-00	0.02	0.02	0.03	0.02	0.02	0.02								
16-Aug-00	0.03	0.03	0.02	0.03	0.03	0.02								
4-Oct-00	0.01	0.01	0.02	0.01	0.01	0.01								
13-Dec-00	0.07	0.05	0.02	0.08	0.04	0.05								
20-Mar-01	0.12	0.13	0.12	0.15	0.14	0.12								
27-Jun-01	0.07	0.07	0.01	0.01	0.01	0.01								
15-Aug-01	0.03	0.01	0.02	0.37	0.11	0.08								
17-Oct-01	0.03	0.03	0.04	0.03	0.03	0.02								
12-Dec-01	0.01	0.02	0.01	0.01	0.03	0.02								
23-Apr-02	0.03	0.03	0.05	0.03	0.03	0.03								
20-Jun-02	0.02	0.01	0.01	0.01	0.01	0.01								
21-Aug-02	0.05	0.05	0.05	0.05	0.05	0.05								
23-Oct-02	0.05	0.05	0.05	0.05	0.05	0.05								
13-Mar-03	0.05	0.05	0.05	0.05	0.05	0.05								
9-Apr-03	0.05	0.05	0.05	0.05	0.05	0.05								
29-May-03	0.07	0.07	0.07	0.07	0.07	0.06								
24-Jul-03	0.05	0.05	0.05	0.05	0.05	0.05								
17-Sep-03	0.05	0.05	0.05	0.05	0.05	0.05								
5-Nov-03	0.05	0.05	0.05	0.05	0.05	0.05								
7-Jan-04	0.05	0.05	0.05	0.05	0.05	0.05								
3-Mar-04	0.09	0.08	0.08	0.08	0.08	0.09								
4-May-04	0.05	0.05	0.05	0.05	0.05	0.05								
30-Jun-04	0.05	0.05	0.05	0.05	0.05	0.05								
20.05.92							0.089	0.098	0.066	0.066	0.067	0.089	0.094	0.016
1.07.92							0.029	0.094	0.023	0.02	0.052	0.023	0.175	0.013
6.08.92							0.056	0.075	0.051	0.049	0.056	0.029	0.227	0.036
13.10.92							0.122	0.036	0.012	0.035	0.031	0.021	0.035	0.011
11.12.92							0.305	0.049	0.027	0.028	0.026	0.074	0.042	0.017
17.2.93							0.096	0.101	0.055	0.055	0.036	0.026	0.8	0.021
12.05.93							0.037	0.083	0.047	0.047	0.046	0.083	0.078	0.005
22.07.93							0.039	0.041	0.172	0.036	0.046	0.025	0.068	0.62
30.09.93							0.016	0.024	0.016	0.026	0.028	0.043	0.025	0.02
26.11.93							0.029	0.038	0.036	0.034	0.041	0.042	0.02	0.029
12.01.94							0.04	0.041	0.021	0.019	0.06	0.072	0.1	0.007
11.03.94							0.101	0.135	0.107	0.238	0.17	0.032	0.02	0.016
11.05.94							0.032	0.038	0.03	0.034	0.032	0.044	0.05	0.29
13.07.94							0.037	0.041	0.071	0.044	0.039	0.013	0.06	0.025
27.09.94							0.023	0.033	0.021	0.022	0.007	0.026		0.024
7.12.94							0.018	0.025	0.015	0.022	0.1	0.29	0.02	0.04
17.02.95							0.165		0.315	0.235	0.265	0.02	0.02	
5.04.95							0.033	0.031	0.028	0.038	0.026	0.019	0.01	0.03
5.07.95							0.038	0.04	0.044	0.031	0.033	0.027	0.08	0.01
13.09.95							0.04	0.046	0.04	0.056	0.04	0.053	0.01	0.05
12.12.95							0.019	0.099	0.027	0.033	0.156	0.032	0.03	0.03
1.02.96							0.028	0.042	0.019	0.106	0.022	0.072	0.07	0.02

