Redland City Council

Raby Bay Risk Assessment Workshop

May 2014

Constructive Solutions

Realising potential

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1. Introduction

This report describes the process and outcomes of a workshop held at Raby Bay on 1st April 2014 to assess the risks associated with a planned trial of new repair practices for upper level failures in fill on Raby Bay Canal Estate. In summary, the report outlines:

- The workshop process and participants;
- Community expectations of Raby Bay ratepayers;
- The failure mechanism to be addressed in the trials;
- Other failure mechanisms;
- Key Performance Indicators to evaluate the success of the trials;
- Risk assessment, consequences and likelihood of management options; and
- An action plan to outline the way forward.

1.1 Project history

Rectification of the periodic canal bank failures of the batters in the Raby Bay canals is a large scale, long term and expensive problem. It is clear from Council data that the frequency of canal bank failures has remained relatively static over the past 7 to 10 years and is imposing an unsustainable cost burden on Council and the Ratepayers.

Past repair methods have included:

- Bored piles at top of slope;
- Deep bored pile slope retainments;
- Screw piles;
- Driven timber piles at bottom of slope;
- Reconstruction of revetment wall and ties into piles; and
- Reconstruct pools, jetties, jetty piles, landscaping, etc.

In summary, the task as presently defined involves:

- Total canal batters approximately 22km;
- Repaired to date approximately 1.7km;
- Unsupported batters remaining approximately 20.3km; and
- $9.8M (307m) of unsupported wall is programmed for repair over the next 2 years.[1]

The reactive methods that had been implemented to date were resulting in repairs that cost, on average, in the range of $17,000/m to $30,000/m. Given the length of batter remaining to be treated on the Estate, continuance of this method is not economically sustainable. It is also desirable to conduct rectification works prior to significant movement and resulting damage occurring; ie. conduct “pro-active remediation”.

[1] Figures for discussion purposes only. Planning Estimate sourced from forward works program and includes contingencies for unknowns that would be refined following geotech and design.

The time has come to initiate a much less costly, pro-active and effective remediation methodology. KBR have concluded in their July 2012 report that the slope failures at Raby Bay are primarily upper level (smaller scale) failures in fill and potential repair methods of less than $1,000/m had been proposed by some suppliers. Accordingly, the purpose of this workshop was to assess such proposed alternative strategies, to assess the risks involved and clearly propose a way forward.

2. The Workshop

2.1 Workshop Participants

The workshop was facilitated by Steve O'Rourke and Dr Ron Black of Constructive Solutions Pty Ltd and participants included:

- Redland City Council Marine Infrastructure Planning team;
- Redlands City Council Project Design, Development and Delivery;
- Raby Bay Ratepayers Association;
- Consultants responsible for previous geotechnical investigations;
- Geotechnical contractors; and
- Remediation contractors representative of potential options available for remediation.

A full list of workshop attendees is included as Appendix 3.

2.2 Workshop Objectives

Given that a series of remediation trials are to be conducted, a number of questions were addressed in the workshop to fully define the objectives of those trials; viz.

- In broad terms, what are the revetment failures or imminent failure criteria that warrant a trial?
- Can any suitable locations be identified?
- What does a trial involve, and what method(s) will be employed?
- How can success or failure of the trial(s) be measured?
- What are the risks associated with the trial(s)
- How can these risks be reduced to a manageable level?
- How can risks be allocated between designers, builders and Council to avoid over-design?

3. Community Expectations

As noted in 2.1, the Raby Bay Ratepayers Association was represented at the workshop and they outlined very clearly their expectations of the proposed trials. Their views may be summarized as follows:

- Early failures began when the Developer was still on site, and thus they could be managed as and when they arose;
- The problems are not adequately communicated to new residents moving into the Raby Bay Canal estate;
- The time for further geotechnical studies has passed and what the ratepayers want is some action to trial strategies that can prevent or reduce further localised failures, provide some structural integrity for fill immediately behind the revetment wall and prevent loss of soil locally behind the revetment wall;
- It needs to be remembered that about 30% of owners live overseas and their properties are rented out;
- They are not seeking to ignore the “deep failure “ problems of fissured clays, but believe that these failures, which can only be remediated by expensive piling, can be dealt with as and where they arise; and
- What is needed is a long-term sustainable solution.

