

Report on Ground Improvement Costs for Cleared Sites in the Canterbury Area

Prepared for Earthquake Commission

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KINGSTONS



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1.0 EXECUTIVE SUMMARY

1.1 PURPOSE OF THE REPORT

The Ground Improvement Programme (GIP) is an EQC-led, internationally collaborative research programme which informs more affordable and practical ways of making residential land less vulnerable to liquefaction.

The GIP was divided into two main work streams:

- The Ground Improvement Trials – ‘Science Trials’
- The Ground Improvement Pilot Projects – ‘the Pilot’

The Science Trials developed, tested and verified affordable shallow ground improvement methods in the residential red zone, which can be used to strengthen residential land vulnerable to liquefaction. The Pilot applied Science Trial learnings to residential properties to determine the costs and practicalities associated with the various methods.

The purpose of this report is to establish a cost structure and rates for undertaking ground improvement works on cleared sites with liquefaction vulnerability in the Canterbury area.

1.2 THE COST STRUCTURE AND RATES

The cost structure and rates for ground improvement works have been sourced from residential properties that had liquefaction-related damage and were part of the Pilot.

The contracts were procured by both open and closed tenders, and carried out under standard industry contract terms to establish market-related prices under normal construction conditions.

The costs for undertaking the ground improvement works are structured into four areas: Design and Management Fees, Building and Resource Consent Costs, Enabling Works, and Ground Improvement Rates.

1.3 GROUND IMPROVEMENT METHODS

During the period covered by this report (January 2014 to January 2015), the Science Trials results were internationally peer reviewed and analysed resulting in significant advancements in residential ground improvement methods.

In April 2015 the Ministry of Business, Innovation and Employment (MBIE) updated section 15.3 of their guidance document ‘Repairing and rebuilding houses affected by the Canterbury earthquakes’ to include the results of the Science Trials after they had been peer reviewed.

This report outlines the ground improvement methods incorporated into the MBIE guidance:

- Stone columns
- Driven timber poles
- Reinforced soil-cement raft – rotovated mixed ex-situ
- Reinforced gravel rafts.

1.4 CALCULATION OF GROUND IMPROVEMENT RATES

The ground improvement rates for different methods have been established from tenders received. The tenders were let with a schedule of prices and relevant information so that the designs included in MBIE's guidance could be priced. The actual costs to complete the awarded contracts were also included in the rates calculation.

The Appendices include:

- the schedule of rates and the quantities of the various contract awards
- adjusted schedules showing how MBIE's recommended designs, based on the four ground improvement methods, have been priced.

The approach to establishing rates for ground improvement works is on the basis of conservatism in order to achieve balanced results relevant to current prices that could be proven to be representative of this form of work. To achieve the conservative approach and obtain a representative evaluation, costs have been reviewed over as many different Pilot projects as possible.

It should be noted that all cost information throughout this report is GST exclusive.

2.0 RATES TABLES

2.1 GROUND IMPROVEMENT WORKS COST STRUCTURE

The costs for undertaking the ground improvement works are structured into four areas:

- a. Design and Management Fees – the consultancy fees for establishing and managing the project
- b. Building and Resource Consent Costs – the costs associated with the Local and Regional Authority consenting process
- c. Enabling Works Costs – site specific costs required to clear the site or prepare the property for the ground improvement works and the costs to restore the property to its pre-construction condition
- d. Ground Improvement Rates – the construction costs associated with undertaking ground improvement works

Rates tables have been established for Design and Management Fees, Building and Resource Consent Costs and Ground Improvement Rates.

The costs associated with enabling works on the property are specific to each site. These costs, which may include the demolition of a dwelling, removal and re-establishment of fencing, repairs to damaged footpaths, protection or removal of trees and so on, cannot be quantified to a standardised rate and are therefore excluded from this report.

2.2 DESIGN AND MANAGEMENT FEES

Costs in respect of geotechnical and engineering services have been established for the variety of site situations and conditions that are expected to be experienced. These costs apply to all projects and are scaled to the degree of complexity that the respective properties require.

The following table indicates the costs of providing the geotechnical and engineering services required for ground improvements.

GEOTECHNICAL & ENGINEERING FEES	Level of Design Complexity		
	Low (MBIE Endorsed)	Medium (Bespoke Design)	High (Bespoke Design)
<u>Engineering Design Fees</u>			
Site investigation	\$1,650	\$2,150	\$3,150
Detailed design and specifications	\$2,000	\$3,000	\$4,000
Survey	\$2,000	\$2,000	\$2,000
Design alterations for services and access	\$750	\$1,150	\$1,650
Senior review	\$750	\$750	\$750
<u>Construction Fees</u>			
IPENZ CM3 level of construction monitoring	\$1,400	\$1,900	\$2,500
Contractor briefs/works start-up	\$350	\$550	\$750
Construction management	\$2,350	\$3,450	\$4,600
TOTAL COST	\$11,250	\$14,950	\$19,400

Note:

Low level of design complexity: These are based on MBIE-endorsed ground improvement methods with standard designs.
 Medium and high levels of design complexity: These require bespoke designs.

2.3 BUILDING AND RESOURCE CONSENT COSTS

The requirement for a building and/or resource consent is dependent on the property features and the nature of the ground improvement methods.

CONSENT COSTS	Consent Costs if Required							
	Always Required	Specifically Required	Low	Med	High			
<u>Building Consent Application</u>								
Exemption	\$550							
Application fee			\$400	\$1,500	\$1,500			
Specification preparation			\$200	\$400	\$400			
Preparation of application package			\$200	\$400	\$400			
Additional consent costs – compliance inspections			\$300	\$600	\$600			
<u>Resource Consent Application</u>								
Application fee preparation			\$5,800	\$7,800	\$11,000			
Archaeologist assessment and permit		\$1,200						
Arborist assessment report		\$1,200						
Groundwater assessment report		\$7,500						
Traffic management fees and permit		\$1,800						
TOTAL COST	\$550		\$1,100	\$5,800	\$2,900	\$7,800	\$2,900	\$11,000

Note:

A building consent exception is always required on MBIE-endorsed ground improvement methods by Christchurch City Council.

2.4 GROUND IMPROVEMENT RATES TABLE

The following table schedules the rates that have been calculated for the four ground improvement methods assessed as being the leading options for carrying out this work.

GROUND IMPROVEMENT RATES TABLE

Treatment Method	Treatment Rate in \$/m ²	Treatment Area	Distance Around Building Footprint	Treatment Cost
<u>Stone columns (MBIE ref. G5a)</u>				
Stone columns 700mm diam. with 12% replacement ratio	\$146.41	270m ²	2m	\$39,530.70
Stone columns 900mm diam. with 16% replacement ratio	\$166.23	270m ²	2m	\$44,882.10
Stone columns 900mm diam. with 18% replacement ratio	* \$180.30	270m ²	2m	\$48,681.00
Stone columns 900mm diam. with 20% replacement ratio	* \$201.69	270m ²	2m	\$54,456.30
<u>Driven timber poles (MBIE ref. G5b)</u>				
Timber poles (uglies) 250mm diam. SED 3.8m long at 1.2m centres, 200mm gravel layer	\$208.23	270m ²	2m	\$56,222.10
Timber poles (uglies) 250mm diam. SED 3.8m long at 1.1m centres, 200mm gravel layer	* \$242.24	270m ²	2m	\$65,404.80
Timber poles (uglies) 250mm diam. SED 3.8m long at 1.0m centres, 200mm gravel layer	* \$271.31	270m ²	2m	\$73,253.70
<u>Rotovated soil mixing (MBIE ref.G2a)</u>				
Excavate 1200mm deep, replace and cement stabilise in position with 8% cement ratio (work above water table)	* \$183.73	204m ²	1m	\$37,480.92
<u>Rotovated soil mixing (MBIE ref.G2a)</u>				
Excavate 1200mm deep, replace and cement stabilise in position with 8% cement ratio (work below water table)	* \$209.33	204m ²	1m	\$42,703.32
<u>Reinforced gravel rafts (MBIE ref. G1b)</u>				
Excavate 1200mm deep, compacted hardfill 1200mm deep (work above water table)	* \$175.64	204m ²	1m	\$35,830.56
<u>Reinforced gravel rafts (MBIE ref. G1b)</u>				
Excavate 1200mm deep, compacted hardfill 1200mm deep (work below water table)	* \$204.53	204m ²	1m	\$41,724.12

Notes

* MBIE-endorsed methods.

Rates are compiled from tendered ground improvement pilot projects.

Rates were calculated from tenders received over a period from January 2014 to January 2015. An escalation factor is required to be added to these rates to allow for cost increases after these dates.

All rates exclude GST.

See Appendix A for the establishment of these rates.

3.0 GROUND IMPROVEMENT PROGRAMME

3.1 BACKGROUND

The CES of 2010-2011 generated significant liquefaction-related damage to both land and buildings, exacerbating the economic impact of those events and accounting for a third of the total cost of the recovery.

Building homes on liquefaction vulnerable land requires expensive and robust foundation systems. These enable the building to meet acceptable standards of earthquake resilience but do not improve the ground condition. In contrast, ground improvement methods stiffen and/or thicken the near-surface soil crust providing a non-liquefying building platform for a less expensive foundation system to improve the resilience of both the building and the land. While ground improvement methods existed, these were for large-scale commercial builds and are often too expensive and impractical for small residential sites.

EQC initiated GIP to develop and verify affordable residential ground improvement methods so that liquefaction vulnerable properties could be made more resilient in future earthquakes.

The GIP included:

- Science Trials – a world leading research project to develop, test and verify residential ground improvement methods
- The Pilot – ground improvement construction contracts undertaken on residential properties to determine the associated practicalities and costs.

3.2 SCIENCE TRIALS

In 2013, Science Trials were undertaken in the red zone to develop and test the effectiveness of various shallow ground repair methods in creating a non-liquefying crust. Destructive and non-destructive repair methods were investigated in representative Canterbury soils.

Destructive methods require clearance directly above the treatment area. This means they can only be used on cleared sites (where the original building and in-ground services have been removed). This report focuses on the costs that are associated with destructive methods (cleared sites).

Non-destructive methods were investigated for properties where the buildings remained and were capable of being repaired. Very few options are available for such sites. The Science Trials led to the development of a new method, Horizontal Soil Mixing, which was successfully tested and further developed in a separate pilot project. The costs associated with this method are documented in the report 'Ground Improvement Pilot Project, Horizontal Soil Mixed Beams "Proof of Concept" Completion Report' (in press) and are not within this report.

3.3 THE PILOT PROJECT

The Pilot studied actual construction projects on residential properties vulnerable to liquefaction that were procured under competitive tender conditions. It set out to achieve the following objectives:

- Determine an appropriate cost structure for MBIE-endorsed ground improvement methods that can be applied to differing soil types for liquefaction vulnerable residential properties in Canterbury
- Establish whether there are adequately skilled and equipped contractors to carry out residential ground improvement in Canterbury that will encourage a competitive market and ensure that the repair methods are affordable and can be practically applied
- Raise the level of stakeholder confidence in the viability of residential ground improvement methods. These stakeholders include EQC, MBIE, private insurers, homeowners, consenting authorities, consulting engineers and the wider building industry
- Study issues, associated problems and concerns that could be encountered during the process of undertaking ground improvements on individual properties.

4.0 GROUND IMPROVEMENT COSTS AND FEES

4.1 ESTABLISHMENT OF COSTS

A process has been set up to identify the particular requirements of an individual property to undergo ground improvement and to establish the most cost-effective and practical method of construction. The following processes establish the costs of remediating a property:

- A site review process establishes the condition of the property and the inspections or reports that are required for the property to undergo ground improvement.
- If the site is listed on Environment Canterbury (ECan) records as being a Hazardous Activities and Industries List (HAIL) site an environmental desktop study and/or a Detailed Site Investigation (DSI) report is required. The type of contamination will also determine which ground improvement method is most appropriate.
- The geotechnical information on the property is established. The Canterbury Geotechnical Database may give sufficient geotechnical information on the subject property or may only give general information on the surrounding area. If the information is insufficient, additional geotechnical investigations may be required to ascertain the true nature of the ground conditions.
- From the inspections and site reports, a geotechnical engineer can then decide on and specify the most appropriate improvement method for the site, whether it be an MBIE-specified method or a bespoke design. Detailed design will be undertaken and drawings and specifications produced for the ground improvement method selected for the property. Standard specifications and drawings are expected to be referenced.
- Waimakariri District Council (WDC) does not require building consent or an application for an exemption from building consent for any of the ground improvement methods endorsed by MBIE. On completion of ground improvement work, WDC requires a Statement of Professional Opinion on the Suitability of Land for Building Construction and as-built drawings for its records.
- Christchurch City Council (CCC) requires an application for building consent exemption before any ground improvement works can begin. On completion of ground improvement work CCC requires a statement of suitability and as-built drawings for its records. (If the ground improvement method is endorsed by MBIE an exemption can be obtained. (CCC's current building consent exemption application fee is \$550.)
- If resource consent is required for ground improvement works, a consent application needs to be prepared for the property, usually by a planning consultant, and lodged with the relevant council for processing.
- Site-specific enabling works are required before the ground remediation work can begin. These could include forming access to the work site, isolating services and protecting or removing trees, garden features, swimming pools, etc.
- The appropriate ground improvement works assessed by the geotechnical engineer as being required are then undertaken to remediate the site.
- Site visits are to be undertaken by the geotechnical engineer during the construction of the ground improvements, so that they can observe that the improvement works are

being undertaken in accordance with the design requirements and issue a Statement of Professional Opinion on the Suitability of Land for Building Construction.

- The ground improvement contractor repairs any property that is disturbed or damaged during construction.

4.2 PRECONSTRUCTION COSTS AND CONSULTANTS' FEES

HAIL Sites

ECan maintains a database of properties where activities on the Ministry for the Environment's HAIL have more than likely taken place. This database is referred to as the Listed Land Use Register (LLUR). If a property is identified on the LLUR as being potentially contaminated, a DSI is required to confirm the presence and extent of any ground contamination.