Tweed Shire Council Water Quality Data

TOTAL PHOSPHORUS mg/l

Date	Sampling location													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
17.04.96							0.09	0.112	0.028	0.67	0.041	0.023	0.04	0.11
19.06.96							0.028	0.08	0.009	0.5	0.01	0.081	0.01	0.07
20.08.96							0.052	0.051	0.03	0.055	0.061	0.05	0.09	0.03
30.10.96							0.01	0.01	0.01	0.35	0.01	0.07	0.01	0.01
11.12.96							0.034	0.05	0.064	0.048	0.112	0.07	0.01	0.09
12.02.97							0.04	0.04	0.06	0.04	0.04	0.1	0.01	0.01
9.04.97							0.05	0.34	0.07	0.06	0.1	0.07	0.01	0.01
11.06.97							0.04	0.04	0.04	0.14	0.8		0.02	0.01
6.08.97												0.03	0.01	0.01
1.10.97							0.22	0.07	0.03	0.03	0.03	0.02	0.19	0.01
19.11.97							0.04	0.05	0.03	0.03	0.03	0.04	0.02	0.01
21.01.98							0.05	0.05	0.03	0.05	0.05	0.05	0.01	0.07
7.04.98							0.04	0.08	0.05	0.04	0.04	0.02	0.03	0.01
29.04.98							0.1	0.02	0.01	0.02	0.03	0.04	<0.01	0.01
17.06.98							0.08	0.11	0.06	0.07	0.09	0.1	<0.01	0.02
19.08.98							0.28	0.08	0.07	0.07	0.07	0.04	0.04	0.01
15.10.98							0.06	0.04	0.04	0.04	0.04	0.01	0.05	0.01
8.12.98							0.03	0.01	0.01	0.01	0.01	0.12	0.01	0.02
11.02.99							0.12	0.11	0.11	0.1	0.1	0.02	0.01	0.01
20.04.99							0.08	0.02	0.05	0.02	0.12	0.01	0.01	0.01
3.06.99							0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3.08.99							0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01
15.09.99							0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01
11.11.99							0.02	0.04	0.01		0.02	0.01	0.01	0.01
6/01/2000							0.01	0.02	0.01	0.01	0.01	0.06	0.05	0.01
22/02/2000							0.06	0.08	0.07	0.07	0.04	0.02	0.05	0.01
17/05/2000							0.06	0.04	0.02	0.03	0.03	0.01	0.05	0.05
5/07/2000							0.01	0.01	0.01	0.02	0.01	0.02	0.05	0.05
30/08/2000							0.06	0.02	0.05	0.01	0.05	0.02	0.05	0.05
15/11/2000							0.13	0.03	0.03	0.03	0.04	0.02	0.05	0.05
10/01/2001							0.01	0.01	0.01	0.02	0.02	0.05	0.05	0.05
22/03/2001							0.07	0.06	0.04	0.03	0.05	0.01	0.05	0.05
23/05/2001							0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05
11/07/2001							0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05
19/09/2001							0.01	0.02	0.01	0.07	0.01	0.01	0.05	0.05
22/11/2001							0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05
30/01/2002							0.01	0.01	0.01	0.01	0.01	0.02	0.05	0.05
20/03/2002							0.03	0.04	0.03	0.03	0.03	0.04	0.05	1.05
1/05/2002							0.04	0.04	0.04	0.26	0.04	0.04		0.05
29/05/2002							0.04	0.03	0.03	0.04	0.04	0.05		0.05
10/07/2002							0.05	0.05	0.05	0.12	0.05	0.05		
25/09/2002							0.05	0.05	0.05	0.05	0.05	0.05		
25/11/2002							0.05	0.05	0.05	0.05	0.05	0.05		
15/01/2003							0.05	0.05	0.05	0.05	0.05	0.05		
18/02/2003							0.05	0.05	0.05	0.05	0.05	0.05		
15/04/2003							0.05	0.05	0.05	0.05	0.05	0.05		
19/06/2003							0.05	0.05	0.05	0.05	0.05	0.05		
12/08/2003							0.05	0.05	0.05	0.05	0.05	0.05		
1/10/2003							0.05	0.05	0.05	0.05	0.05	0.05		
3/12/2003							0.05	0.05	0.05	0.05	0.05	0.05		
21/01/2004							0.08	0.06	0.05	0.14	0.05	0.05		
31/03/2004							0.05	0.05	0.07	0.05	0.05	0.05		
18/05/2004							0.05	0.05	0.05	0.05	0.05	0.05		
21/07/2004							0.05	0.05	0.05	0.05	0.05			

Sampling points in Tweed River

number name

- 1** Upstream from hotel
- 2** Mid stream opposite boat ramp
- 3** Mouth of Rous River
- 4** Tumbulgum bridge
- 5** Tumbulgum outfall
- 6** Downstream of Tumbulgum outfall
- 7** Barneys Point bridge
- 8** Chinderah Bay
- 9** Opposite Caravan Park
- 10** At outfall
- 11** Off end of island
- 12** Shallow Bay
- 13** Kirkwood Road
- 14** Northern end of Ekerebagh Island

APPENDIX M

- FLORA AND FAUNA ASSESSMENT