

RABY BAY CANAL BATTER STABILITY UPDATE

Geotechnical Investigation Options Report

Prepared for:

REDLAND CITY COUNCIL

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Acknowledgments

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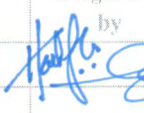
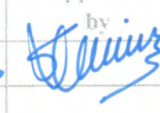
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Revision History

Revision	Date	Comment	Signatures		
			Originated by	Checked by	Approved by
A	18/05/10	Issued to Client for review			

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Summary

In 2008, Kellogg Brown & Root Pty Ltd was commissioned by Redland City Council to carry out a Desktop Study review of previous work into the stability of canal batters within the Raby Bay Canal Estate development and to examine rectification option concepts. This work was completed in January 2009 (Report BEJ809-W-REP-001 Rev. A dated 19 January 2009).

This review advised that due to the lack of specific and representative geotechnical information for the canal batters there was a limited understanding of the causes and mechanisms of the observed slope failures. Geotechnical risk is often the largest risk in civil engineering construction. Even for apparently similar ground conditions, it is possible to have a change in property, strength and behaviour that may influence the whole soil geotechnical structure. Therefore the report recommended further targeted geotechnical testing to refine the geotechnical parameters for more detailed stability modelling which will allow design optimisation and a reduction in the cost of remedial works. Taking into consideration that there are approximately 30 km of canal frontage that could potentially fail, optimizing the design of the remedial works will generate significant savings for Redland City Council in the long-term.

Subsequently Redland City Council advised that geotechnical specialists will be engaged to carry out the recommended testing and commissioned Kellogg Brown & Root Pty Ltd to prepare a testing specification, develop options (staging) to carry out the testing and estimate the costs related to three different options. The specification was used to call tenders mid 2009. The tendering was not successful because the quotations were too expensive. This report examines the options for geotechnical testing and presents an economic and safety justification for geotechnical testing.

It is recommended that the 'Option C' geotechnical investigation plan be carried out at Raby Bay. This option considers the following:

- Previous slope/wall failure at Raby Bay.
- The much high cost of marine access investigations compared to land access. Early tests are land based only.
- Construction sequence of Raby Bay.
- The cash flow implications for Redland City Council.

The following is the summary of the recommended Option C plan with cost estimate (rounded):

Stage description	Estimated cost (A\$) inc. GST
– Stage C1 (9 boreholes)	210,000
– Stage C2 (9 boreholes)	240,000
– Stage C3 (9 boreholes)	250,000
– Stage C4 (8 boreholes)	230,000
– Stage C5 (8 boreholes)	230,000
– Stage C6 (7 boreholes)	240,000
– Stage C7 (10 boreholes)	260,000
Total cost	\$1,660,000

This proposed Geotechnical investigation is easily justified from a safety view point (refer Section 3.2). The proposed geotechnical investigation has an internal rate of return of between 38% and 150% (approximately \$26 million to \$58 million savings in capital works costs (less geotechnical costs) over 20 years).

1 Introduction

Raby Bay is a residential canal estate located at Cleveland, Redland City in southern Moreton Bay, Queensland. The site was formerly mainly tidal wetlands. The estate was developed in the 1980s to 1990s using a cut to fill method, constructed in the dry and subsequently flooded. During and after construction some of the canal batters failed in a classic slip circle fashion.

On a case-by-case basis where the failures occurred, various geotechnical and design specialist consultants have been engaged to address slope failures and other ground movements over the history of the development. Various remedial responses and restoration methods have been employed generally with technical success, but at high cost.

The complexity of mechanisms behind ground movements and slope failures, the variety of failure manifestations, and the very high projected costs of restoration works have led the Council to investigate more permanent and economical approaches to the problem.

In 2008, Kellogg Brown & Root Pty Ltd (KBR) was commissioned by Redland City Council (RCC) to carry out a Desktop Study to do the review of all previous work into the stability of canal batters within the Raby Bay Canal Estate development and to examine rectification option concepts. This work was completed in January 2009. After reviewing all the available information, the desktop review highlighted a limited understanding of the causes and mechanisms of slope failures due to the lack of more specific and representative geotechnical information. Therefore it was recommended that targeted geotechnical testing was required to refine the geotechnical parameters for more detailed stability modelling. KBR provided a technical specification to RCC for the calling of geotechnical investigation tenders in mid 2009. Unfortunately the quotations received were above Council's budget at the time. Hence, this report was commissioned to look at more efficient alternatives.

1.1 OBJECTIVES

The aim of this report is to outline a targeted geotechnical testing program (field and laboratory) by providing different options and stages of execution, plus giving priority to areas with the highest failure rates. Efficiency of the investigation whilst providing enough information for capital cost savings is a key criterion.

The different options and the number of boreholes proposed for each stage have been developed to acquire insights into the mechanisms of canal bank failure by providing sufficient representative sampling, whilst keeping the number of tests required to the minimum possible. The amount and distribution of tests proposed for each stage will provide the necessary geotechnical data to allow designers to develop the most

suitable, effective and economical solution to minimise development of further slope failures and provide accurate information for the design of remedial works where the failure has already occurred.

Past quotations have highlighted the much greater cost of marine access testing compared to land based. Minimising marine access testing is therefore an important criterion.

2 Methodology

Key criteria are:

- boreholes are targeted near areas that have experienced failures in the past
- easy access to the proposed borehole locations; the proposed geotechnical investigation covers 42 land access boreholes and 18 water access boreholes; minimising the very expensive marine access holes
- cost minimisation
- minimal disruption to residents
- maximise opportunity to introduce efficiencies into the testing program (e.g. substitute cheap tests and correlations for dear tests).

KBR assessed three different investigation options. They are:

- Option A: Single-stage geotechnical investigation
- Option B: Three-stage geotechnical investigation
- Option C: Multi-stage geotechnical investigation

The borehole locations with approximate coordinates are in Appendix D.

2.1 OPTION A: SINGLE-STAGE INVESTIGATION

This option envisages a single stage geotechnical investigation for the whole of the Raby Bay development. A total of 60 boreholes throughout the entire site is proposed to provide sufficient sampling density to be able to draw conclusions about the entire site. Disadvantage with this option is the high once off cost and no testing refinement opportunity.

The estimated cost for this option is A\$1,500,000 including GST.

Figure A1 shows the location of the boreholes. Bill of Quantities Table 1 (BQ1) details the cost estimate for this investigation. Both Figure A1 and BQ1 are in Appendix A of this report.

2.2 OPTION B: THREE-STAGE INVESTIGATION

This option has the same number of boreholes as Option A. The proposed stages have an initial focus on areas of past failures.

Table 1.1 indicates the estimated cost of each stage.

Table 1.1 Option B Cost Estimate

			Cost (\$)
Stage B1	–	La–11B	246,273
	–	Wa–6B	210,088
Stage B2	–	La–10B	225,855
	–	Wa–4B	141,702
Stage B3	–	La–21B	450,453
	–	Wa–8B	278,474
Total			1,552,845

Legend: La Land Access
W2 Water Access
B – Boreholes

Figure B1 shows the location of the boreholes. BQ2 shows the estimated cost of this investigation. Both Figure B1 and BQ2 are available in Appendix B.

The total cost of Option B is higher than Option A due to multiple mobilisations/demobilisations; however Option B offers the possibility of testing refinements in Stages B2 and B3. The savings due to these refinements are not included in Table 1.1.

2.3 OPTION C: MULTI-STAGE INVESTIGATION

This option is a further breakdown of Option B. There are a total of seven stages of investigation considered in this option. It also focuses early testing in areas of past failures and places with land access to minimise early costs.

Due to the multiple testing stages there is a good probability that the number of boreholes could be reduced as the geotechnical investigation progresses. The multiple stages also provide opportunity for testing refinement economies in the later stages.

Table 1.2 indicates the cost estimate. Option C has the highest cost estimate due to the numerous mobilisation/demobilisations. The possible borehole reduction and testing refinement savings mentioned above have not been included in Table 1.2.

Table 1.2 Option C Cost Estimate

			Cost (\$)
Stage C1	–	La–9B	205,437
Stage C2	–	La–7B	164,601
	–	W2–2B	73,316
Stage C3	–	La–6B	144,183
	–	W2–3B	107,509
Stage C4	–	La–5B	123,765
	–	Wa–3B	107,509
Stage C5	–	La–5B	123,765
	–	Wa–3B	107,509
Stage C6	–	L2–2B	62,511
	–	Wa–5B	175,895

			Cost (\$)
Stage C7	–	L2–8B	185,019
	–	Wa–2B	73,316
Total			1,654,335

Legend: *La* *Land Access*
 W2 *Water Access*
 B *– Boreholes*

Figure C1 indicates the location of the boreholes. Table BQ3 shows the cost of the investigation. Both Figure C1 and BQ3 are in Appendix C.