Costs associated with the preparation of a DSI will vary depending on the types of activity that have been identified as having taken place on the site and the number of soil samples required for the reporting process. The property-specific assessment form will identify the expected cost category for preparation of a DSI report.

	Surface Small Site	Surface Large Site	Surface + Deep Small Site	Surface + Deep Large Site
Detailed Site Investigation	\$3,600	\$4,100	\$4,200	\$4,700

Further costs associated with the management of contaminated soil are to be assessed as required.

Resource consent is also required under the Resource Management (National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health) Regulations 2011 for any properties that are listed on the LLUR. Costs associated with the resource consent application are identified as part of the resource consent cost assessment discussed in Section 4.2.4 below.

Geotechnical Engineering Fees

A geotechnical engineer is required to assess the ground conditions in order to recommend the most suitable ground improvement method. If available information from the Canterbury Geotechnical Database is insufficient, further geotechnical investigation is required. The engineer also arranges the contract, observes the construction process and issues a Statement of Professional Opinion on the Suitability of Land for Building Construction on completion.

With the issuing of the revised MBIE guidelines and the New Zealand Geotechnical Society Ground Improvement Standard Specification, together with the expected volume of ground improvement work, there will be competition amongst geotechnical engineers, with repetition of work and the standardisation of drawings and specifications.

Results from the ground improvement pilot confirmed that the majority of cleared sites liquefaction vulnerable properties are capable of being repaired using the designs recommended in the MBIE guidance update of 2015.

The following table summarises the cost structure for the geotechnical and engineering fees. These are based on three levels of design complexity. 'Low' includes MBIE-endorsed ground improvement methods as well as bespoke designs where there are no site specific issues. The other two categories require bespoke design and have more complex design requirements.

GEOTECHNICAL & ENGINEERING FEES	Level of Design Complexity		
	Low	Medium	High
<u>Engineering Design Fees</u>			
Site-specific investigation	\$1,650	\$2,150	\$3,150
Detailed design and specifications	\$2,000	\$3,000	\$4,000
Survey	\$2,000	\$2,000	\$2,000
Design alterations for services and access	\$750	\$1,150	\$1,650
Senior review	\$750	\$750	\$750
<u>Construction Fees</u>			
IPENZ CM3 level of construction monitoring	\$1,400	\$1,900	\$2,500
Contractor briefs/works start-up	\$350	\$550	\$750
Construction management	\$2,350	\$3,450	\$4,600
TOTAL COST	\$11,250	\$14,950	\$19,400

Resource Consents

Ground improvement works may require resource consent from any of the following authorities:

- ECan
- CCC
- WDC

Resource consent requirements are based on the nature of the ground improvement method and site features. Proposals must be assessed against the provisions in the relevant statutory plan(s).

Rules have been developed that are specific to land repair activities. These new land repair rules were inserted in the Christchurch City Plan, the Natural Resources Regional Plan and the proposed Land and Water Regional Plan via section 27 of the Canterbury Earthquake Recovery Act 2011. The provisions were reviewed and updated to become operative on 5 September 2014.

As a result of these updates to the land repair rules in the Christchurch City Plan, the Natural Resources Regional Plan and the proposed Land and Water Regional Plan on 5 September 2014, the majority of land repair works on liquefaction vulnerable sites do not require resource consent from CCC and/or ECan.

There are currently no specific land repair rules in the Waimakariri District Plan, therefore the 'general provisions' in the Waimakariri District Plan apply.

Resource consent cost categories include fees for a planning consultant to prepare a resource consent application, and council consent processing fees. The preparation and processing of resource consent applications will vary in complexity, depending on which rules have triggered the requirement for resource consent. The property-specific assessment forms will identify the expected level of complexity for consent preparation and processing and whether a technical assessment will be required to accompany an application for resource consent.

On completion of the ground improvement works, documentation on the extent of the work undertaken and accompanying engineering certification is lodged with the respective councils as records on their property files.

As the ground improvement pilot began before consenting changes were implemented by the consenting authorities, resource consent applications were required on all pilot properties. This provided a comprehensive understanding of the costs associated with gaining ground-repair-related consents.

The following table summarises the costs associated with obtaining any necessary building and/or resource consents to undertake land repair works:

CONSENT COSTS	Consent Costs if Required							
	Always Required	Specifically Required	Low		Med		High	
<u>Building Consent Application</u>								
Exemption	\$550							
Application fee			\$400		\$1,500		\$1,500	
Specification preparation			\$200		\$400		\$400	
Preparation of application package			\$200		\$400		\$400	
Additional consent costs – compliance inspections			\$300		\$600		\$600	
<u>Resource Consent</u>								
Application fee and resource consent preparation				\$5,800		\$7,800		\$11,000
Archaeologist assessment and permit		\$1,200						
Arborist assessment report		\$1,200						
Groundwater assessment report		\$7,500						
Traffic management fees and permit		\$1,800						
TOTAL COST	\$550		\$1,100	\$5,800	\$2,900	\$7,800	\$2,900	\$11,000

Site-Specific Enabling and Completion Works

Each property will need to be assessed for any work that is required. The enabling work may include the dwelling removal, which could have already been carried out to allow access, isolate services and enable tree protection or removal or other enabling work. On completion restorative works will be required with the replacement of fences, repairs to damaged footpaths and the like.

As the enabling work cannot be defined due to the unique nature of each site, for the purposes of this cost analysis these costs have been excluded.

5.0 TENDER PROCESS FOR GROUND IMPROVEMENT PROJECTS

5.1 TENDERING

A series of tenders for single and batches of properties was arranged in order to encourage as much participation as possible by local and national construction companies, with a view to establishing not only competitive tendering for each project but also a database of companies for the various ground improvement methods.

Tender documentation fully specified the technical requirements of various ground improvement methodologies, and required detailed information to be submitted with the tender submissions that would enable the tender evaluation team to assess fully the suitability of each tenderer. The tender procurement procedures, overseen by a government probity specialist, were fully documented throughout the tender process by the tender evaluation team to ensure that the resulting tender recommendations were correctly established.

The conditions of contract included in the tender documents were those of NZS 3910:2003 Conditions of Contract for Building and Civil Engineering Construction, with special conditions relevant to the specific nature of the projects.

The tenders were focused on specific ground improvement methods, but also allowed tenderers to offer alternative methods on the proviso that those methods could be proven by the tenderers to be technically viable. This provided for a good cross-section of all technically suitable methods to be reviewed and, where appropriate, be taken to construction.

As a means of establishing that a particular method met the criteria of the specification, a thorough testing regime was included in the contract. The results of the testing processes undertaken before the start of construction enabled the engineer to confirm the adequacy of the specification in relation to the particular soil makeup. Testing at the completion of construction gave the engineer confidence that the specification had produced the predicted results.

The initial strategy under the pilot programme was to tender four packages of approximately ten sites per package. The package sizes were later refined to suit available sites and the requirement to focus on selected construction methods in an effort to give additional costing results to substantiate the costs of each of the methods that were reviewed.

After the conclusion of the work on the projects in the pilot programme, a further ground improvement method and a refinement to an existing method were identified as being likely to be published in MBIE guidelines. Tenders were called for the rotovated mixed ex-situ technique of constructing a 1.2m reinforced soil-cement raft. Two projects were let to identify the costs and efficiency of the method. From these projects and subsequent discussions with the two contractors, costs were established for the refined 1.2m reinforced gravel raft method.

5.2 TENDER PROGRAMME

In all, 10 separate batches of properties were tendered covering 29 properties. This was reduced and contracts were awarded in nine batches of 28 properties through the withdrawal of one property and the amalgamation of two tenders.

The first tender gave contractors the choice of tendering on various options of ground improvement and the opportunity to offer their own alternative methods. Subsequent tenders linked properties with similar soil types, thereby providing a basis for targeting selected ground improvement methods while still leaving options open for obtaining alternative methodologies.

5.3 INITIAL TENDER RESPONSES

The following table records the initial tender responses against various ground improvement methods. It should be noted that some of the tenders received did not meet engineering requirements and are not included in the pricing. Only construction methods that met the tender evaluation criteria are reported in the table below.

Tender	Properties	No of Tenderers	Improvement Method Type	Range of Initial Prices Stated in Area of Improvement
T1	Fuller St	4	Reinforced gravel raft	\$208.72 – \$379.91/m ²
		3	In-situ mixed-soil cement raft	\$222.04 – \$283.35/m ²
		1	Driven timber poles	\$414.85/m ²
T2	Bower Ave 1	4	Stone columns	\$134.35 – \$546.16/m ²
		1	In-situ mixed-soil cement raft	\$280.81/m ²
T3A	Wilson Rd McBratneys Rd Niven St 1 Barbadoes St	2	In-situ mixed-soil cement raft	\$247.29 – \$351.73/m ²
3B	Redwood Pl	1	In-situ mixed-soil cement raft	\$307.27/m ²
3C	Speight St	2	Reinforced gravel raft	\$208.24 – \$280.98/m ²
	Tavendale Pl			
T4	Landy St	1	Stone columns	\$143.15/m ²
		2	Reinforced gravel raft	\$296.09 – \$622.68/m ²
T5	Palmer Rd Bower Ave 2	1	Stone columns	\$122.11/m ²
T6A	Chardale St	2	Stone columns	\$105.06 – \$227.27/m ²
	Niven St 2	5	Timber poles	\$176.68 – \$294.22/m ²
T6B	Northaw St Pages Rd	6	Driven timber poles 1.2m c/c	\$177.49 – \$355.88/m ²
T7	Tavendale Pl	3	Driven timber poles 1.2m c/c	\$190.49 – \$210.93/m ²
T8	Hendon St McFaddens Rd	3	Driven timber poles 1.2m c/c	\$197.87 – \$287.35/m ²

A tender evaluation team was established to review the tenders when received for aspects of compliance with technical criteria, the conditions of tender and probity. Tenders deemed to be technically unsuitable were eliminated and the lower-priced complying tenders were reviewed for compliance with regard to work experience, resources and personnel, methodology and management systems, and adherence to programme. Tender

tags were reviewed and referred back to the tenderers where necessary for explanation, and removal as appropriate, in order to obtain complying tenders.

5.4 TENDERS AWARDED

Tenders received and checked for technical viability confined the methods to four solutions, namely:

- Stone columns
- Driven timber poles
- In-situ mixed-soil cement rafts
- Reinforced gravel rafts.

In assessing the acceptability of construction methods, reference was made to existing MBIE guidelines and methods that had demonstrated good performance in the Science Trials carried out in the residential red zone in 2013. Tenders were received from contractors for alternative options, but due to non-conformity with specifications, technical reasons, other deviations from the expected MBIE guideline revisions and cost, the following methods were not considered at the time:

- Rammed aggregate piers 2.5m deep
- Driven timber poles using ‘ugly’ (non-shaven) poles
- Large-diameter driven timber poles placed at greater than 1.2m centres
- Continuous flight auger columns.

The decision to exclude these options was due to uncertainty at the time around regulatory endorsement. MBIE has now endorsed the use of ‘ugly’ poles and large-diameter poles placed at greater than 1.2m centres for ground improvements. It has also provided increased tolerances for diameters and lengths of poles, which should reduce material costs.

Tenders were awarded to contractors on nine projects as detailed in the following table:

Tender	Properties	Contractor	Contract Award Amount	Expected Final Amount	Improvement Method
T1	Fuller St	Contractor 1	\$547,900	\$689,725	Reinforced gravel raft
T2	Bower Ave 1	Contractor 2	\$55,756	\$58,495	Stone columns
T3A	Wilson Rd McBratneys Rd Niven St 1 Barbadoes St	Contractor 3	\$467,946	\$761,136 (additional site added)	In-situ mixed-soil cement raft
T4	Landy St	Contractor 2	\$72,433	\$97,161	Stone columns
T5	Palmers Rd Bower Ave 2	Contractor 2	\$125,081	\$145,106	Stone columns
T6A	Chardale St Niven St 2	Contractor 2	\$125,026	\$112,616	Stone columns

T6B	Speight St Pages Rd	Contractor 4	\$192,093	\$268,970	Driven timber poles
T7	Tavendale Pl	Contractor 4	\$206,486	\$291,823	Driven timber poles
T8	Hendon St McFaddens Rd	Contractor 4	\$163,840	\$221,561	Driven timber poles

5.5 POST-TENDER ANALYSIS OF THE TENDER PROCESS

Low tender responses and high and inconsistent pricing were characteristics of the tenders received. The lack of a developed market for ground improvement work and multiple contractors vying for specific methods led to a limited source of rates for the different ground improvement methods.

A post-tender analysis of these tenders and information gathered from tenderers at post-tender debriefs suggested several reasons for this:

- There is a general lack of specialist civil engineering contractors in the market at this time to undertake these small-scale types of residential ground improvement works.
- The ground improvement methods are generally untried and unproven due to a lack of demand in residential situations, although similar work has been undertaken on commercial projects. The lack of demand has discouraged the large capital investment required of companies to obtain the specialised plant and equipment necessary for applying these ground improvement methods.
- The procurement procedures and tender conditions required by EQC to be incorporated in the tenders were perceived by some tenderers as excessive for projects of this type, size and complexity. The formal tender approach discouraged smaller contracting companies that were not conversant with these formal tender conditions, even though they might have had the ability to use the simpler ground improvement methods.
- There is no established market for the ground improvement methods. With most of the improvement methods recently developed, contractors had little historical information in order to establish the production factors for pricing the resource elements they would be using. This led to contractors taking a conservative approach in committing to the fixed rates required on these projects.
- There are intellectual property issues with some construction methods. These appeared to have inflated prices among those contractors who sought to capitalise on them and recover some of their development costs.

6.0 GROUND IMPROVEMENT METHODS AND COSTINGS

6.1 GROUND IMPROVEMENT METHODS

Not all types of ground improvement can be applied to all sites. Stone columns and driven timber poles have restrictions in their use on all soil types, either through geotechnical constraints or through practical installation.