4. Shallow Failure Mechanism

In July 2012, KBR's Geotechnical Investigation Analysis Report concluded that there appears to be a wedge of uncompacted fill underneath the canal batter rock protection, resulting frequently in relatively shallow failures mainly confined to this uncompacted fill material (see below for profiles). They assert that there are alternative rectification methods, such as soil stabilisation, that would be much more economical than the current rectification strategies of using long piles. The current design implies the existence of a critical deep slip circle failure, which they have not found in the field to occur in many instances – in the few instances when this occurs, the problem can be addressed in this manner.

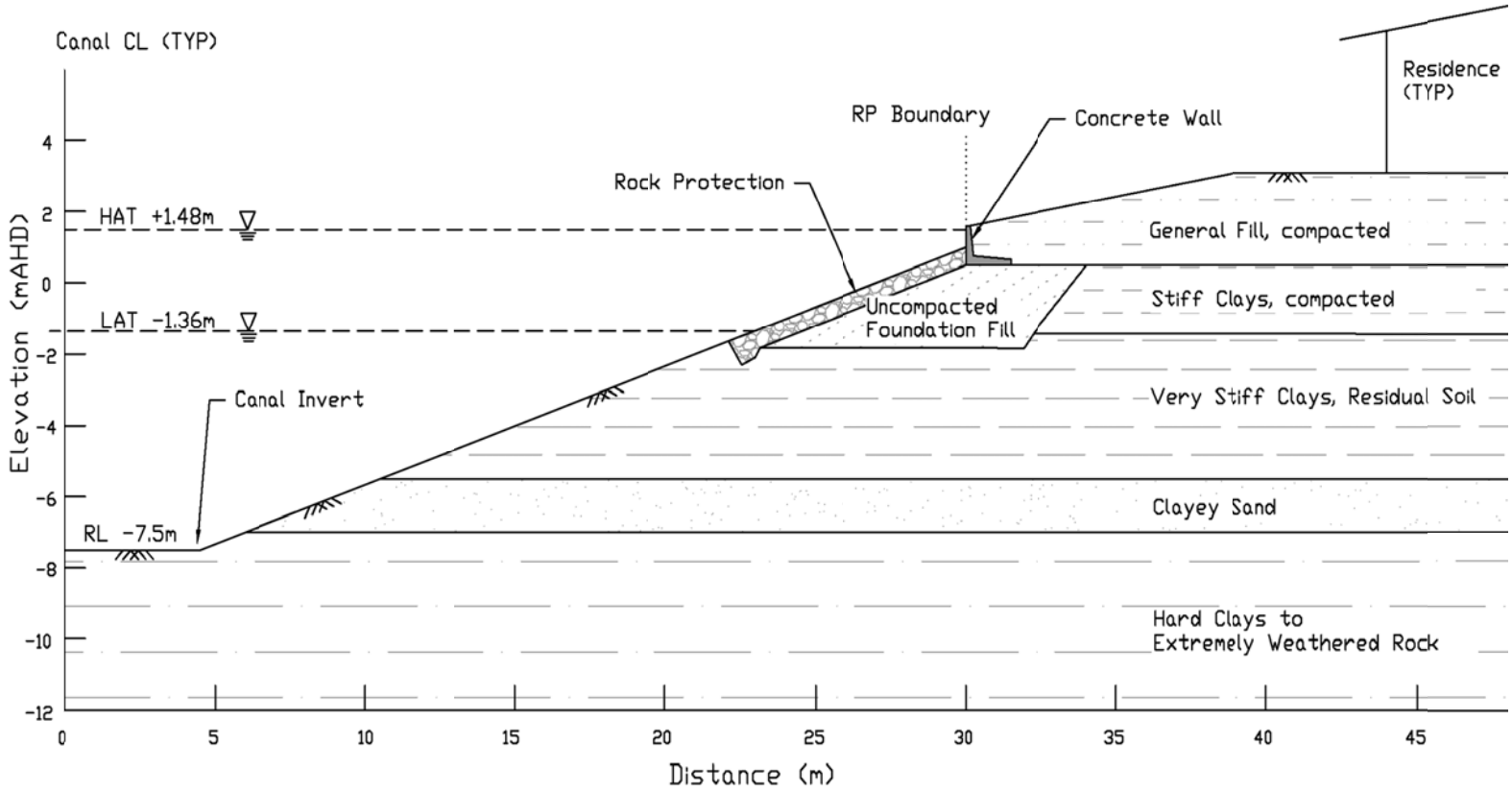


Figure 1: Indicative canal batter soil profile

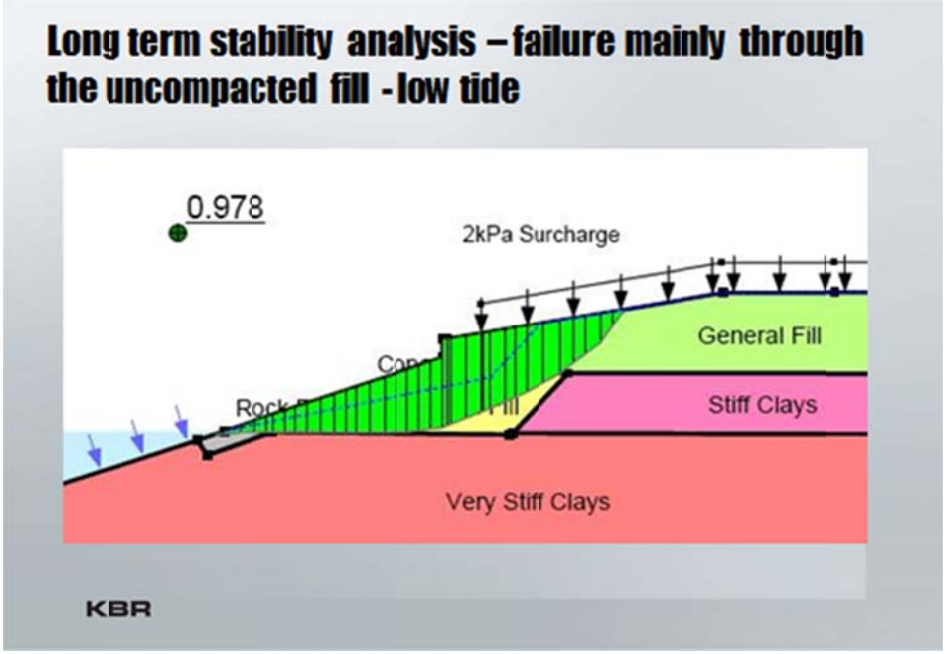


Figure 2: Long term stability analysis

5. Trial Site Locations

After discussion within the Group, it was generally agreed amongst affected parties that the there is no direct evidence of deep slip circle slip failures of the fissured clays being a contributing factor to recent failures. It was noted that:

- KBR concluded that there had been very few failures to date that could be attributed to this mechanism;
- There was no evidence that these failures would become any more prevalent in the next 20 or 30 years; and
- Appropriate repair methods were implemented during construction of the canal where this type of failure was identified.

Accordingly, the trials discussed in this workshop relate solely to the rectifying problems due to failures in the shallow uncompacted fill described above.

It was initially considered by some participants that, if possible:

- The selected site(s) should be one that is already showing movement – in that way, the effectiveness of the treatments can be evaluated; and
- When treatment has been carried out, the site should be loaded to failure – this was not supported by the Ratepayers Association representatives.

However the site selection process was further discussed with the following key parameters determined for site selection and preparation:

- 30mm to 50mm of wall movement observed and monitored;
- Significant revetment wall movement (greater than 50mm);
- Geotechnical information from previous studies would be available in the immediate area, noting that additional bore holes would be required to determine depth of fill material characteristics;
- Occupied sites will have public relations value if the resident is enthusiastic about the trial and remediation;
- It was noted that five adjacent lots on Masthead Drive (for example) may meet the above criteria. It was also noted that if the proposed grout injection treatment (or alternative methodology) is successful then there would be no need for further action at these lots. If not, then more expensive solutions (say screw piling) could be the subject of further trials at these sites; and
- A pre-trial site should be used to ensure that the grout injection process does not further de-stabilise the slope.