3 The economic and safety rationale for detailed geotechnical investigations

3.1 INTRODUCTION

This chapter looks at the justification for detailed geotechnical testing.

The degree of geotechnical investigation works depends on the complexity of the ground conditions, the proposed development, time restrictions, and financial constraints. In general, investigation intensity can be categorized as follows:

- Method 1: Limited investigations leading to the use of lower bound soil parameters and hence (probably) excessive factors of safety.
- Method 2: Limited investigations plus reliance on past design assumptions and experiences.
- Method 3: Detailed geotechnical investigations.

Method 1 usually ends up with costly design solutions while the risk of uncertainties remains. Inappropriate soil parameters and factors may be used. An example is the use of soil parameters from direct shear tests, which are a fairly cheap, instead of the more expensive triaxial tests, which might be a more appropriate for the given soil type and ground condition.

Method 2 may not be as costly as Method 1 but is frequently dangerous. No two locations are alike, therefore previous experience and design assumptions may not apply.

Method 3 is the ideal geotechnical site investigation intensity, especially for a large site like Raby Bay. Whilst the objective is to have soil data results that adequately represent the entire site, this should be done as efficiently as possible. A pilot testing program can be used to refine the number and nature of subsequent tests.

3.2 CASE HISTORIES – RISK OF FAILURE DUE TO INADEQUATE GEOTECHNICAL INVESTIGATIONS

Geotechnical risk is often the largest risk in civil engineering construction. Even with apparently similar ground conditions, it is possible to have subtle change in property, strength and behaviour that may influence the whole soil geotechnical structure.

The National Research Council (1984) recommends that at least 3% of the total project cost should be dedicated to site investigations. Actual expenditure in practice can be as low as 0.1% to 0.5% of the total project cost. A low level of investigation increases the level of risk. This risk increase is usually unknown to the property owner or developer, unless there is a failure.

The three case histories described below illustrate where inadequate or poor site investigations resulted in cost overruns and structural failures. The first two cases come from a paper (Moh 2004) presented at a conference in Singapore. The third example is just one of the many near-miss or geotechnical failures that have occurred in Australia. Most cases of inadequate geotechnical investigation causing costly failures have not been documented or published in the literature.

Case 1 – Landslip in the Lincoln Community, Taipei, Taiwan

This incident occurred on 18th August 1997 when 28 lives were lost during in a landslide during a typhoon. Two of the main reasons for the slip failure were an inaccurate site investigation report where the presence of shale was not indicated, and the improper selection of geotechnical design parameters.

Case 2 – Excessive settlements and tilting of structures adjacent to a construction site, Taipei, Taiwan

Boreholes were drilled during the design stage that indicated benign subsoil conditions. Subsequently there was excessive settlements and tilting of the buildings adjacent to the site. Subsequent exploratory excavations after the demolition of the tilted buildings revealed that there was a thin layer of about 300mm of sandy soil containing decayed timber that was missed by the initial investigation. More detailed site investigations would have detected this layer and probably prevented this incident.

Case 3 – Cost overrun for the change of a foundation system, Adelaide, South Australia (Jaksa 2000)

The upgrading of facilities at the University of Adelaide with a total budget cost of A\$41 million involved two new buildings. The budget cost of the two new buildings alone was estimated to be A\$24 million. The tender prices for the site investigation varied from 0.025% to 0.04% of the A\$24 million. During the pile acceptance testing, a bored pile foundation failed at the service load level. The foundation system had to be revised, which added A\$170,000 cost, plus there was an extension of the construction period of between 4 and 6 weeks. Jaksa said that one of the factors that caused the underestimation of the pile foundation capacity was the minimalist approach to the geotechnical site investigation. It was fortunate that the inadequate pile capacity was discovered during the pile loading tests.

3.3 CAPACITY REDUCTION FACTORS – THE ECONOMIC JUSTIFICATION FOR DETAILED GEOTECHNICAL INVESTIGATIONS

The authors are not aware of any documented cases of two closely comparable projects where one had an appropriate level of geotechnical investigation, and second had inadequate investigations leading to extra capital costs. Nevertheless, the Codes effectively require the use of high factors of safety when the geotechnical investigation is minimal. In this section the economic effect of these Code provisions is examined.

The Australian Standard for Piling Design and Installation AS 2159-1995 Table 4.1 advises that a soil capacity reduction factor of 0.45 should be applied when there is ‘limited site investigation’ and 0.65 should be used when there is ‘comprehensive site

investigation'. Therefore an apparent increase in structure strength of 44% is required due to limited geotechnical investigations.

In the case of piles used to strengthen a clay soil batter (i.e. the Raby Bay canal batter situation), the lateral capacity of the piles is proportional to the pile penetration into the clay (Broms 1981). Hence, if a 44% increase in strength is required due to a limited geotechnical investigation then the piling should cost 44% more. This cost increase might be less once mobilisation/demobilisation and overheads are taken into account. Therefore a *cost saving* due to a comprehensive geotechnical investigation of 20% is plausible.

3.3.1 Economic analysis

- A comprehensive geotechnical investigation of the Raby Bay site is estimated to cost \$1.5 million. If some additional geotechnical investigation is required later then the total geotechnical investigation cost could be about \$2.0 million.
- Assume 20 km of canal frontage must be repaired (out of the 30 km total frontage at Raby Bay) using piles.
- Assume a total repair cost with limited geotechnical investigation (i.e. today's situation) = \$15,000/lin m x 20,000 m = \$300 million.
- Assume a total repair cost with comprehensive geotechnical investigation is 20% cheaper = \$12,000/lin m x 20,000 m = \$240 million; i.e. a savings of \$60 million.
- A comprehensive geotechnical investigation therefore costs only 0.83% of the capital cost which is modest compared to the National Research Council recommendation of 3%.
- The internal rate of return of a comprehensive geotechnical investigation, assuming the repair work takes 20 years = 150%.
- Sensitivity check: If the geotechnical investigation costs twice the above assumption and the capital cost saving is 10% not 20%, then the internal rate of return of a comprehensive geotechnical investigation = 38%, which is still a high value.

3.4 SUMMARY

A comprehensive geotechnical investigation is easily justifiable from a safety viewpoint. The economic justification for a comprehensive geotechnical investigation is compelling. Therefore we recommend that a comprehensive geotechnical investigation be conducted for the Raby Bay canal batter stabilisation work.

4 Conclusions and recommendations

KBR recommends that RCC proceed with the Option C geotechnical investigation at Raby Bay. This option focuses early testing in areas of past failures and areas accessible by land, to minimise early costs and maximise benefits. Due to the proposed staging the possibility of testing refinement and/or a reduction in the number of boreholes as the geotechnical investigation progresses is possible.

Comprehensive geotechnical investigation is easily justifiable from safety and cost considerations.

5 References

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Appendix A

OPTION A – DETAILS

Option A
Bill of Quantities - BQ1

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +/- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	41	\$2,725	\$111,725
1.3 Management and attendance	day	63	\$1,000	\$63,000
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	63	\$1,850	\$116,550
1.5 Making good of site after testing	Item	42	\$250	\$10,500
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	42	\$200	\$8,400
SUBTOTAL				\$334,575
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	42	\$2,640	\$110,880
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	21	\$1,695	\$35,595
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	21	\$3,390	\$71,190
2.4 Vane Shear (VS) - (PQ)	No.	42	\$2,825	\$118,650
2.5 Undisturbed tube samples - (PQ)	No.	42	\$1,978	\$83,076
SUBTOTAL				\$419,391
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	8	\$100	\$840
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	8	\$100	\$840
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	8	\$100	\$840
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	8	\$90	\$756
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	8	\$25	\$210
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	8	\$60	\$504
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	21	\$600	\$12,600
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	21	\$1,000	\$21,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	5	\$1,500	\$7,875
SUBTOTAL				\$45,465
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$16,800	\$16,800
4.2 Interpretive Geotechnical Report	Item	1	\$63,000	\$63,000
SUBTOTAL				\$79,800
TOTAL COST				\$879,231

Option A
Bill of Quantities - BQ1

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations
Preliminary Bill of Quantities and Cost Estimate