Stone columns (MBIE ref. G5a)

Stone column ground improvement involves adding vertical columns of stone into the ground to a depth of at least 4m below the ground surface. A layer of compacted gravel can then be put over the top of the columns, ready for the construction of new house foundations.

Driven timber poles (MBIE ref. G5b)

Driven timber poles are installed vertically in the ground in a triangular grid pattern to at least 4m below the ground surface. A layer of compacted gravel can then be placed over the top of the installed poles, ready for the construction of new house foundations.

Reinforced soil-cement rafts (MBIE ref. G2a and MBIE ref. G2b)

Reinforced soil-cement rafts involve the construction of a 1.2m thick compacted crust made of cement-stabilised soil with reinforcing mesh called a geogrid. There are three methods: Ex-situ soil-cement mixing (MBIE ref. G2a), rotovated mixed ex-situ (MBIE ref. G2a) and in-situ soil mixing (MBIE ref. G2b).

Only the in-situ soil mixing method was trialled (to a depth of 2.1m, with 1.6m depth of soil treated). The ex-situ soil-cement raft was not trialled due to the difficulties likely to be encountered on sites with high ground water levels and the requirement to support the excavation sides.

Reinforced gravel rafts (MBIE ref. G1b)

Reinforced gravel rafts involve the construction of a 1.2m deep compacted 'raft' of engineered aggregate (gravel).

The ground improvement pilot specified a 2.1m deep treatment. At this depth there were construction difficulties encountered on the selected site, with high ground water levels and a requirement to support the excavated sides. The site required sheet piling the sides of the excavation, dewatering the excavation during excavation and the hardfill replaced.

The recent MBIE endorsement of a geogrid reinforced raft with reduced 1.2m thick treatment directly under the house footprint has led to a desktop estimate of the costs of this method.

6.2 CALCULATION OF COSTS

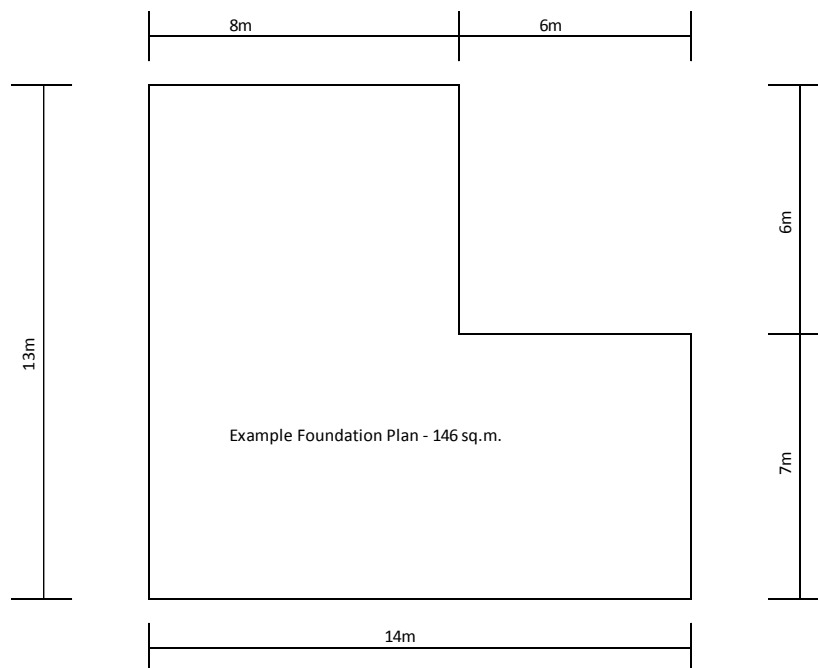
Ground improvement works in the Pilot were contracted on a 'measure and value' basis. The tender process required granular pricing of materials, quantities, labour and equipment in order to allow the pricing to be applied to ground improvement methods in a future MBIE guidance update.

The ground improvement rates are expressed as a square metre rate inclusive of all the contract costs to be multiplied by the intended treatment area. The site requirement for ground improvements is proportional to the time required to install the improvements. As such, the preliminary and general costs (which are largely time related) have been included in the square metre rates.

The tendered schedule has been used as the basis for calculation of the rates. An analysis of the costs were undertaken to ensure that any additional work or contract variations were included in the rates table. Any variations to the contract that were site specific and not particular to the technique of installing the method have been excluded from the calculations.

6.3 TREATMENT AREAS

Treatment areas of ground improvement have been defined as the building footprint of the MBIE representative floor plan as indicated below, plus the allowance defined by MBIE guidelines for extending the treatment area beyond the perimeter foundation line.



The treatment area for stone columns is the house footprint of 146m² plus a 2m perimeter, giving a total treatment area of 270m².

The treatment area for driven timber poles is the house footprint of 146m² plus a 2m perimeter, giving a total treatment area of 270m².

The treatment area for reinforced soil-cement raft is the house footprint of 146m² plus a 1m perimeter, giving a total treatment area of 204m².

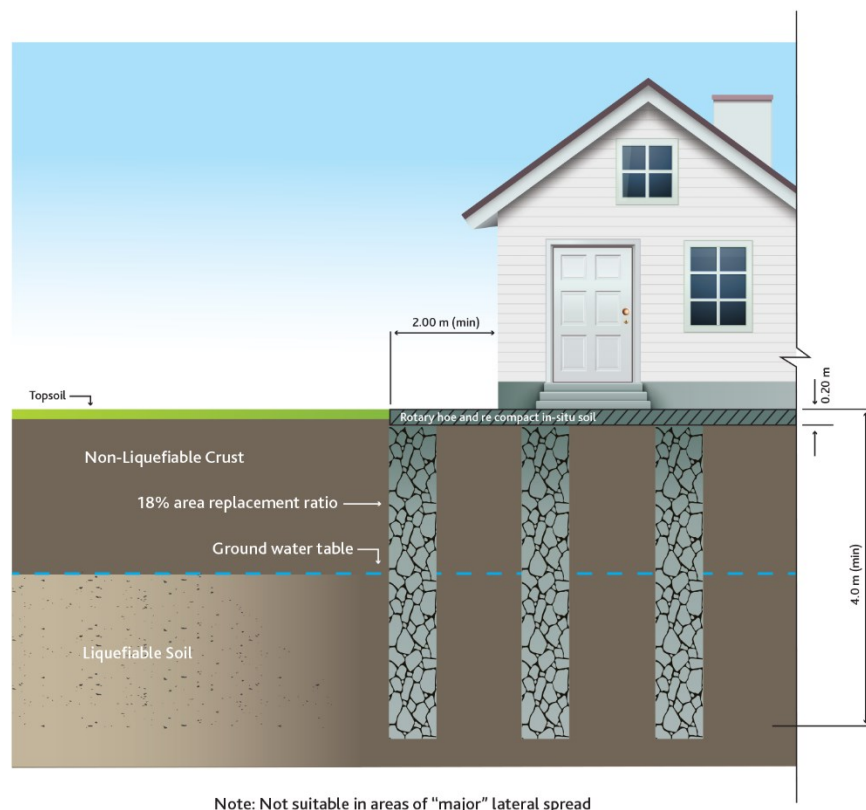
The treatment area for reinforced gravel raft is the house footprint of 146m² plus a 1m perimeter, giving a total treatment area of 204m².

7.0 GROUND IMPROVEMENT RATE CALCULATIONS

7.1 STONE COLUMNS (MBIE ref. G5a)

Stone columns provide a technically effective method and have proven to be one of the cheaper solutions for ground improvement. The process of installing stone columns requires a specialised vibroflot rig forcing aggregate in a predetermined replacement ratio into the ground, resulting in the densification of the natural ground to the predetermined depth.

The construction method for stone columns is shown in the following drawing and is as described in the latest MBIE guidelines.



The rates applicable to the stone column method have been calculated from the following sequence of work:

- Strip topsoil typically 200mm thick
- Stone columns are installed in a triangular grid at centres to achieve the required area replacement ratio to suit the soil classification. The columns are typically 4.25m long and, depending on the soil, the area replacement ratios are adjusted to 12%, 16%, 18% or 20%
- The top 200mm of the stone columns are rotovated and mixed with the existing soils to form a blanket layer
- The top surface is compacted with a heavy roller to achieve 95% maximum dry density
- The topsoil is reinstated or removed.

Tenders

The following table records prices received in square metres of treated area in tenders that were technically acceptable for stone column ground improvement.

Tender	Property	Contractor	Contract Awarded	Treatment Area	Cost per m ² of Treated Area	Total Cost
T6a	Niven St 2	Contractor 2	Yes	587m ²	\$105.03/m ²	\$61,651 ¹
T6a	Chardale St	Contractor 2	Yes	603m ²	\$105.10/m ²	\$63,374
T5	Bower Ave 2	Contractor 2	Yes	563m ²	\$128.93/m ²	\$72,588 ¹
T2	Bower Ave 1	Contractor 2	Yes	415m ²	\$134.35/m ²	\$55,755 ¹
T4	Landy St	Contractor 2	Yes	506m ²	\$143.15/m ²	\$72,434 ¹
T5	Palmers Rd	Contractor 2	Yes	365m ²	\$143.81/m ²	\$52,493 ¹
T1	Fuller St	Contractor 5		2,625m ²	\$173.62/m ²	\$455,753 ²
T1	Fuller St	Contractor 1		2,625m ²	\$215.73/m ²	\$566,291 ²
T2	Bower Ave 1	Contractor 5		415m ²	\$473.88/m ²	\$196,660 ²
T2	Bower Ave 1	Contractor 4		415m ²	\$546.16/m ²	\$226,656 ²
T2	Bower Ave 1	Contractor 1		415m ²	\$601.17/m ²	\$249,486 ²

¹ Tender tags reviewed, referred back to tenderer and adjusted to comply with tender requirements.

² Tender tags reviewed not referred back to tenderer due to price disparity.

The tenders received stated the plant that was to be used, the replacement ratios and the methodology to be employed in the ground improvement works.

As can be analysed from the above table, there is a distinct difference between the prices received from Contractor 2 and those from the three other tenderers on smaller residential treated areas. It is also relevant that the other three tenderers did not submit tenders after the second tender. These three tenderers have undertaken commercial work with larger plant installing stone columns, highlighting the inefficiency and costs of using large plant on residential sites. Contractor 2 was awarded all of the stone column projects.

Construction

During the preconstruction and construction phases of the projects, some administrative difficulties were encountered with regard to the detailed contractual requirements. This meant increased involvement by Tonkin + Taylor in managing these issues. With repetition and the streamlining of the methodology these issues should diminish.

From a construction perspective the work was generally reported as being carried out successfully from site observations by Tonkin + Taylor. Although quality control was initially a problem on the first site, better quality control was introduced by Contractor 2 on the later projects and no further problems with respect to this issue have been reported.

Additional post-construction verification testing costs and bespoke engineering fees are required when using replacement ratios not specified in the MBIE guidance update.

The following table schedules the respective rates for the projects completed, with adjustments to suit the MBIE-endorsed method and the redefined treatment areas.

**GROUND IMPROVEMENT COMPILATION
SUMMARY FOR STONE COLUMNS (MBIE ref. G2)**

CLEARED SITES - NON-HAIL

Treatment Area 2m Surrounding Structure				Cost of Treated Area (\$/m ²)			
Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	12%	16%	18%	20%
Stone columns 700mm diam. with 12% replacement ratio	Bower Ave 2 (ex HAIL)	572	270	\$111.57			
	Palmer Rd (ex HAIL)	653	270	\$135.72			
	Bower Ave 1	508	270	\$133.61			
	Average			\$126.97			
	Contractor 5		270	\$145.28			
	Contractor 6		270	\$163.40			
	Contractor 7		270	\$149.99			
Stone columns 900mm diam. with 16% replacement ratio	Bower Ave 1	508	270		\$121.80		
	Niven St 2	782	270		\$136.50		
	Chardale St	706	270		\$136.50		
	Average				\$131.60		
	Contractor 5		270		\$168.93		
	Contractor 6		270		\$190.00		
	Contractor 7		270		\$174.41		
Stone columns 900mm diam. with 18% replacement ratio	Bower Ave 1	508	270			\$130.13	
	Niven St 2	782	270			\$140.72	
	Chardale St	706	270			\$140.72	
	Average					\$137.19	
	Contractor 5		270			\$184.98	
	Contractor 6		270			\$208.05	
	Contractor 7		270			\$190.98	
Stone columns 900mm diam. with 20% replacement ratio	Landy St (ex HAIL)	607	270				\$172.08
	Contractor 5		270				\$201.03
	Contractor 6		270				\$226.10
	Contractor 7		270				\$207.55
	Average		270	\$146.41	\$166.24	\$180.30	\$201.69

Note: Bespoke engineering design and additional post-construction verification testing will be required for replacement ratios below 18% as specified in the MBIE guidelines.

All rates exclude GST.

Refer to Appendix A for the calculation of the rates.

Conclusions and Concerns

The following influence the rates for this ground improvement method:

- There is concern that of the four stone column tenderers Contractor 2 stood out from the others from a price perspective. It is also a concern that in a market-related environment there will likely be a move to capitalise on this situation, and future prices will likely increase to conform with the rest of the market.
- Given the tender responses and a study of the contractors that could potentially be capable of carrying out stone column construction should large-scale work be required, there are likely to be sufficient specialised resources to undertake this work in the short to medium term. There are now three stone piling rigs in use in the Canterbury area and a further rig is available to be brought in if there is demand.
- As Contractor 2 is still developing in the market, there is a risk in terms of the sustainability of Contractor 2's rates.
- Contractor 2's equipment is new. The long-term usage, maintenance and depreciation costs have not been studied and the effects of these costs on the rates have not been established.
- Although Contractor 2 was the only successful stone column tenderer, there are other contractors undertaking work using similar systems that are likely to comply with the MBIE guidelines. The market is still developing and once the extent of future work is established more contractors will enter this market.