6. Key Performance Indicators (KPIs)

The Group determined that the trial would be judged to be a success if for:

The Trial

- There is a significant reduction in the cost of repair; and
- Movement is arrested as demonstrated by inclinometer readings.

The Chosen Remedy

- There is a reduction in the average number of wall failures;
- There is a reduction in the net present value cost per lot (including administration costs);
- Negative community feedback is reduced, or if there are positive responses;
- There is a reduction in the time spent on site (fewer workers, less heavy machinery);
- Loss of amenity due to failures is minimized; Continuous improvement (in time, cost and quality) results from the implementation of the trial methodology – which in turn will lead to an improved ability to predict potential failures, that is, improved understanding of the processes;
- Better understanding the problem so that the number of lots requiring any form and type of rectification is clear; and
- The trial represents a successful solution that can be used proactively to provide a reduction in the average number of wall repairs.

6.1 Random failures

Given that there are on average, four repairs per year at present, failures will continue throughout the trial period and probably out of the trial test area. The question remains – are these failures different from the slip mechanism in the upper part of the batter that is the subject of the trials?

The strategy that could be used to address these failures would include:

- Use an array of inclinometers to determine whether the failure extends down into the natural materials;
- Proceed to rectify by grout, or piling as appropriate to the depth of failure determined; and
- Utilise the knowledge gained from the random failures to add to that gained from the trial section.

7. Risk Register

The workshop conducted a risk assessment on the proposed trials to examine:

- The key risks and immediate consequences confronting the trials to stabilise potential failures confined to fill;
- The causes of these risks;
- The effectiveness of the current risk treatments that are in place;
- The consequence level of each risk;
- The likelihood of each risk occurring;
- The residual risk that thus resulted from the nominated consequence level and likelihood; and
- Additional actions that may be considered to further mitigate the risks.

It should be noted that a further and more detailed risk assessment will be necessary on completion of the trials and prior to any implementation of selected techniques at Raby Bay.

The outcome of these assessments is given in **Appendix 1**.

The Risk Assessment tools used, including tables of consequence, likelihood, effectiveness and the residual risk outcomes are shown in **Appendix 2**.

8. Conclusions and Recommendations

8.1 Conclusions

The current very costly method of rectification of the periodic, but regular, canal bank failures in the batters of the canals is considered by the affected parties to be unsustainable in the long term.