Boreholes using Crane Barge (Access limited, through water only)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including Crane Barge 1.5T @ 6.0m reach to facilitate testing)	Item	1	\$8,050	\$8,050
1.2 Initial Establishment (set up) and Disestablishment insitu Test Rig on Skid Sled	Item	1	\$480	\$480
1.3 Reestablishment, set-up Insitu testing Rig	item	17	\$3,600	\$61,200
1.4 Crane Barge hire (including operator)	day	54	\$2,875	\$155,250
1.5 Management and attendance	day	54	\$1,000	\$54,000
1.6 Ancillary Equipment (e.g. drilling rig and crew)	day	54	\$1,850	\$99,900
1.7 Making good of site after testing	Item	18	\$250	\$4,500
1.8 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	18	\$200	\$3,600
SUBTOTAL				\$386,980
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	18	\$2,640	\$47,520
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	9	\$1,695	\$15,255
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	9	\$3,390	\$30,510
2.4 Vane Shear (VS) - (PQ)	No.	18	\$2,825	\$50,850
2.5 Undisturbed tube samples - (PQ)	No.	18	\$1,978	\$35,604
SUBTOTAL				\$179,739
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	4	\$100	\$360
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	4	\$100	\$360
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	4	\$100	\$360
3.4 Shrink-Swell Index (AS1289.1.1) (PQ)	No.	4	\$90	\$324
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	4	\$25	\$90
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	4	\$60	\$216
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	9	\$600	\$5,400
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	9	\$1,000	\$9,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	2	\$1,500	\$3,375
SUBTOTAL				\$19,485
4 Reporting				
4.1 Factual Geotechnical Report (Inc. Land and Marine)	Item	1	\$7,200	\$7,200
4.2 Interpretive Geotechnical Report (Inc. Land and Marine)	Item	1	\$27,000	\$27,000
SUBTOTAL				\$34,200
TOTAL COST				\$620,404
Total Cost of Soil Investigation				\$1,499,635

Notes:

PQ = Provisional Quantity

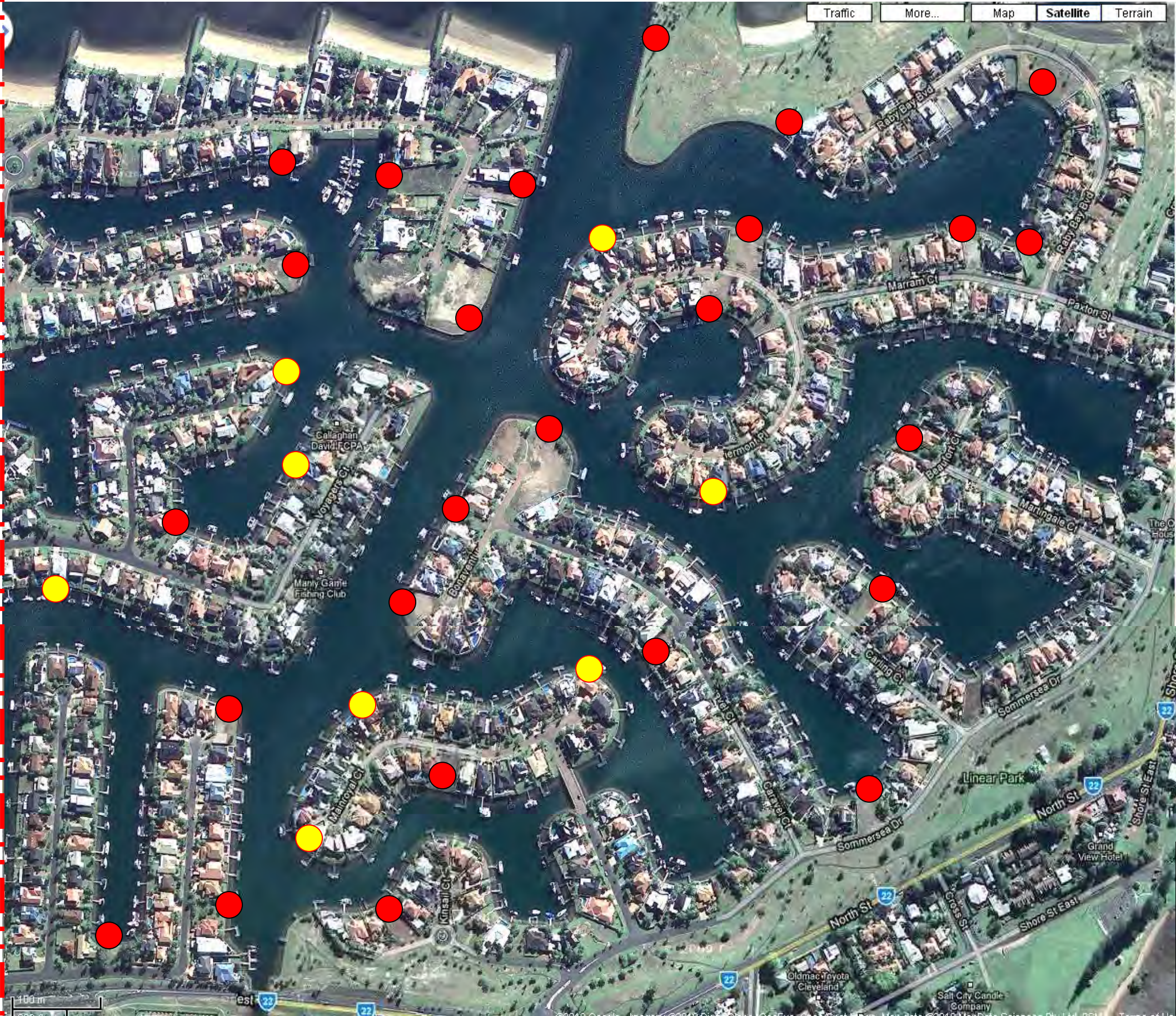
PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)



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CONTINUATION ON PAGE 1 OF 2



OPTION A
Fig. A1

LEGEND:	
 Boreholes using Drilling Rig (Easily accessible through land)	42 Nos.
 Boreholes using Crane Barge (Access limited, through water only)	18 Nos.
TOTAL	60 Nos.

Appendix B

OPTION B – DETAILS

Option B (Stage 1)
Bill of Quantities - BQ2

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +/- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	10	\$2,725	\$27,250
1.3 Management and attendance	day	17	\$1,000	\$16,500
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	17	\$1,850	\$30,525
1.5 Making good of site after testing	Item	11	\$250	\$2,750
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	11	\$200	\$2,200
SUBTOTAL				\$103,625
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	11	\$2,640	\$29,040
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	6	\$1,695	\$9,323
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	6	\$3,390	\$18,645
2.4 Vane Shear (VS) - (PQ)	No.	11	\$2,825	\$31,075
2.5 Undisturbed tube samples - (PQ)	No.	11	\$1,978	\$21,758
SUBTOTAL				\$109,841
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	2	\$100	\$220
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	2	\$100	\$220
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	2	\$100	\$220
3.4 Shrink-Swell Index (AS1289.1.1) (PQ)	No.	2	\$90	\$198
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	2	\$25	\$55
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	2	\$60	\$132
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	6	\$600	\$3,300
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	6	\$1,000	\$5,500
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$2,063
SUBTOTAL				\$11,908
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$4,400	\$4,400
4.2 Interpretive Geotechnical Report	Item	1	\$16,500	\$16,500
SUBTOTAL				\$20,900
TOTAL COST				\$246,273

Option B (Stage 1)
Bill of Quantities - BQ2

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations
Preliminary Bill of Quantities and Cost Estimate

Boreholes using Crane Barge (Access limited, through water only)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including Crane Barge 1.5T @ 6.0m reach to facilitate testing)	Item	1	\$8,050	\$8,050
1.2 Initial Establishment (set up) and Disestablishment insitu Test Rig on Skid Sled	Item	1	\$480	\$480
1.3 Reestablishment, set-up Insitu testing Rig	item	5	\$3,600	\$18,000
1.4 Crane Barge hire (including operator)	day	18	\$2,875	\$51,750
1.5 Management and attendance	day	18	\$1,000	\$18,000
1.6 Ancillary Equipment (e.g. drilling rig and crew)	day	18	\$1,850	\$33,300
1.7 Making good of site after testing	Item	6	\$250	\$1,500
1.8 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	6	\$200	\$1,200
SUBTOTAL				\$132,280
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	6	\$2,640	\$15,840
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	3	\$1,695	\$5,085
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	3	\$3,390	\$10,170
2.4 Vane Shear (VS) - (PQ)	No.	6	\$2,825	\$16,950
2.5 Undisturbed tube samples - (PQ)	No.	6	\$1,978	\$11,868
SUBTOTAL				\$59,913
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	1	\$100	\$120
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	1	\$100	\$120
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	1	\$100	\$120
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	1	\$90	\$108
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	1	\$25	\$30
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	1	\$60	\$72
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	3	\$600	\$1,800
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	3	\$1,000	\$3,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$1,125
SUBTOTAL				\$6,495
4 Reporting				
4.1 Factual Geotechnical Report (Inc. Land and Marine)	Item	1	\$2,400	\$2,400
4.2 Interpretive Geotechnical Report (Inc. Land and Marine)	Item	1	\$9,000	\$9,000
SUBTOTAL				\$11,400
TOTAL COST				\$210,088
Total Cost of Soil Investigation For Stage 1				\$456,361