Schedule of Rates

Whilst Contractor 2 has performed well on the projects, the above concerns need to be taken into account in order to establish rates that can be sustained and defensible. In order to substantiate the Contractor 2 rates, supporting data on costing has been gathered from three other contractors that can or can potentially carry out stone column construction. We consider it prudent to include the rates from the three contractors as well as the Contractor 2 rates in order to obtain a more robust market-related rate for stone columns.

Contractor 5

Contractor 5 offered a price on Tender 1 (Fuller St). Its tender was not considered due to its non-availability to perform the work due to other commitments. The cost established for this work was \$168.93/m² for a replacement ratio of 16%. The tender was for a large site, which suggests that the price would have been lower than for a smaller site.

Contractor 6

Contractor 6 offered prices for rammed aggregate piers, a similar method of construction to stone columns, on Tender 1 (Fuller St) at a rate of \$216.62/m² and Tender 2 (Bower Ave 1) at \$521.46/m². These prices were not considered at the time of tender as they were high in relation to other tender offers for the same projects.

Further prices were obtained informally from work carried out by Contractor 6 at Meadow St, Kaiapoi. These indicated a rate, when adjusted to exclude the engineering services provided, of approximately \$190/m² at a replacement ratio of 16%.

Contractor 7

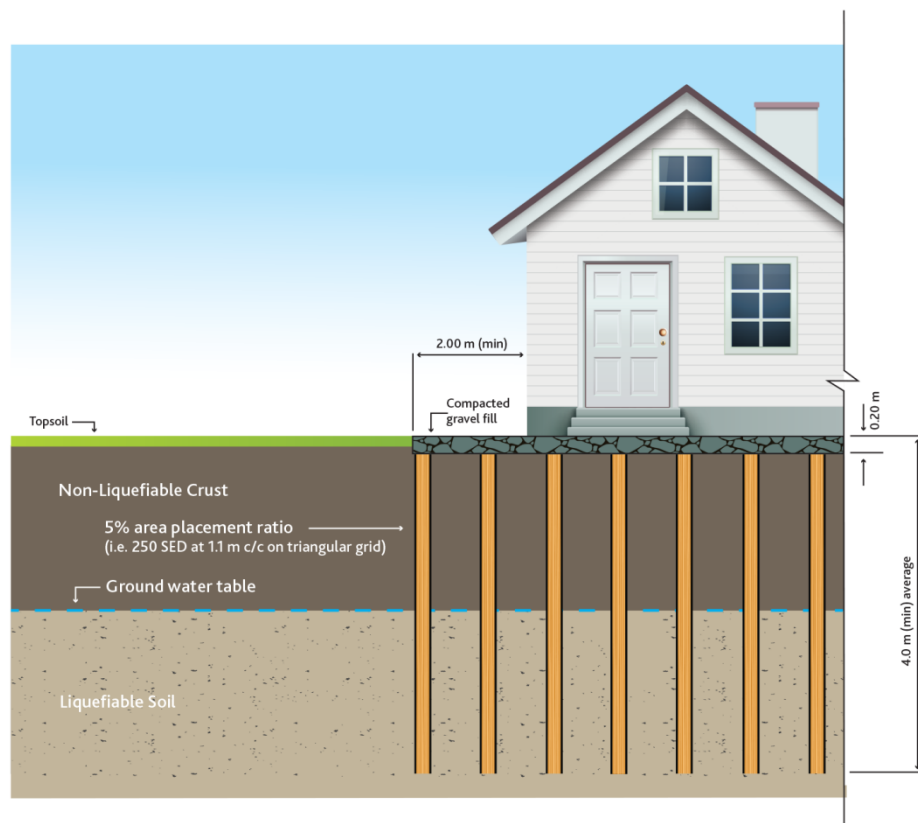
Contractor 7 has been very involved in developing ground remediation techniques in the past two years in Christchurch. It currently has plant in Christchurch that will be used for stone columns. Its research into the operations required for stone poles has led it to offer a rate of \$150-\$180/m³ for stone columns. When converted to square metres, this would equate to \$174.41/m² at a replacement ratio of 16%.

7.2 DRIVEN TIMBER POLES (MBIE ref. G5b)

Methodology

Driven timber poles provide a technically effective method of ground improvement in ground that is too silty to enable the construction of stone columns or rammed aggregate piers. The process of installing timber poles requires a specialised piling rig, which vibrates or drives the timber poles vertically into the soil to a predetermined depth.

The construction method for driven timber poles is shown in the following drawing and is as described in the latest MBIE guidelines:



The rates applicable to driven timber poles have been calculated from the following sequence of work:

- Strip topsoil typically 200mm thick

- Drive 3.8m long x 250mm diameter SED H5 (ex 4.2m long) timber poles to a depth of 4.0m below natural ground level in a triangular grid at centres either 1.2m or 1.0m to suit the soil classification of the site and/or MBIE requirements
- A 200mm thick compacted gravel blanket is provided over the top of the timber poles
- Topsoil is reinstated or removed.

Tenders

The following table records prices received in square metres of treated area from tenders that complied with the tender documents and were deemed technically acceptable at the time.

Tender	Property	Contractor	Contract Awarded	Treated Area	Cost per m ² of Treated Area	Total Cost	
T6A	Chardale St	Contractor 4		603m ²	\$173.49/m ²	\$106,614	²
T6B	Northaw St	Contractor 4		541m ²	\$175.26/m ²	\$94,816	²
T6A	Niven St 2	Contractor 4		587m ²	\$179.25/m ²	\$105,220	²
T7	Tavendale Pl	Contractor 4	Yes	1,084m ²	\$190.49/m ²	\$206,486	¹
T6B	Pages Rd	Contractor 4	Yes	420m ²	\$193.71/m ²	\$81,357	¹
T1	Fuller St	Contractor 8		2,625m ²	\$182.38/m ²	\$478,748	²
T6B	Pages Rd	Contractor 4	Yes	420m ²	\$193.71/m ²	\$81,357	
T8	Hendon St	Contractor 4	Yes	424m ²	\$197.33/m ²	\$83,670	¹
T8	McFaddens Rd	Contractor 4	Yes	404m ²	\$198.45/m ²	\$80,172	¹
T7	Tavendale Pl	Contractor 9		1,084m ²	\$200.30/m ²	\$217,125	²
T8	Hendon St	Contractor 9		424m ²	\$201.62/m ²	\$85,487	²
T8	McFaddens Rd	Contractor 9		404m ²	\$201.19/m ²	\$81,281	²
T7	Tavendale Pl	Contractor 10		1,084m ²	\$210.94/m ²	\$228,659	²
T6A	Chardale St	Contractor 1		603m ²	\$213.19/m ²	\$128,554	²
T6A	Chardale St	Contractor 10		603m ²	\$237.36/m ²	\$143,128	²
T6B	Northaw St	Contractor 10		541m ²	\$238.69/m ²	\$129,131	²
T6B	Pages Rd	Contractor 10		420m ²	\$245.29/m ²	\$103,022	²
T6A	Niven St 2	Contractor 10		587m ²	\$251.66/m ²	\$147,724	²
T6A	Chardale St	Contractor 8		603m ²	\$257.79/m ²	\$155,447	²
T6B	Northaw St	Contractor 8		541m ²	\$260.37/m ²	\$140,860	²
T6A	Niven St 2	Contractor 8		587m ²	\$263.78/m ²	\$154,839	²
T6B	Pages Rd	Contractor 8		420m ²	\$276.48/m ²	\$116,122	²
T6A	Niven St 2	Contractor 1		587m ²	\$279.74/m ²	\$164,207	²
T6A	Chardale St	Contractor 9		603m ²	\$290.05/m ²	\$174,900	²
T6A	Niven St 2	Contractor 9		587m ²	\$298.50/m ²	\$175,220	²
T6B	Northaw St	Contractor 9		541m ²	\$306.31/m ²	\$165,714	²
T6B	Pages Rd	Contractor 9		420m ²	\$328.78/m ²	\$138,088	²

T6B	Northaw St	Contractor 11	541m ²	\$345.84/m ²	\$187,099	²
T6B	Pages Rd	Contractor 11	420m ²	\$354.17/m ²	\$148,751	²

¹ Tender tags reviewed, referred back to tenderer and adjusted to comply with the tender requirements.

² Tender tags reviewed, not referred back to tenderer due to price disparity.

Information received with the tenders detailed the plant, equipment and methodology to be used in the installation. The disparity between the rates highlighted these differences. Several of the tenderers had completed commercial projects using their particular plant for which it was better suited.

Contractor 4 was awarded all of the driven timber pole contracts. Tenders received from other contractors indicated a relatively competitive market for the timber poles.

Construction

As the installation method is relatively simple and the plant and equipment standard and available, Contractor 4 was able to work on multiple sites concurrently.

Prior to construction, concerns were raised by Tonkin & Taylor that the specified spacing of the poles at 1.2m centres may not be sufficient to meet future MBIE requirements. The specification was consequently changed and poles at 1.0m centres were specified for all sites.

There proved to be a problem encountered on the Pages Rd site, where a dense layer of soil was encountered at approximately 3.0m deep that meant the poles were unable to be driven into the ground to the depth specified. An engineering decision was made to install shorter poles on this site. The instalment method carried out by Contractor 4 was not well suited to the soil conditions at site and alternative methods of pile installation could have overcome this problem.

Rate information for the two different pole spacings of 1.2m and 1.0m centres was requested in the tender documentation. Rates of poles at 1.1m centres were later calculated to align with the recommendations in the 2015 MBIE guidelines update.

During the pilot programme poles called 'uglies', which are unshaved poles, were not considered suitable. The MBIE guidelines now permit their usage and the rates have been adjusted by the reduced cost of these poles.

The following table schedules the respective rates for the projects completed, with adjustments to suit the MBIE-endorsed method and the redefined treatment areas.

**GROUND IMPROVEMENT COMPILATION SUMMARY FOR
DRIVEN TIMBER POLES (MBIE ref. G5b) CLEARED SITES - NON-HAIL**

Treatment Area 2m Surrounding Structure				Cost of Treated Area (\$/m ²)		
Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	1.2m ctrs	1.1m ctrs	1.0m ctrs
Driven timber poles (uglies) 250mm diam. SED 3.8m long at 1.2m centres	Tavendale Pl	1273	540	\$206.97		
	Speight St	711	270	\$199.02		
	Pages Rd	512	270	\$207.00		
	Hendon Rd	511	270	\$216.20		
	McFaddens Rd	495	270	\$211.98		
Driven timber poles (uglies) 250mm diam. SED 3.8m long at 1.1m centres	Tavendale Pl	1273	540		\$242.24	
Driven timber poles (uglies) 250mm diam. SED 3.8m long at 1.0m centres	Tavendale Pl	1273	540			\$269.28
	Speight Rd	711	270			\$273.34
	Average			\$208.23	\$242.24	\$271.31

All rates exclude GST.

Refer to Appendix A for the calculation of the rates.

Conclusions and Concerns

The following have influence on the rates for this ground improvement method:

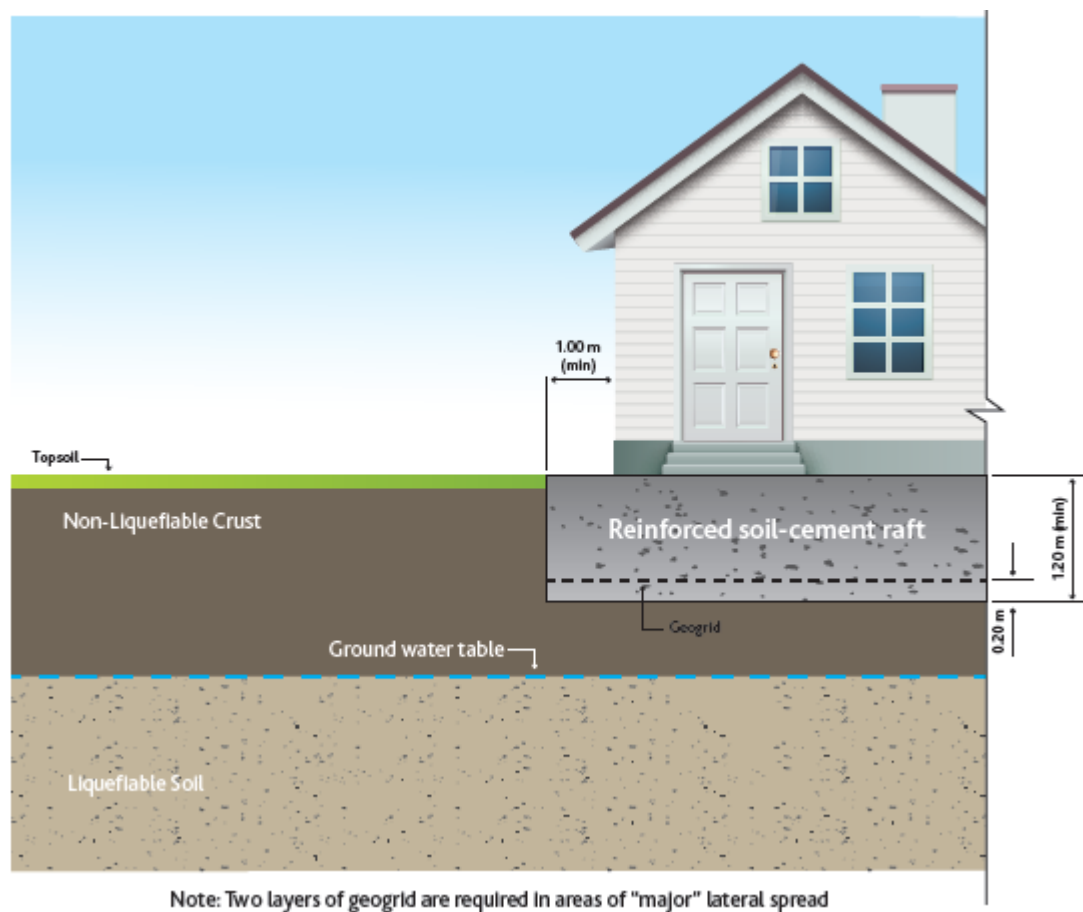
- During the tender discussions with Contractor 4 it became apparent that the local supply of 250mm SED poles, 3.6m long was possibly heading towards being short. Poles from the North Island would need to be brought in to supplement the supply. This did not eventuate for these contracts, but there is an ongoing risk that there will be increased supply costs for the product. The updated MBIE guidelines provide increased tolerances for dimensions of timber poles.
- Whilst there was a wide range of prices for the driven timber poles method, the method is relatively simple and equipment is not particularly specialised. It is envisaged that, once the method is more fully understood in the industry, there will be several more players entering the market. This will generate competition, and with the adaptation of more specialised equipment will overcome soil density problems in driving the poles.