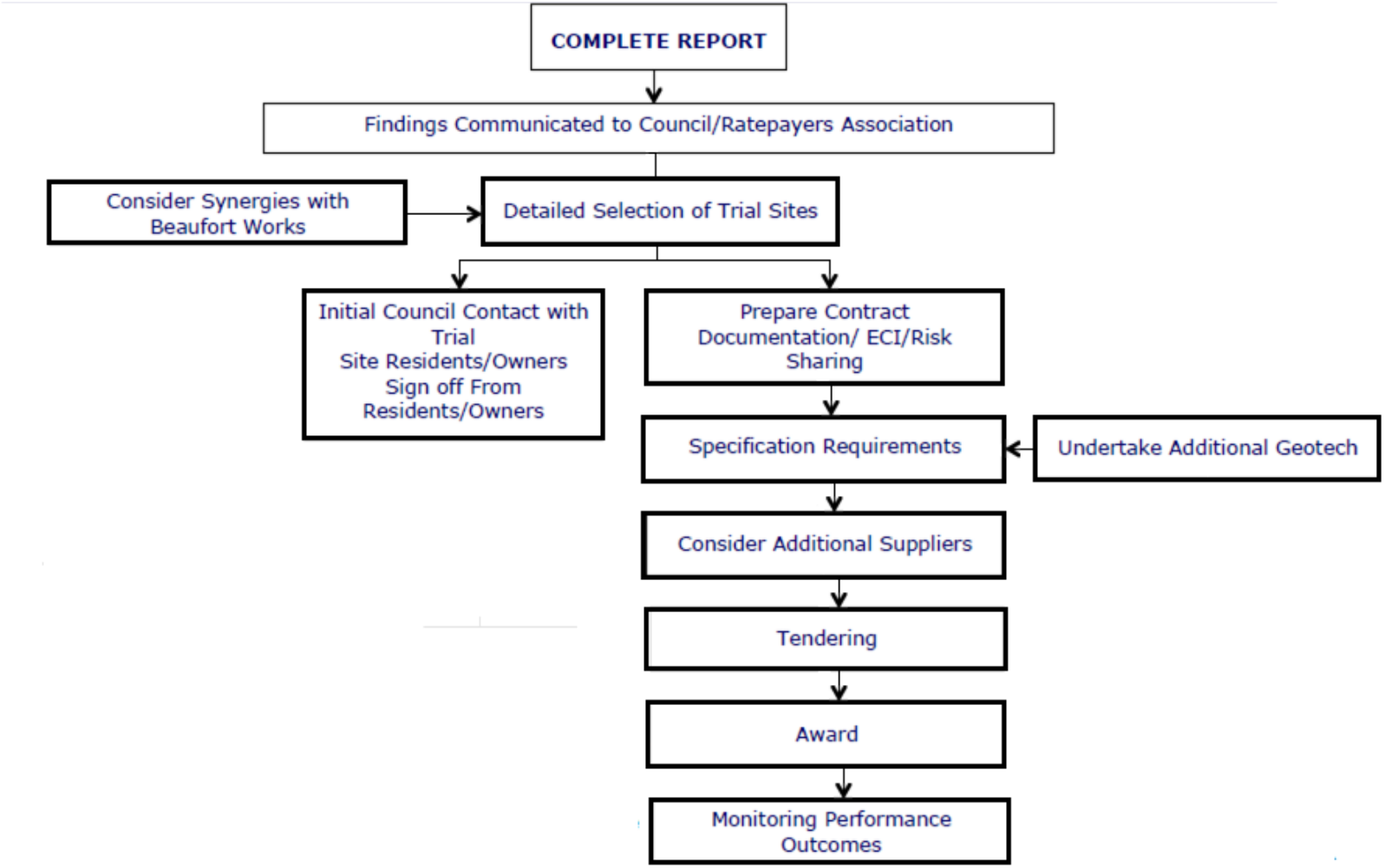
The workshop participants discussed the treatment of smaller slips in fill using grout injection (or similar) technologies that can be a substantially cheaper, less intrusive and proactive solution that may, subject to successful trialling and proven longer term performance, address the problems observed. If and when soil slips occur in lower level, fissured clays, these can be treated on a case-by-case basis using the much more costly methods currently in use.

It will be necessary to conduct trials of grout injection and other methods proposed by the specialist contractors to determine their likely success, and the risks of these trials have been evaluated by the workshop and are now in general terms understood.

8.2 Outcomes

The outcomes from the Workshop can be summarised by the action flow chart set out in Section 9 (below) which Council and the Ratepayers Association have undertaken to implement.

9. Action Plan



APPENDIX 1
Trial Site Risk Register

No.	Statement of Risk and immediate Consequences	Causation	Existing Risk Treatments	Effective-ness	Conseq. Level	Likeli-hood	Residual Risk Rating & treatment status *
1	Fail to achieve significant cost reduction per metre	• Changing ground conditions • Changes in development impacting on loadings on wall • Grouting techniques doesn't work • Increased material costs • Change in regulatory (e.g. environmental) requirements • Access problems • Council approach to procurement and risk sharing • Market competition	• Geotechnical information available • Designs customised to site • Proposed trial • Access from road or canal • Collaboration with contractors to achieve optimal risk apportionment • Continual market testing • Risk workshop • Existing reports on similar risk treatments	2 4 4 4 2 3	Major	Unlikely	High
2	Recorded movement will not have reduced within six months of treatment	• Incorrect treatment used for failure mechanism • Technique used was not successful • Failure of monitoring equipment • Deep failure occurring	• Trial is only to address shallow failure • Multiple techniques used • Multiple monitoring equipment • Inclinometer approach to better define deeper failures	4 4 4	Moderate	Possible	High
3	Proposed treatment will make current situation worse	• Introducing high pressure grout on low FoS slope	• Pre trial site on Council/vacant land • Review case studies	4 4	Minor	Unlikely	Low
4	Unacceptable environmental impact	• Grout entering water system	• Inert grouts used • Bunding on outside of seawall • Environmental	4 4 4	Minor	Unlikely	Low