Notes:

PQ = Provisional Quantity

PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)

Option B (Stage 2)
Bill of Quantities - BQ2

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +/- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	9	\$2,725	\$24,525
1.3 Management and attendance	day	15	\$1,000	\$15,000
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	15	\$1,850	\$27,750
1.5 Making good of site after testing	Item	10	\$250	\$2,500
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	10	\$200	\$2,000
SUBTOTAL				\$96,175
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	10	\$2,640	\$26,400
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	5	\$1,695	\$8,475
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	5	\$3,390	\$16,950
2.4 Vane Shear (VS) - (PQ)	No.	10	\$2,825	\$28,250
2.5 Undisturbed tube samples - (PQ)	No.	10	\$1,978	\$19,780
SUBTOTAL				\$99,855
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	2	\$100	\$200
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	2	\$100	\$200
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	2	\$100	\$200
3.4 Shrink-Swell Index (AS1289.1.1) (PQ)	No.	2	\$90	\$180
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	2	\$25	\$50
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	2	\$60	\$120
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	5	\$600	\$3,000
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	5	\$1,000	\$5,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$1,875
SUBTOTAL				\$10,825
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$4,000	\$4,000
4.2 Interpretive Geotechnical Report	Item	1	\$15,000	\$15,000
SUBTOTAL				\$19,000
TOTAL COST				\$225,855

Option B (Stage 2)
Bill of Quantities - BQ2

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations
Preliminary Bill of Quantities and Cost Estimate

Boreholes using Crane Barge (Access limited, through water only)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including Crane Barge 1.5T @ 6.0m reach to facilitate testing)	Item	1	\$8,050	\$8,050
1.2 Initial Establishment (set up) and Disestablishment insitu Test Rig on Skid Sled	Item	1	\$480	\$480
1.3 Reestablishment, set-up Insitu testing Rig	item	3	\$3,600	\$10,800
1.4 Crane Barge hire (including operator)	day	12	\$2,875	\$34,500
1.5 Management and attendance	day	12	\$1,000	\$12,000
1.6 Ancillary Equipment (e.g. drilling rig and crew)	day	12	\$1,850	\$22,200
1.7 Making good of site after testing	Item	4	\$250	\$1,000
1.8 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	4	\$200	\$800
SUBTOTAL				\$89,830
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	4	\$2,640	\$10,560
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	2	\$1,695	\$3,390
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	2	\$3,390	\$6,780
2.4 Vane Shear (VS) - (PQ)	No.	4	\$2,825	\$11,300
2.5 Undisturbed tube samples - (PQ)	No.	4	\$1,978	\$7,912
SUBTOTAL				\$39,942
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	1	\$100	\$80
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	1	\$100	\$80
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	1	\$100	\$80
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	1	\$90	\$72
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	1	\$25	\$20
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	1	\$60	\$48
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	2	\$600	\$1,200
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	2	\$1,000	\$2,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$750
SUBTOTAL				\$4,330
4 Reporting				
4.1 Factual Geotechnical Report (Inc. Land and Marine)	Item	1	\$1,600	\$1,600
4.2 Interpretive Geotechnical Report (Inc. Land and Marine)	Item	1	\$6,000	\$6,000
SUBTOTAL				\$7,600
TOTAL COST				\$141,702
Total Cost of Soil Investigation For Stage 2				\$387,975

Notes:

PQ = Provisional Quantity

PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)

Option B (Stage 3)
Bill of Quantities - BQ2

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +/- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	20	\$2,725	\$54,500
1.3 Management and attendance	day	32	\$1,000	\$31,500
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	32	\$1,850	\$58,275
1.5 Making good of site after testing	Item	21	\$250	\$5,250
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	21	\$200	\$4,200
SUBTOTAL				\$178,125
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	21	\$2,640	\$55,440
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	11	\$1,695	\$17,798
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	11	\$3,390	\$35,595
2.4 Vane Shear (VS) - (PQ)	No.	21	\$2,825	\$59,325
2.5 Undisturbed tube samples - (PQ)	No.	21	\$1,978	\$41,538
SUBTOTAL				\$209,696
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	4	\$100	\$420
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	4	\$100	\$420
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	4	\$100	\$420
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	4	\$90	\$378
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	4	\$25	\$105
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	4	\$60	\$252
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	11	\$600	\$6,300
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	11	\$1,000	\$10,500
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	3	\$1,500	\$3,938
SUBTOTAL				\$22,733
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$8,400	\$8,400
4.2 Interpretive Geotechnical Report	Item	1	\$31,500	\$31,500
SUBTOTAL				\$39,900
TOTAL COST				\$450,453

Option B (Stage 3)
Bill of Quantities - BQ2

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations
Preliminary Bill of Quantities and Cost Estimate

Boreholes using Crane Barge (Access limited, through water only)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including Crane Barge 1.5T @ 6.0m reach to facilitate testing)	Item	1	\$8,050	\$8,050
1.2 Initial Establishment (set up) and Disestablishment insitu Test Rig on Skid Sled	Item	1	\$480	\$480
1.3 Reestablishment, set-up Insitu testing Rig	item	7	\$3,600	\$25,200
1.4 Crane Barge hire (including operator)	day	24	\$2,875	\$69,000
1.5 Management and attendance	day	24	\$1,000	\$24,000
1.6 Ancillary Equipment (e.g. drilling rig and crew)	day	24	\$1,850	\$44,400
1.7 Making good of site after testing	Item	8	\$250	\$2,000
1.8 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	8	\$200	\$1,600
SUBTOTAL				\$174,730
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	8	\$2,640	\$21,120
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	4	\$1,695	\$6,780
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	4	\$3,390	\$13,560
2.4 Vane Shear (VS) - (PQ)	No.	8	\$2,825	\$22,600
2.5 Undisturbed tube samples - (PQ)	No.	8	\$1,978	\$15,824
SUBTOTAL				\$79,884
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	2	\$100	\$160
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	2	\$100	\$160
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	2	\$100	\$160
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	2	\$90	\$144
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	2	\$25	\$40
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	2	\$60	\$96
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	4	\$600	\$2,400
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	4	\$1,000	\$4,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$1,500
SUBTOTAL				\$8,660
4 Reporting				
4.1 Factual Geotechnical Report (Inc. Land and Marine)	Item	1	\$3,200	\$3,200
4.2 Interpretive Geotechnical Report (Inc. Land and Marine)	Item	1	\$12,000	\$12,000
SUBTOTAL				\$15,200
TOTAL COST				\$278,474
Total Cost of Soil Investigation For Stage 3				\$524,747

Notes:

PQ = Provisional Quantity

PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)

STAGE 1:
Land Access Boreholes 8 Nos.
Water Access Boreholes 6 Nos.



CONTINUATION ON PAGE 2 OF 2

CONTINUATION ON PAGE 1 OF 2



STAGE 1 (cont'd from page 1):
Land Access Boreholes 3 Nos.

STAGE 2:
Land Access Boreholes 10 Nos.
Water Access Boreholes 4 Nos.

STAGE 3:
Land Access Boreholes 21 Nos.
Water Access Boreholes 8 Nos.

OPTION B
Fig. B1

LEGEND:	
 Boreholes using Drilling Rig (Easily accessible through land)	42 Nos.
 Boreholes using Crane Barge (Access limited, through water only)	18 Nos.
TOTAL	60 Nos.

Appendix C

OPTION C – DETAILS

Option C (Stage 1)

Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +/- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	8	\$2,725	\$21,800
1.3 Management and attendance	day	14	\$1,000	\$13,500
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	14	\$1,850	\$24,975
1.5 Making good of site after testing	Item	9	\$250	\$2,250
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	9	\$200	\$1,800
SUBTOTAL				\$88,725
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	9	\$2,640	\$23,760
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	5	\$1,695	\$7,628
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	5	\$3,390	\$15,255
2.4 Vane Shear (VS) - (PQ)	No.	9	\$2,825	\$25,425
2.5 Undisturbed tube samples - (PQ)	No.	9	\$1,978	\$17,802
SUBTOTAL				\$89,870
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	2	\$100	\$180
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	2	\$100	\$180
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	2	\$100	\$180
3.4 Shrink-Swell Index (AS1289.1.1) (PQ)	No.	2	\$90	\$162
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	2	\$25	\$45
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	2	\$60	\$108
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	5	\$600	\$2,700
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	5	\$1,000	\$4,500
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$1,688
SUBTOTAL				\$9,743
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$3,600	\$3,600
4.2 Interpretive Geotechnical Report	Item	1	\$13,500	\$13,500
SUBTOTAL				\$17,100
Total Cost of Soil Investigation For Stage 1				\$205,437

Notes:

PQ = Provisional Quantity

PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)