7.3 REINFORCED SOIL-CEMENT RAFTS – ROTOVATED MIXED EX-SITU (MBIE ref. G2a)

Methodology

A further method of ground improvement has been endorsed by MBIE since the pilot projects were completed. The method provides a 1.2m deep stabilised layer beneath the building platform, achieving the principal objectives of rafting out differential settlements, confining the underlying liquefiable soils and reducing potential ejection.

The construction method for reinforced soil-cement rafts – rotoverted mixed ex-situ (above the ground water table) – on site is shown in the following drawing and is as described in the MBIE guidelines:

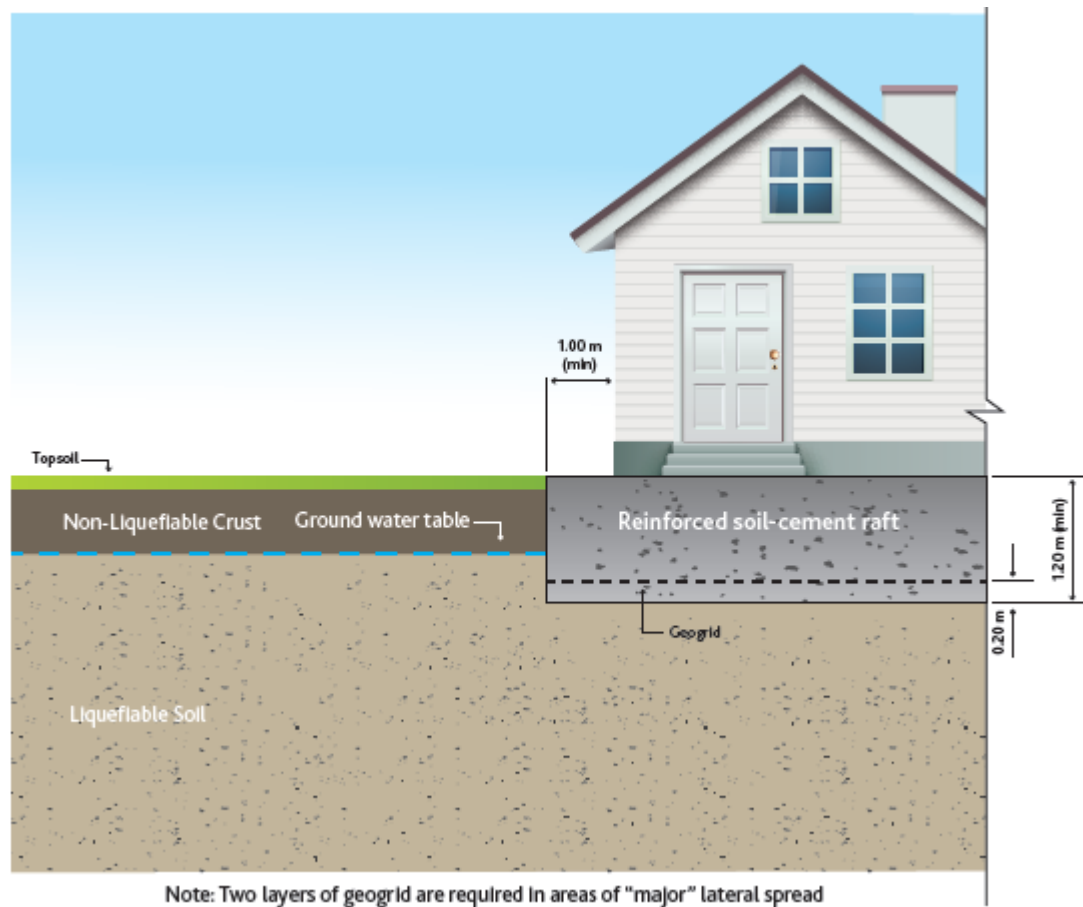


The rates applicable to reinforced soil-cement rafts have been calculated from the following sequence of work:

- Strip topsoil and dispose off-site
- Excavate to 1,100mm below natural ground level across the treatment area and stockpile
- Spread the measured 8% cement by dry mass over the excavation base and rotary hoe the cement evenly over the in-situ material to a depth of 100mm and compact

- Place 100mm layer of material ex-stockpile, spread the measured 8% cement by dry mass over the excavation base, and rotary hoe the cement evenly over the in-situ material and compact
- Place one layer of high-strength bi-directional geogrid over the first layer
- Replace series of 100mm layers, mix in cement and compact to natural ground level.

The construction method for reinforced soil-cement rafts – rotovated mixed ex-situ (below the ground water table) – on site is shown on the following drawing and is as described in the MBIE guidelines:



The rates applicable to reinforced soil-cement rafts have been calculated from the following sequence of work:

- Strip topsoil typically 100mm thick and dispose off-site
- Excavate to 1,000mm below natural ground level across the treatment area and stockpile
- Excavate to 1,200mm below natural ground level across the treatment area and dispose off-site
- Supply and place 200mm thick layer of imported AP40 M4 aggregate and compact

- Spread the measured 10% cement by dry mass over the excavation base and rotary hoe the cement evenly over the hardfill and compact
- Place two layers of high-strength bi-directional geogrid over the hardfill
- Replace series of 100mm layers, mix in cement and compact to natural ground level.

Tenders

Tenders were invited from five contractors to trial the rotovated soil mixing method on two red zone sites at Keller St 1 & 2, Avondale. The aim of the trial was to provide factual information on the constructability of the method whilst achieving the stated performance criteria and providing pricing information based on tendered conditions. The tender allowed for re-establishing the topsoil over the worked areas.

For practical reasons, due to the sites on which the work was undertaken, tenders were awarded for a 900mm deep raft with 300mm topsoil/fill cover over.

The following tenders were received:

Contractor	Contract Awarded	Treated Area	Cost per m ² of Treated Area	Total Cost
Contractor 12	Yes	204m ²	\$121.49/m ²	\$24,784
Contractor 13	Yes	204m ²	\$176.10/m ²	\$35,924
Contractor 14		204m ²	\$189.23/m ²	\$38,603
Contractor 15		204m ²	\$234.09/m ²	\$47,754
Contractor 7		204m ²	\$370.96/m ²	\$75,676

The two lowest prices were reviewed and referred back to the tenderers to comply with the tender requirements.

Construction

Contracts were awarded to Contractor 12 on Keller St 1 and Contractor 13 on Keller St 2. Both contractors completed their respective work efficiently and to the specified standards. Each contractor used its own method of mixing and rotovating the material and both completed their contracts in a reasonably short timeframe.

Rates for this method have been calculated for situations where the base of the excavation is either above or below the water table. Rates have been averaged between the two contractors that were awarded the two contracts. It was considered prudent to average the two prices as the difference between them suggested that the price from Contractor 12 was too low.

The following tables schedule the respective rates for the projects completed, with adjustments to suit the MBIE-endorsed method and the redefined treatment areas.

**GROUND IMPROVEMENT COMPILATION SUMMARY FOR
ROTOVATED MIXED EX-SITU (MBIE ref. G2a)**

**CLEARED SITES - NON-HAIL
WORK ABOVE WATER TABLE**

Treatment Area 1.0m Surrounding Structure

Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	Cost of Treated Area (\$/m ²)	Treatment Cost
<u>Rotovated mixed Ex-situ</u> Excavate 1100mm deep, stabilise and compact 100mm in-situ layer, replace excavated material and cement stabilise in position with 8% cement ratio (No retention or dewatering required)	Keller St 2	642	204	\$156.42	\$31,909.68
	Keller St 1	642	204	\$211.04	\$43,052.16
	Average			\$183.73	\$37,480.92

Rates exclude GST.

**GROUND IMPROVEMENT COMPILATION SUMMARY FOR
ROTOVATED MIXED EX-SITU (MBIE ref. G2a)**

**CLEARED SITES - NON-HAIL
WORK BELOW WATER TABLE**

Treatment Area 1.0m Surrounding Structure

Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	Cost of Treated Area (\$/m ²)	Treatment Cost
<u>Rotovated Mixed Ex-situ</u> Excavate 1100mm deep, place 200mm layer crushed concrete, lay geogrid, replace excavated material and cement stabilise in position with 8% cement ratio 1m outside building footprint (no retention or dewatering required)	Keller St 1	642	204	\$233.63	\$47,660.52
	Keller St 2	642	204	\$185.04	\$37,748.16
	Average			\$209.33	\$42,704.34

Rates exclude GST.

Refer to Appendix A for the calculation of the rates.

Conclusions and Concerns

The following have influence on the rates for this ground improvement method:

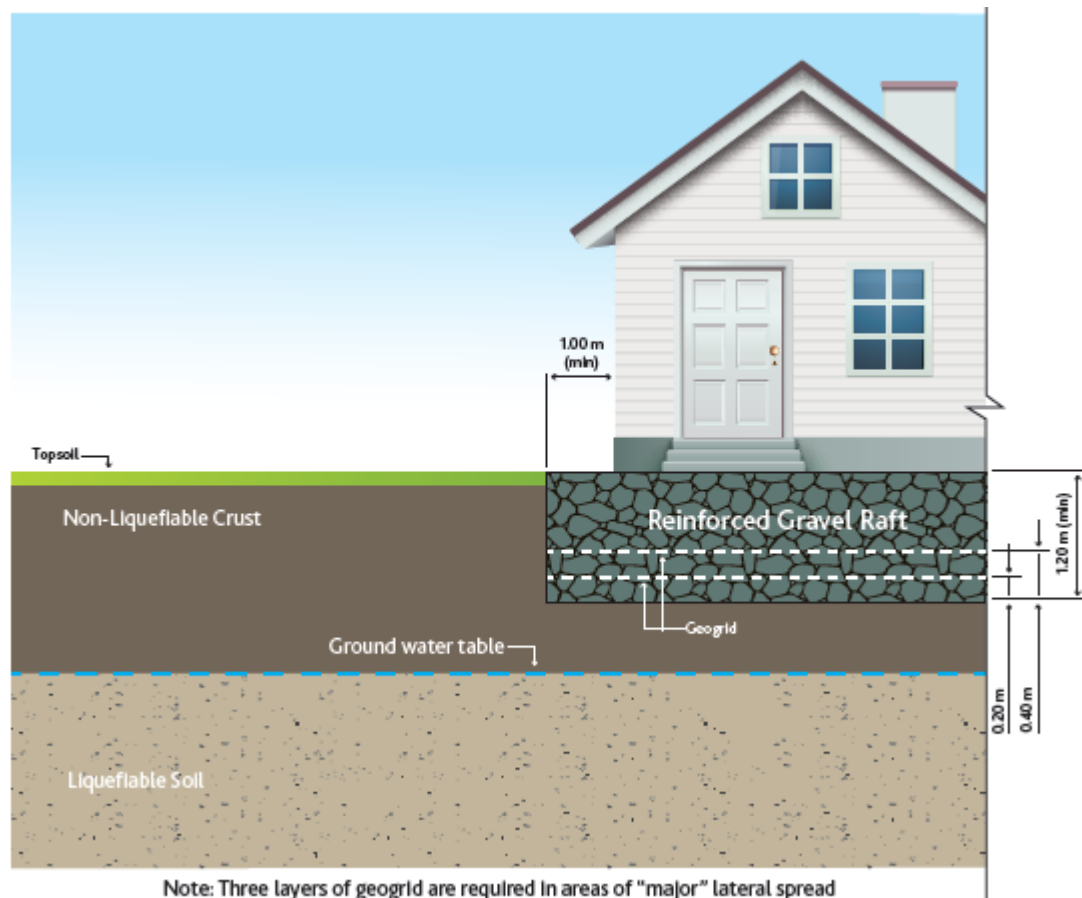
- The advantage of mixing the cement with material in position in the excavation is that a higher degree of quality control can be achieved with the cement dosing rate applied.
- The method of mixing the cement into the soil by rotary hoeing is simple and can be performed without specialist plant and the associated establishment charges. Without the required capital outlay for expensive equipment, it is considered that smaller contractors could be encouraged to develop this method of ground improvement.
- Owing to the shallow excavation, dewatering and/or retaining the sides of the excavation is generally not required for most sites.
- The nature of this method, where the excavated area is exposed during construction, leaves it susceptible to rainfall and storm-water run-off, which can cause significant delays and repeated work.

7.4 REINFORCED GRAVEL RAFTS 1,200mm Deep (MBIE ref. G1d)

Methodology

A further method of ground improvement has been endorsed by MBIE since the pilot projects were completed. The method provides a 1.2m deep compacted raft of engineered aggregate (gravel) beneath the building platform. This aims to achieve the principal objectives of rafting out differential settlements, confining the underlying liquefiable soils and reducing potential ejection.