No.	Statement of Risk and immediate Consequences	Causation	Existing Risk Treatments	Effective-ness	Conseq. Level	Likeli-hood	Residual Risk Rating & treatment status *
			requirements in specification • Cleaning up waste material • Service location	 4 4			
5	Damage to assets on private property	• Uncontrolled expansion of material near private assets	• Dilapidation survey • Work procedures and supervision • Release form signed by Owner	2 4 1	Minor	Unlikely	Low

Set out below are additional risk treatments which can be implemented to further reduce the level of risk:

Risk 1

Increasing geotechnical information – bore holes to better determine layer thicknesses and depths

Increased consultation with potential contractors

Discussion with contractors on apportionment of risk – better risk sharing

Include additional technologies

Consider recovering costs where appropriate for actions which may cause damage to wall

Council to promote trial to community and communicate with impacted residents

Risk 2

Increasing geotechnical information – bore holes to better determine layer thicknesses and depths

Improve monitoring regime

APPENDIX 2
Risk Assessment Matrix

1. CSPL Risk Assessment Tools

Measures of Effectiveness

The following table can be used to assess the effectiveness of existing risk treatments, which should then be taken into account when determining the Consequence, Likelihood and therefore the level of Residual Risk.

No.	Level	Communication and documentation	General effectiveness
5	Excellent	Risk treatments and procedures are implemented, with communication and monitoring on a regular basis to determine their level of effectiveness in 'managing' the risk.	Is effective in reducing the risk under all conditions.
4	Good	Risk treatments and procedures are well documented and implemented, but with some room for improvement. Good communication and understanding of treatments with some degree of monitoring.	Is effective in reducing the risk under most conditions.
3	Fair	Risk treatments and procedures documented, but not well implemented, with minimal monitoring to ensure compliance or to determine their level of relevance.	Is effective in reducing the risk under ideal conditions.
2	Marginal	Risk treatments and procedures are informal, not well communicated and are implemented in an inconsistent manner.	Is partially effective in reducing the risk.
1	Poor or non-existent	Risk treatments and procedures are non–existent or ineffective; not communicated, sparsely implemented and of little value.	Makes little impact in reducing the risk.

Measures of Consequence (or Impact)

Level	Examples						
	Financial (Revenue & Costs)	Information & Data	Property	People	Provision of Service	Reputation	Environment
1. Insignificant	• Low financial loss (e.g. < 1% of revenue or budget)	• Negligible loss of or damage to IT and communications. • No loss of data.	• Negligible damage to or loss of assets.	• No significant injuries. • No significant impact on personnel.	• Short-term, localised interruption to service / performance.	• Issue of no public concern. • Isolated communications expressing concern.	• Minor breach of environmental policy / practices. • Negligible impact on the environment.
2. Minor	• Minor financial loss (e.g. 1% to 2% of revenue or budget)	• Minor loss / damage to IT and communication. Some data catch-up may be required.	• Minor loss / damage. Some repairs may be required.	• Small number of injuries; first aid or out-patients treatment required. • Some inconvenience to personnel.	• Minor, temporary disruption to services; Minor inconvenience to client(s).	• Local public concern. • May cause some complaints (justified or unjustified).	• Minor localised impact; one-off situation easily remedied.
3. Moderate	• High financial loss (e.g. 2% to 5% of revenue or budget)	• Moderate to high loss of IT. Some data may be permanently lost. Workarounds may be required.	• Moderate to high damage requiring specialist/contractor equipment to repair or replace.	• A number of injuries requiring hospitalisation and long-term treatment. • Moderate disruption to work routines and schedules.	• Some serious disruption to services; some contravention of legal/contractual obligations.	• Regional public concern. • Significant complaints. • Some adverse publicity. • Local media coverage.	• Moderate impact on the environment; no long term or irreversible damage. • May incur cautionary notice or infringement notice
4. Major	• Major financial loss (e.g. 5% to 10% of revenue or budget)	• High risk of loss/ corruption of data; significant	• Significant / permanent damage to assets and / or infrastructure.	• Major disruption to work routines and practices. Additional resources may	• Major, long-term disruption to services.	• Significant public concern. • Adverse publicity in national	• Severe impact requiring remedial action and review of processes to prevent