Option C (Stage 2)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +/- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	6	\$2,725	\$16,350
1.3 Management and attendance	day	11	\$1,000	\$10,500
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	11	\$1,850	\$19,425
1.5 Making good of site after testing	Item	7	\$250	\$1,750
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	7	\$200	\$1,400
SUBTOTAL				\$73,825
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	7	\$2,640	\$18,480
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	4	\$1,695	\$5,933
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	4	\$3,390	\$11,865
2.4 Vane Shear (VS) - (PQ)	No.	7	\$2,825	\$19,775
2.5 Undisturbed tube samples - (PQ)	No.	7	\$1,978	\$13,846
SUBTOTAL				\$69,899
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	1	\$100	\$140
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	1	\$100	\$140
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	1	\$100	\$140
3.4 Shrink-Swell Index (AS1289.1.1) (PQ)	No.	1	\$90	\$126
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	1	\$25	\$35
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	1	\$60	\$84
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	4	\$600	\$2,100
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	4	\$1,000	\$3,500
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$1,313
SUBTOTAL				\$7,578
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$2,800	\$2,800
4.2 Interpretive Geotechnical Report	Item	1	\$10,500	\$10,500
SUBTOTAL				\$13,300
TOTAL COST				\$164,601

Option C (Stage 2)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations
Preliminary Bill of Quantities and Cost Estimate

Boreholes using Crane Barge (Access limited, through water only)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including Crane Barge 1.5T @ 6.0m reach to facilitate testing)	Item	1	\$8,050	\$8,050
1.2 Initial Establishment (set up) and Disestablishment insitu Test Rig on Skid Sled	Item	1	\$480	\$480
1.3 Reestablishment, set-up Insitu testing Rig	item	1	\$3,600	\$3,600
1.4 Crane Barge hire (including operator)	day	6	\$2,875	\$17,250
1.5 Management and attendance	day	6	\$1,000	\$6,000
1.6 Ancillary Equipment (e.g. drilling rig and crew)	day	6	\$1,850	\$11,100
1.7 Making good of site after testing	Item	2	\$250	\$500
1.8 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	2	\$200	\$400
SUBTOTAL				\$47,380
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	2	\$2,640	\$5,280
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	1	\$1,695	\$1,695
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	1	\$3,390	\$3,390
2.4 Vane Shear (VS) - (PQ)	No.	2	\$2,825	\$5,650
2.5 Undisturbed tube samples - (PQ)	No.	2	\$1,978	\$3,956
SUBTOTAL				\$19,971
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	0	\$100	\$40
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	0	\$100	\$40
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	0	\$100	\$40
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	0	\$90	\$36
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	0	\$25	\$10
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	0	\$60	\$24
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	1	\$600	\$600
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	1	\$1,000	\$1,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	0	\$1,500	\$375
SUBTOTAL				\$2,165
4 Reporting				
4.1 Factual Geotechnical Report (Inc. Land and Marine)	Item	1	\$800	\$800
4.2 Interpretive Geotechnical Report (Inc. Land and Marine)	Item	1	\$3,000	\$3,000
SUBTOTAL				\$3,800
TOTAL COST				\$73,316
Total Cost of Soil Investigation For Stage 2				\$237,917

Notes:

PQ = Provisional Quantity

PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)

Option C (Stage 3)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +/- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	5	\$2,725	\$13,625
1.3 Management and attendance	day	9	\$1,000	\$9,000
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	9	\$1,850	\$16,650
1.5 Making good of site after testing	Item	6	\$250	\$1,500
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	6	\$200	\$1,200
SUBTOTAL				\$66,375
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	6	\$2,640	\$15,840
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	3	\$1,695	\$5,085
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	3	\$3,390	\$10,170
2.4 Vane Shear (VS) - (PQ)	No.	6	\$2,825	\$16,950
2.5 Undisturbed tube samples - (PQ)	No.	6	\$1,978	\$11,868
SUBTOTAL				\$59,913
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	1	\$100	\$120
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	1	\$100	\$120
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	1	\$100	\$120
3.4 Shrink-Swell Index (AS1289.1.1) (PQ)	No.	1	\$90	\$108
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	1	\$25	\$30
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	1	\$60	\$72
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	3	\$600	\$1,800
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	3	\$1,000	\$3,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$1,125
SUBTOTAL				\$6,495
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$2,400	\$2,400
4.2 Interpretive Geotechnical Report	Item	1	\$9,000	\$9,000
SUBTOTAL				\$11,400
TOTAL COST				<u>\$144,183</u>

Option C (Stage 3)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations
Preliminary Bill of Quantities and Cost Estimate

Boreholes using Crane Barge (Access limited, through water only)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including Crane Barge 1.5T @ 6.0m reach to facilitate testing)	Item	1	\$8,050	\$8,050
1.2 Initial Establishment (set up) and Disestablishment insitu Test Rig on Skid Sled	Item	1	\$480	\$480
1.3 Reestablishment, set-up Insitu testing Rig	item	2	\$3,600	\$7,200
1.4 Crane Barge hire (including operator)	day	9	\$2,875	\$25,875
1.5 Management and attendance	day	9	\$1,000	\$9,000
1.6 Ancillary Equipment (e.g. drilling rig and crew)	day	9	\$1,850	\$16,650
1.7 Making good of site after testing	Item	3	\$250	\$750
1.8 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	3	\$200	\$600
SUBTOTAL				\$68,605
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	3	\$2,640	\$7,920
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	2	\$1,695	\$2,543
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	2	\$3,390	\$5,085
2.4 Vane Shear (VS) - (PQ)	No.	3	\$2,825	\$8,475
2.5 Undisturbed tube samples - (PQ)	No.	3	\$1,978	\$5,934
SUBTOTAL				\$29,957
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	1	\$100	\$60
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	1	\$100	\$60
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	1	\$100	\$60
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	1	\$90	\$54
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	1	\$25	\$15
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	1	\$60	\$36
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	2	\$600	\$900
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	2	\$1,000	\$1,500
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	0	\$1,500	\$563
SUBTOTAL				\$3,248
4 Reporting				
4.1 Factual Geotechnical Report (Inc. Land and Marine)	Item	1	\$1,200	\$1,200
4.2 Interpretive Geotechnical Report (Inc. Land and Marine)	Item	1	\$4,500	\$4,500
SUBTOTAL				\$5,700
TOTAL COST				\$107,509
Total Cost of Soil Investigation For Stage 3				\$251,692

Notes:

PQ = Provisional Quantity

PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)

Option C (Stage 4)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +/- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	4	\$2,725	\$10,900
1.3 Management and attendance	day	8	\$1,000	\$7,500
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	8	\$1,850	\$13,875
1.5 Making good of site after testing	Item	5	\$250	\$1,250
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	5	\$200	\$1,000
SUBTOTAL				\$58,925
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	5	\$2,640	\$13,200
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	3	\$1,695	\$4,238
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	3	\$3,390	\$8,475
2.4 Vane Shear (VS) - (PQ)	No.	5	\$2,825	\$14,125
2.5 Undisturbed tube samples - (PQ)	No.	5	\$1,978	\$9,890
SUBTOTAL				\$49,928
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	1	\$100	\$100
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	1	\$100	\$100
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	1	\$100	\$100
3.4 Shrink-Swell Index (AS1289.1.1) (PQ)	No.	1	\$90	\$90
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	1	\$25	\$25
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	1	\$60	\$60
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	3	\$600	\$1,500
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	3	\$1,000	\$2,500
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$938
SUBTOTAL				\$5,413
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$2,000	\$2,000
4.2 Interpretive Geotechnical Report	Item	1	\$7,500	\$7,500
SUBTOTAL				\$9,500
TOTAL COST				<u>\$123,765</u>

Option C (Stage 4)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations
Preliminary Bill of Quantities and Cost Estimate

Boreholes using Crane Barge (Access limited, through water only)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including Crane Barge 1.5T @ 6.0m reach to facilitate testing)	Item	1	\$8,050	\$8,050
1.2 Initial Establishment (set up) and Disestablishment insitu Test Rig on Skid Sled	Item	1	\$480	\$480
1.3 Reestablishment, set-up Insitu testing Rig	item	2	\$3,600	\$7,200
1.4 Crane Barge hire (including operator)	day	9	\$2,875	\$25,875
1.5 Management and attendance	day	9	\$1,000	\$9,000
1.6 Ancillary Equipment (e.g. drilling rig and crew)	day	9	\$1,850	\$16,650
1.7 Making good of site after testing	Item	3	\$250	\$750
1.8 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	3	\$200	\$600
SUBTOTAL				\$68,605
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	3	\$2,640	\$7,920
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	2	\$1,695	\$2,543
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	2	\$3,390	\$5,085
2.4 Vane Shear (VS) - (PQ)	No.	3	\$2,825	\$8,475
2.5 Undisturbed tube samples - (PQ)	No.	3	\$1,978	\$5,934
SUBTOTAL				\$29,957
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	1	\$100	\$60
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	1	\$100	\$60
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	1	\$100	\$60
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	1	\$90	\$54
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	1	\$25	\$15
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	1	\$60	\$36
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	2	\$600	\$900
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	2	\$1,000	\$1,500
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	0	\$1,500	\$563
SUBTOTAL				\$3,248
4 Reporting				
4.1 Factual Geotechnical Report (Inc. Land and Marine)	Item	1	\$1,200	\$1,200
4.2 Interpretive Geotechnical Report (Inc. Land and Marine)	Item	1	\$4,500	\$4,500
SUBTOTAL				\$5,700
TOTAL COST				\$107,509
Total Cost of Soil Investigation For Stage 4				\$231,274