The construction method for reinforced gravel rafts (above the ground water table) on site is shown in the following drawing and is as described in the MBIE guidelines:

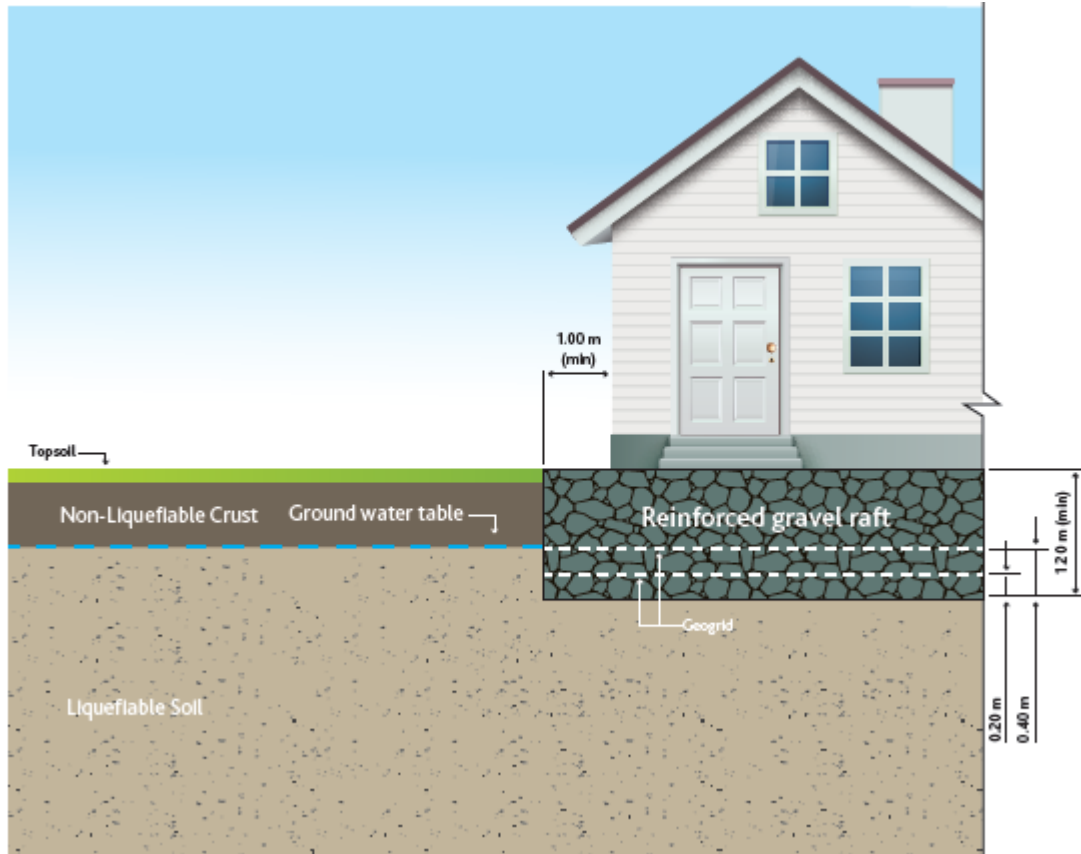


The rates applicable to the 1,200mm gravel raft have been calculated from the following sequence of work:

- Strip topsoil typically 100mm thick and dispose off-site
- Excavate to 1200mm below natural ground level across the treatment area and stockpile
- Supply and place 200mm thick layer of imported AP40 M4 aggregate and compact
- Place two layers of high-strength bi-directional geogrid separated by 200mm thick of imported AP40 M4 aggregate and compact

- Supply and place series of 100mm thick layers of imported AP40 M4 aggregate and compact to natural ground level.

The construction method for reinforced gravel rafts (below the ground water table) on site is shown in the following drawing and is as described in the MBIE guidelines:



The rates applicable to the 1,200mm gravel raft have been calculated from the following sequence of work

- Strip topsoil typically 100mm thick and dispose off-site
- Excavate to 1200mm below natural ground level across the treatment area and stockpile
- Supply and place 200mm thick layer of imported AP40 M4 aggregate and compact
- Spread the measured 10% cement by dry mass over the excavation base and rotary hoe the cement evenly over the hardfill and compact
- Place two layers of high-strength bi-directional geogrid separated by 200mm thick of imported AP40 M4 aggregate and compact
- Supply and place series of 100mm thick layers of imported AP40 M4 aggregate and compact to natural ground level.

Calculation of Rates

This work was not tendered, but given its similarity to the tender for the rotated mixed ex-situ work, it was considered viable to request the two contractors on Keller St to provide additional rates for the shallow reinforced gravel raft.

In order to confirm the validity of the rates received, a desktop review of the rates was carried out by Kingston Partners Limited.

The following table schedules the respective rates for the projects, completed with adjustments to suit the MBIE-endorsed method and the redefined treatment areas.

**GROUND IMPROVEMENT COMPILATION SUMMARY
FOR REINFORCED GRAVEL RAFT (MBIE ref. G1b)**

**CLEARED SITES - NON-HAIL
WORK ABOVE WATER TABLE**

Treatment Area 1.0m Surrounding Structure

Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	Cost of Treated Area (\$/m ²)	Treatment Cost
Reinforced gravel raft Excavate 1200mm deep, replace with imported hardfill (no retention or dewatering required)	Keller St 1 (theoretical)	642	204	\$190.01	\$38,761.24
	Keller St 2 (theoretical)	642	204	\$161.27	\$32,899.80
	Average			\$175.64	\$35,830.52

The costing and constructability of this method are theoretical and have not been proven by tender and site trials.

Rates exclude GST.

Refer to Appendix A for the calculation of the rates.

Conclusions and Concerns

The following have influence on the rates for this ground improvement method:

- The method of importing and placing the reinforced gravel raft can be performed without specialist plant and the associated establishment charges. Without the required capital outlay for expensive equipment, it is considered that smaller contractors could be encouraged to develop this method of ground improvement.
- Owing to the shallow excavation, dewatering and/or retaining the sides of the excavation are not required in most cases.
- The nature of this method, where the excavated area is exposed during construction, leaves it susceptible to rainfall and storm water run-off, which can cause significant delays and repeated work.
- Without the defensibility of calculating rates from an actual project delivered under tender conditions, the calculated rates could be challenged. However, the rates received were consistent with predicted costs through desktop analysis.

- The method is generally limited to sites where the groundwater is below 1m or able to be controlled with a sump pump.

8.0 SUMMARY

8.1 COST EFFECTIVENESS

In summarising the various ground improvement options, four methods stand out as being applicable to the various soil types and site situations, and more cost effective than the other methods. These methods are:

- Stone columns
- Driven timber poles
- Reinforced soil-cement rafts – rotovated mixed ex-situ
- Reinforced gravel rafts.

It has been established through geospatial repair selection that reinforced soil-cement rafts and reinforced gravel rafts can feasibly be used on the majority of liquefaction vulnerable cleared sites. The recent inclusion of 1,200mm thick reinforced gravel rafts in the revised guidelines makes them a universal method depending on the practicality of the sites and the height of the water table.

Other methods, whilst not as cost effective, may be required as ground improvement solutions where none of the above methods is considered suitable.

8.2 CONSERVATISM OF THE RATES

The ground improvement rates have been calculated using information provided in tenders and information obtained from the contracts undertaken. Under different tender conditions, with more contractors participating and proven techniques streamlined over time, it should be expected that better rates would be obtained for the various methods.

8.3 INFORMATION RECEIVED FROM TENDERS

Low tender responses and high and inconsistent pricing were characteristics of the tender process. The lack of a developed market for ground improvements and multiple contractors vying for specific methods led to a limited source of rates that could be utilised in the ground improvement methods that have been established.

8.4 MBIE GUIDELINES

The Ground Improvement Pilot Project was undertaken concurrently with the peer review of the Science Trials and the development of the MBIE guidance update. With the 2015 MBIE guidance update now available, the rates have been calculated on these latest method designs.

The ground improvement rates have been calculated independently of any foundation and other reconstruction work.

9.0 APPLICABILITY OF LIMITATIONS

This report has been prepared by Kingston Partners Limited for the sole benefit of the Earthquake Commission. It should not be relied upon by any other party and covers the full extent of the due diligence that we have carried out to date.

KINGSTON PARTNERS LIMITED

T N COE
Associate

M J CASEY
Director

10.0 APPENDIX A – RATE CALCULATION SCHEDULES

EARTHQUAKE COMMISSION

GROUND IMPROVEMENT COMPILATION SUMMARY FOR STONE COLUMNS (MBIE ref. G2)

CLEARED SITES - NON-HAIL

Treatment Area 2m Surrounding Structure				Cost of Treated Area (\$/m ²)			
Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	12%	16%	18%	20%
Stone columns 700mm diam. with 12% replacement ratio	Bower Ave 2 (ex HAIL)	572	270	\$111.57			
	Palmer Rd (ex HAIL)	653	270	\$135.72			
	Bower Ave 1	508	270	\$133.61			
	Average			\$126.97			
	Contractor 5		270	\$145.28			
	Contractor 6		270	\$163.40			
	Contractor 7		270	\$149.99			
Stone columns 900mm diam. with 16% replacement ratio	Bower Ave 1	508	270		\$121.80		
	Niven St 2	782	270		\$136.50		
	Chardale St	706	270		\$136.50		
	Average				\$131.60		
	Contractor 5		270		\$168.93		
	Contractor 6		270		\$190.00		
	Contractor 7		270		\$174.41		
Stone columns 900mm diam. with 18% replacement ratio	Bower Ave 1	508	270			\$130.13	
	Niven St 2	782	270			\$140.72	
	Chardale St	706	270			\$140.72	
	Average					\$137.19	
	Contractor 5		270			\$184.98	
	Contractor 6		270			\$208.05	
	Contractor 7		270			\$190.98	
Stone columns 900mm diam. with 20% replacement ratio	Landy St (ex HAIL)	607	270				\$172.08
	Contractor 5		270				\$201.03
	Contractor 6		270				\$226.10
	Contractor 7		270				\$207.55
	Average		270		\$146.41	\$166.24	\$180.30

Note: Bespoke engineering design and additional post-construction verification testing will be required for replacement ratios below 18% as specified in the MBIE guidelines.

All rates exclude GST.

**TENDER 2 - STONE COLUMNS
CONTRACTOR 2
Bower Ave 1**

Tendered Area				
	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1	LS	1	1,500.00	1,500.00
1.1.2	LS	1	Incl	-
1.1.3	LS	1	200.00	200.00
1.1.4	LS	1	200.00	200.00
1.1.5	LS	1	500.00	500.00
1.1.6	LS	1	100.00	100.00
1.1.7	LS	1	1,000.00	1,000.00
1.1.8	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1	m ²	415	1.00	415.00
1.2.2	m ²	415	5.00	2,075.00
1.2.3	m ³	83	40.00	3,320.00
1.2.4	m ²	415	2.20	913.00
1.2.5	m ²	415	25.00	10,375.00
1.2.6	m ³	83	10.00	830.00
1.2.7	m ²	415	2.20	913.00
1.2.8	m ²	415	1.00	415.00
1.3 Stone Columns				
Construct stone columns 4.5m long 900mm diam.				
1.7.1	No	105	300.00	31,500.00
1.7.2	LS	1	1,000.00	1,000.00
Accepted Tender Value				\$ 55,756.00

**TENDER 2 - STONE COLUMNS (MBIE ref. G5a)
CONTRACTOR 2
Bower Ave 1**

MBIE House Area + 2m 4.5m Column x 700mm diam x 12%				
	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1	LS	1	1,500.00	1,500.00
1.1.2	LS	1	Incl	-
1.1.3	LS	1	200.00	200.00
1.1.4	LS	1	200.00	200.00
1.1.5	LS	1	500.00	500.00
1.1.6	LS	1	100.00	100.00
1.1.7	LS	1	1,000.00	1,000.00
1.1.8	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1	m ²	270	1.00	270.00
1.2.2	m ²	270	5.00	1,350.00
1.2.3	m ³	54	40.00	2,160.00
1.2.4	m ²	270	2.20	594.00
1.2.5	m ²	270	25.00	6,750.00
1.2.6	m ³	54	10.00	540.00
1.2.7	m ²	270	2.20	594.00
1.2.8	m ²	270	1.00	270.00
1.3 Stone Columns (MBIE ref. G5a)				
Construct stone columns 4.5m long 700mm diam.				
1.7.1	No	84	210.00	17,640.00
1.7.2	LS	1	1,000.00	1,000.00
Adjustments				
<u>Omit</u>				
Cut to waste	m ²	-270	5.00	(1,350.00)
Undercut & Replace	m ³	-54	40.00	(2,160.00)
Geofabric to subgrade	m ²	-270	2.20	(594.00)
Drainage blanket	m ²	-270	25.00	(6,750.00)
Re-use site-won material	m ³	-54	10.00	(540.00)
Geofabric to drainage blanket	m ²	-270	2.20	(594.00)
<u>Add</u>				
Rotary hoe and recompact upper 250mm	m ²	270	2.50	675.00
Respread topsoil	m ²	270	1.00	270.00
Additional administrative assistance	sum			3,000.00
CPT Tests	4 No		750.00	3,000.00
Adjusted cost of project (270m² treatment area)				\$ 30,125.00

270 m² \$ 111.57 /m²

Calculation of reduced treatment area

270 m² at 12% = 32.4m²
700mm diam col = 0.385m²
32.4 / .385 = 84 columns

Rotary hoe rate from T6 - Niven St 2
Respread topsoil from T6 - Niven St 2

**TENDER 5 - STONE COLUMNS
CONTRACTOR 2
Palmer Rd (Non HAIL Equivalent)**

Tendered Area

	<u>Unit</u>	<u>Quant</u>	<u>Rate</u>	<u>Amount</u>
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	3,700.00	3,700.00
1.1.2 Contract administration	LS	1		incl
1.1.3 Site cleanup and demobilisation	LS	1	2,850.00	2,850.00
1.1.4 Temporary fencing and signage	LS	1		incl
1.1.5 Site entry protection, repair & traffic management	LS	1	900.00	900.00
1.1.6 Erosion & sediment and dust control	LS	1		incl
1.1.7a Pre-construction condition survey	LS	1	500.00	500.00
1.1.7b Pre-construction condition survey - buried services	PS	1	2,500.00	2,500.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
Strip 100 topsoil to landfill	m ³	36.5	50.00	1,825.00
Construct stone columns 4.5m long 700mm diam. to 16% replacement	No	152	220.00	33,440.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	365	10.00	3,650.00
Supply & place geogrid	m ²	365	2.20	803.00
Import topsoil	m ²	365	5.00	1,825.00
				\$ 52,493.00