Level	Examples						
	Financial (Revenue & Costs)	Information & Data	Property	People	Provision of Service	Reputation	Environment
		catch-up will be required. • Business continuity plans need to be implemented.		be required. • Significant number of serious injuries requiring hospitalisation and long-term treatment. Small number of fatalities.	• Serious breach of a legal / contractual obligation.	media. • Embarrassment to the organisation. • Damage to credibility and confidence in the organisation. • Inquiry by regulators. • State or regional media coverage.	reoccurrence. • Penalties and / or direction or compliance order incurred.
5. Catastrophic	• Huge financial loss (e.g. >10% of revenue or budget)	• Extensive loss of / damage to IT and communications assets and infrastructure. • Permanent loss of data. Widespread disruption to the business.	• Widespread, substantial / permanent damage to assets and/or infrastructure.	• Long-term disruption to work practices and routines. Impact on well-being of personnel. • Extensive, life-threatening impact; potentially large numbers of serious injuries and fatalities.	• Long term/irreversible impact on ability to deliver client services. • Viability of the organisation in its current form is questionable.	• Major public concern. • Widespread, ongoing national and possibly international media attention. • Severe embarrassment to the organisation. • Loss of credibility and confidence in the organisation. • Adverse findings and/or penalties by regulator.	• Long-term, large-scale damage to habitat or environment. • Serious / repeated breach of legislation / licence conditions. • Cancellation of licence and / or prosecution.

Measures of Likelihood

No.	Level	Description	Examples
5	Almost certain	The event will occur in most conditions	Expected frequency range: Greater than one or more per annum
4	Likely	The event will probably occur in most conditions	Expected frequency range: Between one in 5 years and one per annum
3	Possible	The event should happen at some time	Expected frequency range: Between one in 10 years and one in 5 years
2	Unlikely	The event could happen at some time	Expected frequency range: Between one in a 100 years and one in 10 years
1	Rare	The event may only occur in exceptional circumstances	Expected frequency range: Less than one in a hundred years

Residual Risk Assessment Matrix

Likelihood		Consequence				
		Insignificant	Minor	Moderate	Major	Catastrophic
		1	2	3	4	5
Almost certain	5	M (ii)	H (ii)	E (i)	E (iv)	E (v)
Likely	4	M (i)	H (i)	H (ii)	E (ii)	E (iv)
Possible	3	L (iv)	M (ii)	H (i)	H (iv)	E (iii)
Unlikely	2	L (ii)	L (iv)	M (iii)	H (iii)	E (i)
Rare	1	L (i)	L (iii)	M (ii)	M (iii)	H (iv)

Legend	L (i – iv)	M (i – iii)	H (i – iv)	E (i – v)
Risk Level:	Low	Moderate	High	Extreme
Refer to:		Manager	Executive Management	Board
Refer within:	1 month	1 month	1 week	1 day
Actions:	Routine procedures	Routine procedures	Specific treatment	Specific treatment
Monitoring:	Quarterly	Quarterly	Monthly	Weekly

APPENDIX 3
Attendance List

REDLAND CITY COUNCIL

RABY BAY RISK ASSESSMENT WORKSHOP Tuesday 1 April 2014

ATTENDANCE SHEET

NAME	AFFILIATION/POSITION	SIGNATURE
Ron Black	SNE Cons. Const. Sol/ns	
Morray Ebbs	RCC	
Toby Epsom	RCC	
Steve O'Rourke	Constructive Solution	
Alex Litwinowicz	GHD	
Peter Elkington	Soil Surveys	
George Harris	RBRPA	
Peter Cummings	KBR	
Benjamin Bruce	RCC	
Michael Kriedemann	RCC	
Brad Salton	RCC	
Greg Finay	RCC	
David Humphrey	RCC	
Gordon Wilson	RBRPA	
Scott Candy	URETEK	
Ian Purdie	RCC	
Michael McAuley	GHD	
Peter Sampson	Aurecon	
Barney Seldenburys	Aurecon	