Notes:

PQ = Provisional Quantity

PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)

Option C (Stage 5)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	4	\$2,725	\$10,900
1.3 Management and attendance	day	8	\$1,000	\$7,500
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	8	\$1,850	\$13,875
1.5 Making good of site after testing	Item	5	\$250	\$1,250
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	5	\$200	\$1,000
SUBTOTAL				\$58,925
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	5	\$2,640	\$13,200
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	3	\$1,695	\$4,238
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	3	\$3,390	\$8,475
2.4 Vane Shear (VS) - (PQ)	No.	5	\$2,825	\$14,125
2.5 Undisturbed tube samples - (PQ)	No.	5	\$1,978	\$9,890
SUBTOTAL				\$49,928
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	1	\$100	\$100
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	1	\$100	\$100
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	1	\$100	\$100
3.4 Shrink-Swell Index (AS1289.1.1) (PQ)	No.	1	\$90	\$90
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	1	\$25	\$25
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	1	\$60	\$60
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	3	\$600	\$1,500
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	3	\$1,000	\$2,500
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$938
SUBTOTAL				\$5,413
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$2,000	\$2,000
4.2 Interpretive Geotechnical Report	Item	1	\$7,500	\$7,500
SUBTOTAL				\$9,500
TOTAL COST				\$123,765

Option C (Stage 5)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations
Preliminary Bill of Quantities and Cost Estimate

Boreholes using Crane Barge (Access limited, through water only)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including Crane Barge 1.5T @ 6.0m reach to facilitate testing)	Item	1	\$8,050	\$8,050
1.2 Initial Establishment (set up) and Disestablishment insitu Test Rig on Skid Sled	Item	1	\$480	\$480
1.3 Reestablishment, set-up Insitu testing Rig	item	2	\$3,600	\$7,200
1.4 Crane Barge hire (including operator)	day	9	\$2,875	\$25,875
1.5 Management and attendance	day	9	\$1,000	\$9,000
1.6 Ancillary Equipment (e.g. drilling rig and crew)	day	9	\$1,850	\$16,650
1.7 Making good of site after testing	Item	3	\$250	\$750
1.8 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	3	\$200	\$600
SUBTOTAL				\$68,605
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	3	\$2,640	\$7,920
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	2	\$1,695	\$2,543
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	2	\$3,390	\$5,085
2.4 Vane Shear (VS) - (PQ)	No.	3	\$2,825	\$8,475
2.5 Undisturbed tube samples - (PQ)	No.	3	\$1,978	\$5,934
SUBTOTAL				\$29,957
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	1	\$100	\$60
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	1	\$100	\$60
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	1	\$100	\$60
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	1	\$90	\$54
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	1	\$25	\$15
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	1	\$60	\$36
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	2	\$600	\$900
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	2	\$1,000	\$1,500
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	0	\$1,500	\$563
SUBTOTAL				\$3,248
4 Reporting				
4.1 Factual Geotechnical Report (Inc. Land and Marine)	Item	1	\$1,200	\$1,200
4.2 Interpretive Geotechnical Report (Inc. Land and Marine)	Item	1	\$4,500	\$4,500
SUBTOTAL				\$5,700
TOTAL COST				\$107,509
Total Cost of Soil Investigation For Stage 5				\$231,274

Notes:

PQ = Provisional Quantity

PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)

Option C (Stage 6)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +/- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	1	\$2,725	\$2,725
1.3 Management and attendance	day	3	\$1,000	\$3,000
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	3	\$1,850	\$5,550
1.5 Making good of site after testing	Item	2	\$250	\$500
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	2	\$200	\$400
SUBTOTAL				\$36,575
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	2	\$2,640	\$5,280
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	1	\$1,695	\$1,695
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	1	\$3,390	\$3,390
2.4 Vane Shear (VS) - (PQ)	No.	2	\$2,825	\$5,650
2.5 Undisturbed tube samples - (PQ)	No.	2	\$1,978	\$3,956
SUBTOTAL				\$19,971
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	0	\$100	\$40
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	0	\$100	\$40
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	0	\$100	\$40
3.4 Shrink-Swell Index (AS1289.1.1) (PQ)	No.	0	\$90	\$36
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	0	\$25	\$10
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	0	\$60	\$24
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	1	\$600	\$600
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	1	\$1,000	\$1,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	0	\$1,500	\$375
SUBTOTAL				\$2,165
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$800	\$800
4.2 Interpretive Geotechnical Report	Item	1	\$3,000	\$3,000
SUBTOTAL				\$3,800
TOTAL COST				\$62,511

Option C (Stage 6)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations
Preliminary Bill of Quantities and Cost Estimate

Boreholes using Crane Barge (Access limited, through water only)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including Crane Barge 1.5T @ 6.0m reach to facilitate testing)	Item	1	\$8,050	\$8,050
1.2 Initial Establishment (set up) and Disestablishment insitu Test Rig on Skid Sled	Item	1	\$480	\$480
1.3 Reestablishment, set-up Insitu testing Rig	item	4	\$3,600	\$14,400
1.4 Crane Barge hire (including operator)	day	15	\$2,875	\$43,125
1.5 Management and attendance	day	15	\$1,000	\$15,000
1.6 Ancillary Equipment (e.g. drilling rig and crew)	day	15	\$1,850	\$27,750
1.7 Making good of site after testing	Item	5	\$250	\$1,250
1.8 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	5	\$200	\$1,000
SUBTOTAL				\$111,055
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	5	\$2,640	\$13,200
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	3	\$1,695	\$4,238
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	3	\$3,390	\$8,475
2.4 Vane Shear (VS) - (PQ)	No.	5	\$2,825	\$14,125
2.5 Undisturbed tube samples - (PQ)	No.	5	\$1,978	\$9,890
SUBTOTAL				\$49,928
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	1	\$100	\$100
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	1	\$100	\$100
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	1	\$100	\$100
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	1	\$90	\$90
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	1	\$25	\$25
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	1	\$60	\$60
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	3	\$600	\$1,500
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	3	\$1,000	\$2,500
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$938
SUBTOTAL				\$5,413
4 Reporting				
4.1 Factual Geotechnical Report (Inc. Land and Marine)	Item	1	\$2,000	\$2,000
4.2 Interpretive Geotechnical Report (Inc. Land and Marine)	Item	1	\$7,500	\$7,500
SUBTOTAL				\$9,500
TOTAL COST				\$175,895
Total Cost of Soil Investigation For Stage 6				\$238,406

Notes:

PQ = Provisional Quantity

PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)

Option C (Stage 7)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations

Preliminary Bill of Quantities and Cost Estimate

Rates and Costs in AUD 2010 (exclusive of GST)

Boreholes using Drilling Rig (Easily accessible through land)

Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including minor removal of revetment +/- earthworks & other miscellaneous to facilitate testing)	Item	1	\$24,400	\$24,400
1.2 Reestablishment - each new site	Item	7	\$2,725	\$19,075
1.3 Management and attendance	day	12	\$1,000	\$12,000
1.4 Ancillary Equipment (e.g. Drilling Rig etc.) and crew	day	12	\$1,850	\$22,200
1.5 Making good of site after testing	Item	8	\$250	\$2,000
1.6 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	8	\$200	\$1,600
SUBTOTAL				\$81,275
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	8	\$2,640	\$21,120
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	4	\$1,695	\$6,780
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	4	\$3,390	\$13,560
2.4 Vane Shear (VS) - (PQ)	No.	8	\$2,825	\$22,600
2.5 Undisturbed tube samples - (PQ)	No.	8	\$1,978	\$15,824
SUBTOTAL				\$79,884
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	2	\$100	\$160
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	2	\$100	\$160
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	2	\$100	\$160
3.4 Shrink-Swell Index (AS1289.1.1) (PQ)	No.	2	\$90	\$144
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	2	\$25	\$40
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	2	\$60	\$96
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	4	\$600	\$2,400
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	4	\$1,000	\$4,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	1	\$1,500	\$1,500
SUBTOTAL				\$8,660
4 Reporting				
4.1 Factual Geotechnical Report	Item	1	\$3,200	\$3,200
4.2 Interpretive Geotechnical Report	Item	1	\$12,000	\$12,000
SUBTOTAL				\$15,200
TOTAL COST				\$185,019