**TENDER 5 - STONE COLUMNS (MBIE ref. G5a)
CONTRACTOR 2
Palmer Rd (Non HAIL Equivalent)**

MBIE House Area + 2m

4.5m Column x 700mm diam x 12%

	<u>Unit</u>	<u>Quant</u>	<u>Rate</u>	<u>Amount</u>
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	3,700.00	3,700.00
1.1.2 Contract administration	LS	1		incl
1.1.3 Site cleanup and demobilisation	LS	1	2,850.00	2,850.00
1.1.4 Temporary fencing and signage	LS	1		incl
1.1.5 Site entry protection, repair & traffic management	LS	1	900.00	900.00
1.1.6 Erosion & sediment and dust control	LS	1		incl
1.1.7a Pre-construction condition survey	LS	1	500.00	500.00
1.1.7b Pre-construction condition survey - buried services	PS	1	2,500.00	2,500.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
Strip topsoil and stockpile.	m ²	270	1.00	270.00
Construct stone columns (MBIE ref. G5a) 4.5m long 700mm diam. to 12% replacement	No	84	220.00	18,480.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	270	2.50	675.00
Respread topsoil	m ²	270	1.00	270.00
Adjustments				
CPT Tests	4	No	750.00	3,000.00
Additional administrative assistance		sum		3,000.00

Adjusted cost of project (270m² treatment area)

\$ 36,645.00

270 m²

\$ 135.72 /m²

Calculation of reduced treatment area

270 m² at 12% = 32.4m²
700mm diam col = 0.385m²
32.4 / .385 = 84 columns

Rotary hoe rate from T6 - Niven St 2
Respread topsoil from T6 - Niven St 2

**TENDER 5 - STONE COLUMNS
CONTRACTOR 2
Bower Ave 2 (HAIL)**

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	3,700.00	3,700.00
1.1.2 Contract administration	LS	1		incl
1.1.3 Site cleanup and demobilisation	LS	1	2,850.00	2,850.00
1.1.4 Temporary fencing and signage	LS	1		incl
1.1.5 Site entry protection, repair & traffic management	LS	1	900.00	900.00
1.1.6 Erosion & sediment and dust control	LS	1		incl
1.1.7a Pre-construction condition survey	LS	1	500.00	500.00
1.1.7b Pre-construction condition survey - buried services	PS	1	2,500.00	2,500.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
Strip 100 topsoil to landfill	m ³	56.3	50.00	2,815.00
Construct stone columns 4.5m long 700mm diam. to 16% replacement	No	234	210.00	49,140.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	563	10.00	5,630.00
Supply & place geogrid	m ²	563	2.20	1,238.60
Import topsoil	m ²	563	5.00	2,815.00
Accepted Tendered Value				\$ 72,588.60

**TENDER 5 - STONE COLUMNS (MBIE ref. G5a)
CONTRACTOR 2
Bower Ave 2 (Non HAIL Equivalent)**

MBIE House Area + 2m

4.5m Column x 700mm diam x 12%

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	3,700.00	3,700.00
1.1.2 Contract administration	LS	1		incl
1.1.3 Site cleanup and demobilisation	LS	1	2,850.00	2,850.00
1.1.4 Temporary fencing and signage	LS	1		incl
1.1.5 Site entry protection, repair & traffic management	LS	1	900.00	900.00
1.1.6 Erosion & sediment and dust control	LS	1		incl
1.1.7a Pre-construction condition survey	LS	1	500.00	500.00
1.1.7b Pre-construction condition survey - buried services	PS	1	2,500.00	2,500.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
Strip topsoil and stockpile.	m ³	270	1.00	270.00
Construct stone columns 4.5m long 700mm diam. to 12% replacement	No	84	210.00	17,640.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm (rate from	m ²	270	2.50	675.00
Respread topsoil	m ²	270	1.00	270.00
Respread topsoil	m ²	270	1.00	270.00
Adjustments				
CPT Tests	4	No	750.00	3,000.00
Additional administrative assistance		sum		3,000.00
Adjusted cost of project (270m² treatment area)				\$ 36,075.00

270 m² \$ 133.61 /m²

Calculation of reduced treatment area

270 m² at 12% = 32.4m²
700mm diam col = 0.385m²
32.4 / .385 = 84 columns

Rotary hoe rate from T6 - Niven St 2
Respread topsoil from T6 - Niven St 2

**TENDER 2 - STONE COLUMNS
CONTRACTOR 2
Bower Ave 1**

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1	LS	1	1,500.00	1,500.00
1.1.2	LS	1	Incl	-
1.1.3	LS	1	200.00	200.00
1.1.4	LS	1	200.00	200.00
1.1.5	LS	1	500.00	500.00
1.1.6	LS	1	100.00	100.00
1.1.7	LS	1	1,000.00	1,000.00
1.1.8	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1	m ²	415	1.00	415.00
1.2.2	m ²	415	5.00	2,075.00
1.2.3	m ³	83	40.00	3,320.00
1.2.4	m ²	415	2.20	913.00
1.2.5	m ²	415	25.00	10,375.00
1.2.6	m ³	83	10.00	830.00
1.2.7	m ²	415	2.20	913.00
1.2.8	m ²	415	1.00	415.00
1.3 Stone Columns				
Construct stone columns 4.5m long 900mm diam.				
1.7.1	No	105	300.00	31,500.00
1.7.2	LS	1	1,000.00	1,000.00
Tendered Total				\$ 55,756.00

**TENDER 2 - STONE COLUMNS (MBIE ref. G5a)
CONTRACTOR 2
Bower Ave 1**

MBIE House Area + 2m
4.5m Column x 900mm diam x 16%

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1	LS	1	1,500.00	1,500.00
1.1.2	LS	1	Incl	-
1.1.3	LS	1	200.00	200.00
1.1.4	LS	1	200.00	200.00
1.1.5	LS	1	500.00	500.00
1.1.6	LS	1	100.00	100.00
1.1.7	LS	1	1,000.00	1,000.00
1.1.8	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1	m ²	270	1.00	270.00
1.2.2	m ²	270	5.00	1,350.00
1.2.3	m ³	54	40.00	2,160.00
1.2.4	m ²	270	2.20	594.00
1.2.5	m ²	270	25.00	6,750.00
1.2.6	m ³	54	10.00	540.00
1.2.7	m ²	270	2.20	594.00
1.2.8	m ²	270	1.00	270.00
1.3 Stone Columns (MBIE ref. G5a)				
Construct stone columns 4.5m long 900mm diam.				
1.7.1	No	68	300.00	20,400.00
1.7.2	LS	1	1,000.00	1,000.00
Adjustments				
Omit				
Cut to waste	m ²	-270	5.00	(1,350.00)
Undercut & Replace	m ³	-54	40.00	(2,160.00)
Geofabric to subgrade	m ²	-270	2.20	(594.00)
Drainage blanket	m ²	-270	25.00	(6,750.00)
Re-use site-won material	m ³	-54	10.00	(540.00)
Geofabric to draiange blanket	m ²	-270	2.20	(594.00)
Add				
Rotary hoe and recompact upper 250mm	m ²	270	2.50	675.00
Respread topsoil	m ²	270	1.00	270.00
Over-supply and under supply stone for columns	m ³		65.00	rate only
External administrative assistance	sum			3,000.00
CPT Testing	No	4	750.00	3,000.00
Adjusted cost of project (270m² treatment area)				\$ 32,885.00

270 m² \$ 121.80 /m²

Calculation of reduced treatment area

270 m² at 16% = 43.2m²
900mm diam col = 0.636m²
43.2 / .636 = 68 columns

Rotary hoe rate from T6 - Niven St 2
Respread topsoil from T6 - Niven St 2

**TENDER 6 - STONE COLUMNS
CONTRACTOR 2
Niven St 2**

Tendered Area

	<u>Unit</u>	<u>Quant</u>	<u>Rate</u>	<u>Amount</u>
1.1 Preliminaries and General				
1.1.1	LS	1	1,500.00	1,500.00
1.1.2	LS	1	1,000.00	1,000.00
1.1.3	LS	1		incl
1.1.4	LS	1	400.00	400.00
1.1.5	LS	1	500.00	500.00
1.1.6	LS	1	300.00	300.00
1.1.7a	LS	1	500.00	500.00
1.1.7b	PS	1	2,500.00	2,500.00
1.1.8	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1	m ²	587	1.00	587.00
				Construct stone columns 4.5m long 900mm diam. to 16% replacement
	No	157	330.00	51,810.00
	LS			Stone Column Trial (extra over item) incl
	LS			CPT & SPT Testing incl
	m ²	587	2.50	1,467.50
	m ²	587	1.00	587.00
	m ³		65.00	rate only
				Rotary hoe and recompact upper 250mm
				Respread topsoil
				Over-supply and under supply stone for columns
Tendered Value				\$ 61,651.50

**TENDER 6 - STONE COLUMNS (MBIE ref. G5a)
CONTRACTOR 2
Niven St 2**

MBIE House Area + 2m

4.5m Column x 900mm diam x 16%

	<u>Unit</u>	<u>Quant</u>	<u>Rate</u>	<u>Amount</u>
1.1 Preliminaries and General				
1.1.1	LS	1	1,500.00	1,500.00
1.1.2	LS	1	1,000.00	1,000.00
1.1.3	LS	1		incl
1.1.4	LS	1	400.00	400.00
1.1.5	LS	1	500.00	500.00
1.1.6	LS	1	300.00	300.00
1.1.7a	LS	1	500.00	500.00
1.1.7b	PS	1	2,500.00	2,500.00
1.1.8	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1	m ²	270	1.00	270.00
				Construct stone columns (MBIE ref. G5a) 4.5m long 900mm diam. to 16% replacement
	No	68	330.00	22,440.00
	LS			Stone Column Trial (extra over item) incl
	LS			CPT & SPT Testing incl
	m ²	270	2.50	675.00
	m ²	270	1.00	270.00
	m ³		65.00	rate only
				Rotary hoe and recompact upper 250mm
				Respread topsoil
				Over-supply and under supply stone for columns
Adjustments				
CPT Tests	4	No	750.00	3,000.00
Additional administrative assistance		sum		3,000.00
Adjusted cost of project				\$ 36,855.00

270 m² \$ 136.50 /m²

Calculation of reduced treatment area

270 m² at 16% = 43.2m²
900mm diam col = 0.636m²
43.2 / .636 = 68 columns

Rotary hoe rate from T6 - Niven St 2
Respread topsoil from T6 - Niven St 2

TENDER 6 - STONE COLUMNS
CONTRACTOR 2
Chardale St

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,500.00	1,500.00
1.1.2 Contract administration	LS	1	1,000.00	1,000.00
1.1.3 Site cleanup and demobilisation	LS	1		incl
1.1.4 Temporary fencing and signage	LS	1	400.00	400.00
1.1.5 Site entry protection, repair & traffic management	LS	1	500.00	500.00
1.1.6 Erosion & sediment and dust control	LS	1	300.00	300.00
1.1.7a Pre-construction condition survey	LS	1	500.00	500.00
1.1.7b Pre-construction condition survey - buried services	PS	1	2,500.00	2,500.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1 Strip topsoil and stockpile.	m ²	603	1.00	603.00
Construct stone columns 4.5m long 900mm diam. to 16% replacement	No	162	330.00	53,460.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	603	2.50	1,507.50
Respread topsoil	m ²	603	1.00	603.00
Over-supply and under supply stone for columns	m ³		65.00	rate only

Accepted Tendered Value

\$ 63,373.50

Rotary hoe rate from T6 Niven St 2
 Respread topsoil from T6 Niven St 2

TENDER 6 - STONE COLUMNS (MBIE ref. G5a)
CONTRACTOR 2
Chardale St

MBIE House Area + 2m

4.5m Column x 900mm diam x 16%

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,500.00	1,500.00
1.1.2 Contract administration	LS	1	1,000.00	1,000.00
1.1.3 Site cleanup and demobilisation	LS	1		incl
1.1.4 Temporary fencing and signage	LS	1	400.00	400.00
1.1.5 Site entry protection, repair & traffic management	LS	1	500.00	500.00
1.1.6 Erosion & sediment and dust control	LS	1	300.00	300.00
1.1.7a Pre-construction condition survey	LS	1	500.00	500.00
1.1.7b Pre-construction condition survey - buried services	PS	1	2,500.00	2,500.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1 Strip topsoil and stockpile.	m ²	270	1.00	270.00
Construct stone columns (MBIE ref. G5a) 4.5m long 900mm diam. to 16% replacement	No	68	330.00	22,440.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	270	2.50	675.00
Respread topsoil	m ²	270	1.00	270.00
Over-supply and under supply stone for columns	m ³		65.00	rate only

Adjustments

CPT Tests	4	No	750.00	3,000.00
Additional administrative assistance		sum		3,000.00

Adjusted cost of project

\$ 36,855.00

270 m² \$ 136.50 /m²

Calculation of reduced treatment area

270 m² at 16% = 43.2m²
 900mm diam col = 0.636m²
 43.2 / .636 = 68 columns

Rotary hoe rate from T6 - Niven St 2
 Respread topsoil from T6 - Niven St 2

**TENDER 2 - STONE COLUMNS
CONTRACTOR 2
Bower Ave 1**

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1	LS	1	1,500.00	1,500.00
1.1.2	LS	1	Incl	-
1.1.3	LS	1	200.00	200.00
1.1.4	LS	1	200.00	200.00
1.1.5	LS	1	500.00	500.00
1.1.6	LS	1	100.00	100.00
1.1.7	LS	1	1,000.00	1,000.00
1.1.8	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1	m ²	415	1.00	415.00
1.2.2	m ²	415	5.00	2,075.00
1.2.3	m ³	83	40.00	3,320.00
1.2.4	m ²	415	2.20	913.00
1.2.5	m ²	415	25.00	10,375.00
1.2.6	m ³	83	10.00	830.00
1.2.7	m ²	415	2.20	913.00
1.2.8	m ²	415	1.00	415.00
1.3 Stone Columns				
Construct stone columns 4.5m long 900mm diam.				
1.7.1	No	105	300.00	31,500.00
1.7.2	LS	1	1,000.00	1,000.00
Tendered Total				\$ 55,756.00