Option C (Stage 7)
Bill of Quantities - BQ3

RABY BAY CANAL STUDY- Detailed Geotechnical Investigations
Preliminary Bill of Quantities and Cost Estimate

Boreholes using Crane Barge (Access limited, through water only)

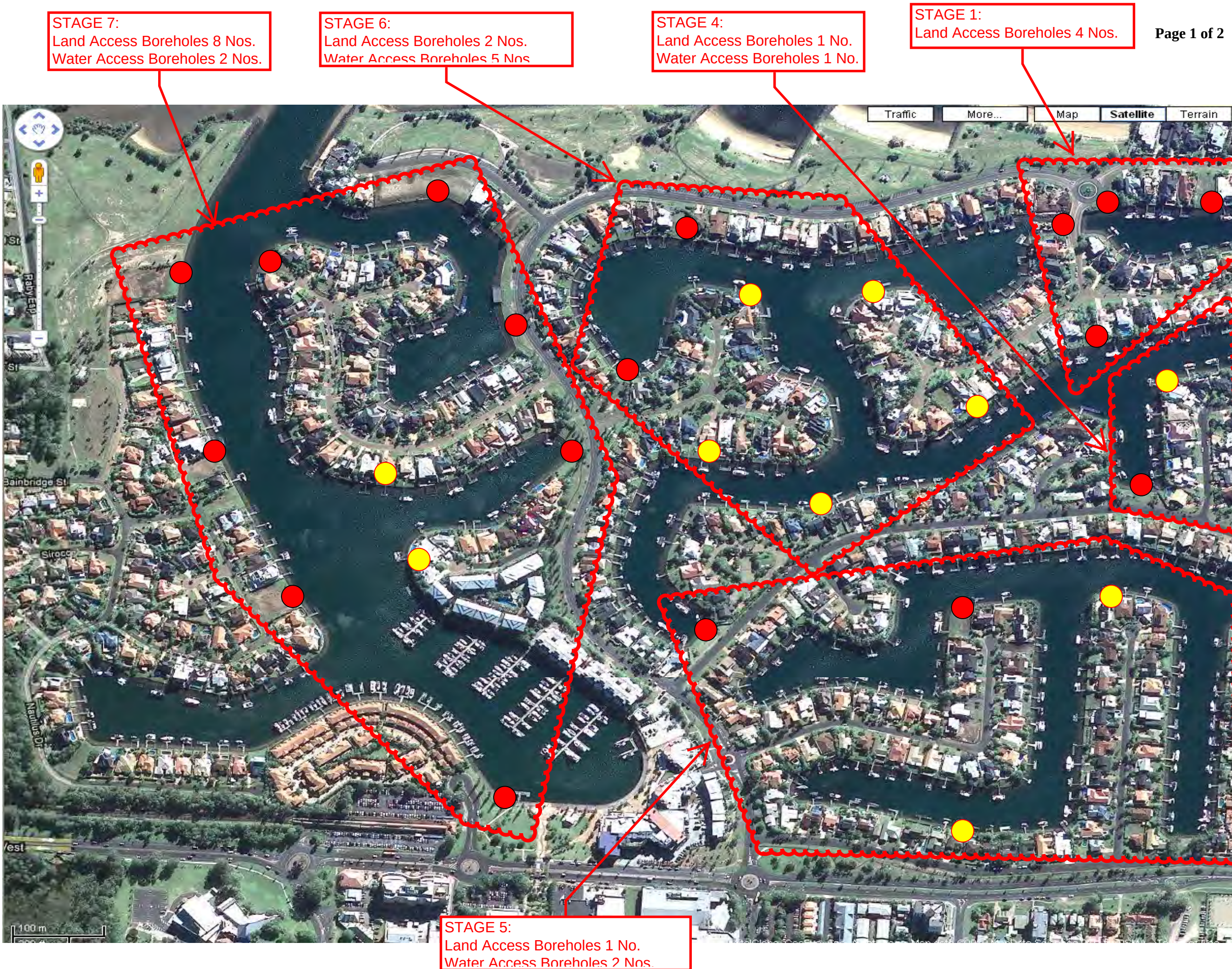
Item Description	Unit	Quantity	Rate	Cost
1 Preliminaries and Overheads				
1.1 Initial Establishment (set up) and Disestablishment (including Crane Barge 1.5T @ 6.0m reach to facilitate testing)	Item	1	\$8,050	\$8,050
1.2 Initial Establishment (set up) and Disestablishment insitu Test Rig on Skid Sled	Item	1	\$480	\$480
1.3 Reestablishment, set-up Insitu testing Rig	item	1	\$3,600	\$3,600
1.4 Crane Barge hire (including operator)	day	6	\$2,875	\$17,250
1.5 Management and attendance	day	6	\$1,000	\$6,000
1.6 Ancillary Equipment (e.g. drilling rig and crew)	day	6	\$1,850	\$11,100
1.7 Making good of site after testing	Item	2	\$250	\$500
1.8 Surveying; XYZ coords to GDA 94 (MGA zone 56), and AHD	Item	2	\$200	\$400
SUBTOTAL				\$47,380
2 In situ Testing and Sampling				
2.1 Cone Penetrometer Test (CPT) - (PQ)	No.	2	\$2,640	\$5,280
2.2 Pore Pressure Dissipation (PPD) - (PQ)	No.	1	\$1,695	\$1,695
2.3 Flat Plate Dilatometer (DMT) - (PQ)	No.	1	\$3,390	\$3,390
2.4 Vane Shear (VS) - (PQ)	No.	2	\$2,825	\$5,650
2.5 Undisturbed tube samples - (PQ)	No.	2	\$1,978	\$3,956
SUBTOTAL				\$19,971
3 Laboratory Testing				
3.1 Particle Size Distribution (AS1289.3.6.1) (PQ)	No.	0	\$100	\$40
3.2 Atterberg Limits (AS1289.3.1.1; AS1289.3.2.1; AS1289.3.3.1) (PQ)	No.	0	\$100	\$40
3.3 Linear Shrinkage (AS1289.3.4.1) (PQ)	No.	0	\$100	\$40
3.4 Shrink-Swell Index (AS1289.1.1.1) (PQ)	No.	0	\$90	\$36
3.5 Field Moisture Content (AS1289.2.1.1) (PQ)	No.	0	\$25	\$10
3.6 Soil Dispersion - Emerson Class Number (AS1289.3.8.1) (PQ)	No.	0	\$60	\$24
3.7 Direct Shear (AS1289.6.2.2) (PQ)	No.	1	\$600	\$600
3.8 Triaxial Strength Tests (AS1289.6.4.2) (PQ)	No.	1	\$1,000	\$1,000
3.9 Other (e.g. Ring Shear) Residual Shear Strength Tests (PS)	Item	0	\$1,500	\$375
SUBTOTAL				\$2,165
4 Reporting				
4.1 Factual Geotechnical Report (Inc. Land and Marine)	Item	1	\$800	\$800
4.2 Interpretive Geotechnical Report (Inc. Land and Marine)	Item	1	\$3,000	\$3,000
SUBTOTAL				\$3,800
TOTAL COST				\$73,316
Total Cost of Soil Investigation For Stage 7				\$258,335

Notes:

PQ = Provisional Quantity

PS = Provisional Sum

Rates and Costs in AUD 2010 (exclusive of GST)



CONTINUATION ON PAGE 2 OF 2

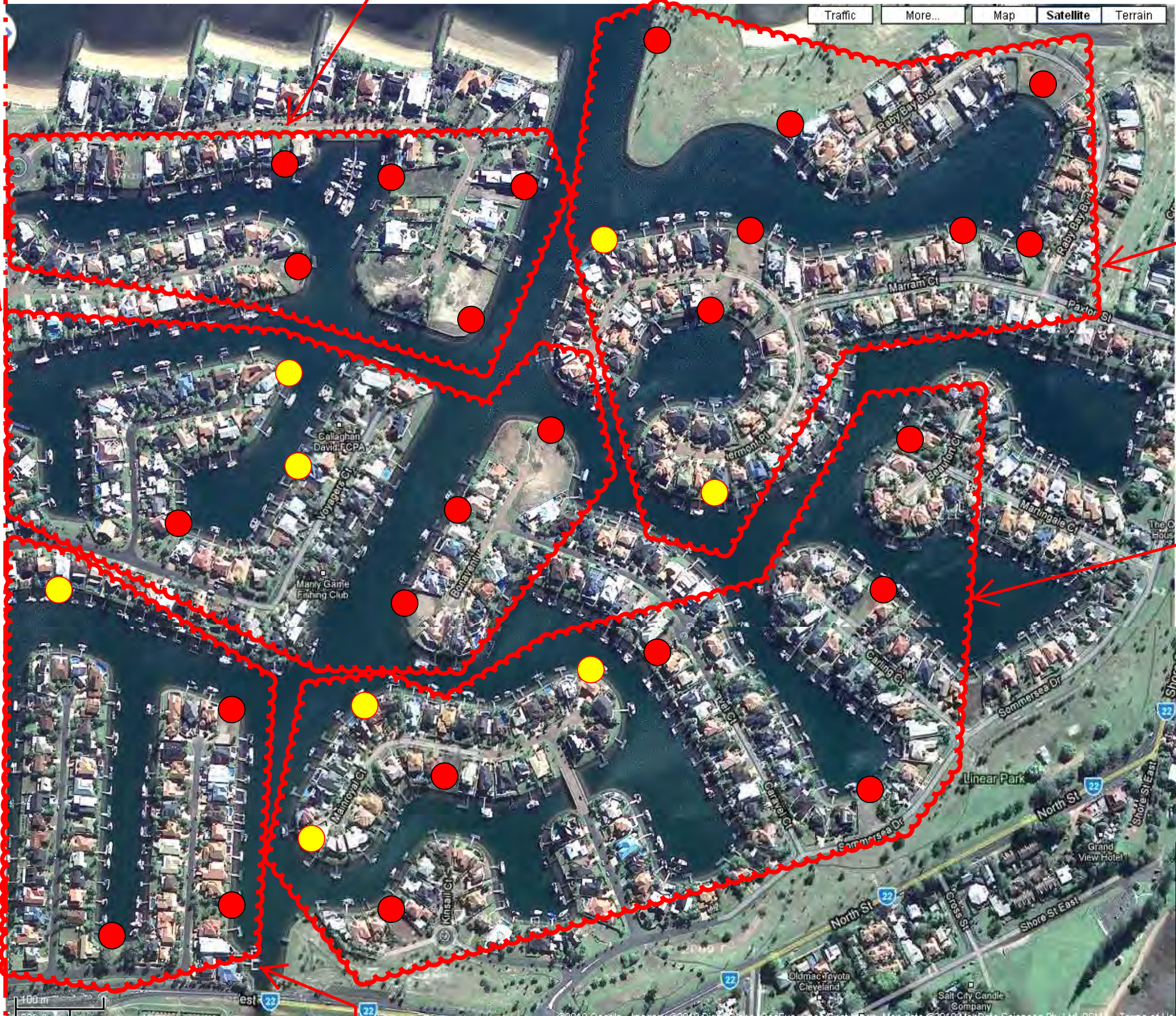
STAGE 4 (cont'd from page 1):
Land Access Boreholes 3 Nos.
Water Access Boreholes 2 Nos.

STAGE 1 (cont'd from page 1):
Land Access Boreholes 5 Nos.

STAGE 2:
Land Access Boreholes 7 Nos.
Water Access Boreholes 2 Nos.

STAGE 3:
Land Access Boreholes 6 Nos.
Water Access Boreholes 3 Nos.

CONTINUATION ON PAGE 1 OF 2



STAGE 5 (cont'd from page 1):
Land Access Boreholes 3 Nos.
Water Access Boreholes 1 No

OPTION C
Fig. C1

LEGEND:	
 Boreholes using Drilling Rig (Easily accessible through land)	42 Nos.
 Boreholes using Crane Barge (Access limited, through water only)	18 Nos.
TOTAL	60 Nos.

Appendix D

BOREHOLE LOCATIONS

APPENDIX D



APPENDIX D (CONT)

BOREHOLE SETOUT TABLE			
REFERENCE No.	EASTING	NORTHING	REMARKS
BH01	525996.613	6956172.693	ACCESSIBLE THROUGH LAND
BH02	526087.882	6956200.479	ACCESSIBLE THROUGH LAND
BH03	526041.879	6955945.935	ACCESSIBLE THROUGH LAND
BH04	526119.315	6955777.845	ACCESSIBLE THROUGH LAND
BH05	526246.907	6955813.023	ACCESSIBLE THROUGH WATER
BH06	526351.574	6955503.503	ACCESSIBLE THROUGH LAND
BH07	526211.416	6955915.524	ACCESSIBLE THROUGH WATER
BH08	526274.591	6956278.438	ACCESSIBLE THROUGH LAND
BH09	526356.471	6956117.709	ACCESSIBLE THROUGH LAND
BH10	526416.941	6955940.846	ACCESSIBLE THROUGH LAND
BH11	526479.097	6956054.357	ACCESSIBLE THROUGH LAND
BH12	526565.035	6955720.925	ACCESSIBLE THROUGH LAND
BH13	526562.446	6956224.262	ACCESSIBLE THROUGH LAND
BH14	526618.695	6956153.410	ACCESSIBLE THROUGH WATER
BH15	526571.505	6955947.040	ACCESSIBLE THROUGH WATER
BH16	526684.665	6955877.454	ACCESSIBLE THROUGH WATER
BH17	526747.639	6956154.031	ACCESSIBLE THROUGH WATER
BH18	526864.159	6956000.845	ACCESSIBLE THROUGH WATER
BH19	526841.305	6955753.603	ACCESSIBLE THROUGH LAND
BH20	526845.933	6955466.348	ACCESSIBLE THROUGH WATER
BH21	526953.050	6956229.240	ACCESSIBLE THROUGH LAND
BH22	526995.497	6956091.074	ACCESSIBLE THROUGH LAND
BH23	527071.174	6956042.314	ACCESSIBLE THROUGH WATER
BH24	527044.480	6955905.796	ACCESSIBLE THROUGH LAND
BH25	527020.444	6955833.860	ACCESSIBLE THROUGH WATER
BH26	527004.932	6955773.610	ACCESSIBLE THROUGH WATER
BH27	527095.950	6955456.166	ACCESSIBLE THROUGH LAND
BH28	527031.613	6956268.100	ACCESSIBLE THROUGH LAND
BH29	527142.282	6956266.748	ACCESSIBLE THROUGH LAND
BH30	527173.224	6955895.716	ACCESSIBLE THROUGH LAND

BOREHOLE SETOUT TABLE			
REFERENCE No.	EASTING	NORTHING	REMARKS
BH31	527230.919	6955707.633	ACCESSIBLE THROUGH LAND
BH32	527219.729	6955492.700	ACCESSIBLE THROUGH LAND
BH33	527285.340	6956286.555	ACCESSIBLE THROUGH LAND
BH34	527308.866	6956165.064	ACCESSIBLE THROUGH LAND
BH35	527285.269	6956049.705	ACCESSIBLE THROUGH WATER
BH36	527294.116	6955945.079	ACCESSIBLE THROUGH WATER
BH37	527405.757	6956264.287	ACCESSIBLE THROUGH LAND
BH38	527355.943	6955700.123	ACCESSIBLE THROUGH WATER
BH39	527308.938	6955559.731	ACCESSIBLE THROUGH WATER
BH40	527486.781	6956104.739	ACCESSIBLE THROUGH LAND
BH41	527469.742	6955621.904	ACCESSIBLE THROUGH LAND
BH42	527407.809	6955513.239	ACCESSIBLE THROUGH LAND
BH43	527546.877	6956227.469	ACCESSIBLE THROUGH LAND
BH44	527629.724	6956197.877	ACCESSIBLE THROUGH WATER
BH45	527634.649	6955746.750	ACCESSIBLE THROUGH WATER
BH46	527686.163	6956410.698	ACCESSIBLE THROUGH LAND
BH47	527836.023	6956321.568	ACCESSIBLE THROUGH LAND
BH48	527803.391	6956215.861	ACCESSIBLE THROUGH LAND
BH49	527763.612	6956129.182	ACCESSIBLE THROUGH LAND
BH50	527760.714	6955926.906	ACCESSIBLE THROUGH WATER
BH51	527694.966	6955762.490	ACCESSIBLE THROUGH LAND
BH52	528113.966	6956364.027	ACCESSIBLE THROUGH LAND
BH53	527987.877	6956208.693	ACCESSIBLE THROUGH LAND
BH54	528108.035	6956200.702	ACCESSIBLE THROUGH LAND
BH55	527966.231	6955987.453	ACCESSIBLE THROUGH LAND
BH56	527946.262	6955831.513	ACCESSIBLE THROUGH LAND
BH57	527941.644	6955619.090	ACCESSIBLE THROUGH LAND
BH58	527421.074	6955809.862	ACCESSIBLE THROUGH LAND
BH59	527465.156	6955899.065	ACCESSIBLE THROUGH LAND
BH60	527586.065	6956002.071	ACCESSIBLE THROUGH LAND