**TENDER 2 - STONE COLUMNS (MBIE ref. G5a)
CONTRACTOR 2
Bower Ave 1**

MBIE House Area + 2m
4.5m Column x 900mm diam x 18%

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1	LS	1	1,500.00	1,500.00
1.1.2	LS	1	Incl	-
1.1.3	LS	1	200.00	200.00
1.1.4	LS	1	200.00	200.00
1.1.5	LS	1	500.00	500.00
1.1.6	LS	1	100.00	100.00
1.1.7	LS	1	1,000.00	1,000.00
1.1.8	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1	m ²	270	1.00	270.00
1.2.2	m ²	270	5.00	1,350.00
1.2.3	m ³	54	40.00	2,160.00
1.2.4	m ²	270	2.20	594.00
1.2.5	m ²	270	25.00	6,750.00
1.2.6	m ³	54	10.00	540.00
1.2.7	m ²	270	2.20	594.00
1.2.8	m ²	270	1.00	270.00
1.3 Stone Columns (MBIE ref. G5a)				
Construct stone columns 4.5m long 900mm diam.				
1.7.1	No	76	300.00	22,800.00
1.7.2	LS	1	1,000.00	1,000.00
Adjustments				
Omit				
1.2.3	m ³	-54	40.00	(2,160.00)
1.2.4	m ²	-270	2.20	(594.00)
1.2.5	m ²	-270	25.00	(6,750.00)
1.2.6	m ³	-54	10.00	(540.00)
1.2.7	m ²	-270	2.20	(594.00)
Add				
Rotary hoe and recompact upper 250mm	m ²	270	2.50	675.00
Respread topsoil	m ²	270	1.00	270.00
Over-supply and under supply stone for columns	m ³		65.00	rate only
Additional administrative assistance	Sum			3,000.00
CPT Testing	No	2	750.00	1,500.00
Adjusted cost of project				\$ 35,135.00
				270 m ² \$ 130.13 /m ²

Calculation of reduced treatment area

270 m² at 18% = 48.6m²
900mm diam col = 0.636m²
48.6 / .636 = 76 columns

Rotary hoe rate from T6 - Niven St 2
Respread topsoil from T6 - Niven St 2

**TENDER 6 - STONE COLUMNS
CONTRACTOR 2
Niven St 2**

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,500.00	1,500.00
1.1.2 Contract administration	LS	1	1,000.00	1,000.00
1.1.3 Site cleanup and demobilisation	LS	1		incl
1.1.4 Temporary fencing and signage	LS	1	400.00	400.00
1.1.5 Site entry protection, repair & traffic management	LS	1	500.00	500.00
1.1.6 Erosion & sediment and dust control	LS	1	300.00	300.00
1.1.7a Pre-construction condition survey	LS	1	500.00	500.00
1.1.7b Pre-construction condition survey - buried services	PS	1	2,500.00	2,500.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1 Strip topsoil and stockpile.	m ²	587	1.00	587.00
Construct stone columns 4.5m long 900mm diam. to 16% replacement	No	157	330.00	51,810.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	587	2.50	1,467.50
Respread topsoil	m ²	587	1.00	587.00
Over-supply and under supply stone for columns	m ³		65.00	rate only
Accepted Tendered Value				\$ 61,651.50

**TENDER 6 - STONE COLUMNS (MBIE ref. G5a)
CONTRACTOR 2
Niven St 2**

MBIE House Area + 2m

4.5m Column x 900mm diam x 18%

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,500.00	1,500.00
1.1.2 Contract administration	LS	1	1,000.00	1,000.00
1.1.3 Site cleanup and demobilisation	LS	1		incl
1.1.4 Temporary fencing and signage	LS	1	400.00	400.00
1.1.5 Site entry protection, repair & traffic management	LS	1	500.00	500.00
1.1.6 Erosion & sediment and dust control	LS	1	300.00	300.00
1.1.7a Pre-construction condition survey	LS	1	500.00	500.00
1.1.7b Pre-construction condition survey - buried services	PS	1	2,500.00	2,500.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1 Strip topsoil and stockpile.	m ³	270	1.00	270.00
Construct stone columns (MBIE ref. G5a) 4.5m long 900mm diam. to 18% replacement	No	76	330.00	25,080.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	270	2.50	675.00
Respread topsoil	m ²	270	1.00	270.00
Over-supply and under supply stone for columns	m ³		65.00	rate only
Adjustments				
CPT Tests	2 No		750.00	1,500.00
Additional administrative assistance	sum			3,000.00
Adjusted cost of project				\$ 37,995.00

270 m² \$ 140.72 /m²

Calculation of reduced treatment area

270 m² at 18% = 48.6m²
900mm diam col = 0.636m²
48.6 / .636 = 76 columns

Rotary hoe rate from T6 - Niven St 2
Respread topsoil from T6 - Niven St 2

**TENDER 6 - STONE COLUMNS
CONTRACTOR 2
Chardale St**

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,500.00	1,500.00
1.1.2 Contract administration	LS	1	1,000.00	1,000.00
1.1.3 Site cleanup and demobilisation	LS	1		incl
1.1.4 Temporary fencing and signage	LS	1	400.00	400.00
1.1.5 Site entry protection, repair & traffic management	LS	1	500.00	500.00
1.1.6 Erosion & sediment and dust control	LS	1	300.00	300.00
1.1.7a Pre-construction condition survey	LS	1	500.00	500.00
1.1.7b Pre-construction condition survey - buried services	PS	1	2,500.00	2,500.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1 Strip topsoil and stockpile.	m ²	603	1.00	603.00
Construct stone columns 4.5m long 900mm diam. to 16% replacement	No	162	330.00	53,460.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	603	2.50	1,507.50
Respread topsoil	m ²	603	1.00	603.00
Over-supply and under supply stone for columns	m ³		65.00	rate only
Accepted Tendered Value				\$ 63,373.50

**TENDER 6 - STONE COLUMNS (MBIE ref. G5a)
CONTRACTOR 2
Chardale St**

MBIE House Area + 2m

4.5m Column x 900mm diam x 18%

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,500.00	1,500.00
1.1.2 Contract administration	LS	1	1,000.00	1,000.00
1.1.3 Site cleanup and demobilisation	LS	1		incl
1.1.4 Temporary fencing and signage	LS	1	400.00	400.00
1.1.5 Site entry protection, repair & traffic management	LS	1	500.00	500.00
1.1.6 Erosion & sediment and dust control	LS	1	300.00	300.00
1.1.7a Pre-construction condition survey	LS	1	500.00	500.00
1.1.7b Pre-construction condition survey - buried services	PS	1	2,500.00	2,500.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
1.2.1 Strip topsoil and stockpile.	m ³	270	1.00	270.00
Construct stone columns (MBIE ref. G5a) 4.5m long 900mm diam. to 18% replacement	No	76	330.00	25,080.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	270	2.50	675.00
Respread topsoil	m ²	270	1.00	270.00
Over-supply and under supply stone for columns	m ³		65.00	rate only
Adjustments				
CPT Tests	2 No		750.00	1,500.00
Additional administrative assistance	sum			3,000.00
Adjusted cost of project				\$ 37,995.00

270 m² \$ 140.72 /m²

Calculation of reduced treatment area

270 m² at 18% = 48.6m²
900mm diam col = 0.636m²
48.6 / .636 = 76 columns

Rotary hoe rate from T6 - Niven St 2
Respread topsoil from T6 - Niven St 2

**TENDER 4 - STONE COLUMNS
CONTRACTOR 2
Landy St (Non Hail equivalent)**

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,500.00	1,500.00
1.1.2 Contract administration	LS	1	1,000.00	1,000.00
1.1.3 Site cleanup and demobilisation	LS	1		incl
1.1.4 Temporary fencing and signage	LS	1	400.00	400.00
1.1.5 Site entry protection, repair & traffic management	LS	1	500.00	500.00
1.1.6 Erosion & sediment and dust control	LS	1	300.00	300.00
1.1.7a Pre-construction condition survey	LS	1	800.00	800.00
1.1.7b Pre-construction condition survey - buried services	PS	1	5,000.00	5,000.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
Strip topsoil and stockpile.	m ²	506	1.00	506.00
Construct stone columns 4.5m long 800mm diam. At 20% replacement.	No	203	270.00	54,810.00
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	506	2.50	1,265.00
Respread topsoil	m ²	506	1.00	506.00
Accepted Tender Value				\$ 67,087.00

**TENDER 4 - STONE COLUMNS (MBIE ref. G5a)
CONTRACTOR 2
Landy St (Non Hail equivalent)**

MBIE House Area + 2m

4.5m Column x 800mm diam x 20%

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,500.00	1,500.00
1.1.2 Contract administration	LS	1	1,000.00	1,000.00
1.1.3 Site cleanup and demobilisation	LS	1		incl
1.1.4 Temporary fencing and signage	LS	1	400.00	400.00
1.1.5 Site entry protection, repair & traffic management	LS	1	500.00	500.00
1.1.6 Erosion & sediment and dust control	LS	1	300.00	300.00
1.1.7a Pre-construction condition survey	LS	1	800.00	800.00
1.1.7b Pre-construction condition survey - buried services	PS	1	5,000.00	5,000.00
1.1.8 Setting-out of works on site and as-built survey	LS	1	500.00	500.00
1.2 Earthworks				
Strip topsoil and stockpile.	m ²	270	1.00	270.00
Construct stone columns (MBIE ref. G5a) 4.5m long 800mm diam. At 20% replacement.	No	108.3	270.00	29,246.44
Stone Column Trial (extra over item)	LS			incl
CPT & SPT Testing	LS			incl
Rotary hoe and recompact upper 250mm	m ²	270	2.50	675.00
Respread topsoil	m ²	270	1.00	270.00
Adjustments				
CPT Tests	4 No		750.00	3,000.00
Additional administrative assistance	sum			3,000.00
Adjusted cost of project				\$ 46,461.44

270 m² \$ 172.08 /m²

Calculation of reduced treatment area

270 m² at 20% = 54.0m²
800mm diam col = 0.503m²
54.0 / .503 = 108.3 columns

Rotary hoe rate from T6 - Niven St 2
Respread topsoil from T6 - Niven St 2

EARTHQUAKE COMMISSION

GROUND IMPROVEMENT COMPILATION SUMMARY FOR
DRIVEN TIMBER POLES (MBIE ref. G5b)

CLEARED SITES - NON-HAIL

Treatment Area 2m Surrounding Structure				Cost of Treated Area (\$/m ²)		
Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	1.2m ctrs	1.1m ctrs	1.0m ctrs
Driven timber poles (uglies) 250mm diam. SED 3.8m long at 1.2m centres	Tavendale Pl	1273	540	\$206.97		
	Speight St	711	270	\$199.02		
	Pages Rd	512	270	\$207.00		
	Hendon Rd	511	270	\$216.20		
	McFaddens Rd	495	270	\$211.98		
Driven timber poles (uglies) 250mm diam. SED 3.8m long at 1.1m centres	Tavendale Pl	1273	540		\$242.24	
Driven timber poles (uglies) 250mm diam. SED 3.8m long at 1.0m centres	Tavendale Pl	1273	540			\$269.28
	Speight Rd	711	270			\$273.34
	Average			\$208.23	\$242.24	\$271.31

All rates exclude GST.

TENDER 7 - TIMBER POLES
CONTRACTOR 4
Tavendale PI

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,904.00	1,904.00
1.1.2 Contract administration	LS	1	8,671.99	8,671.99
1.1.3 Site cleanup and demobilisation	LS	1	1,904.00	1,904.00
1.1.4 Temporary fencing and signage	LS	1	434.56	434.56
1.1.5 Site entry protection, repair & traffic management	LS	1	560.00	560.00
1.1.6 Erosion & sediment and dust control	LS	1	609.28	609.28
1.1.7a Pre-construction condition survey	LS	1	6,406.40	6,406.40
1.1.8 Survey	LS	1	-	-
				20,490.23
1.3.1 Strip topsoil and stockpile.	m ²	1084	-	-
1.3.2 Driven timber poles 3.6m long 250mm diam 1.2m cc	No	958	194.15	185,995.70
Site won material backfill over driven piles	No	371	-	-
Respread topsoil	m ²	1084	-	-
Accepted Tender Value				\$ 206,485.93

TENDER 7 - Driven timber poles (MBIE ref. G5b).
CONTRACTOR 4
Tavendale PI

MBIE House Area + 2m

3.8m Pile 250mm SED 1.2m centres

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,904.00	1,904.00
1.1.2 Contract administration	LS	0.5	8,671.99	4,336.00
1.1.3 Site cleanup and demobilisation	LS	1	1,904.00	1,904.00
1.1.4 Temporary fencing and signage	LS	1	434.56	434.56
1.1.5 Site entry protection, repair & traffic management	LS	1	560.00	560.00
1.1.6 Erosion & sediment and dust control	LS	1	609.28	609.28
1.1.7a Pre-construction condition survey	LS	1	6,406.40	6,406.40
1.1.8 Survey	LS	1	-	-
				16,154.24
1.3.1 Strip topsoil and stockpile.	m ²	540	-	-
Driven timber poles (MBIE ref. G5b), ex 4.2m long				
250mm diam 1.2m centres	No	478	183.68	87,799.04
Site won material backfill over driven piles	No	478	-	-
Respread topsoil	m ²	540	-	-
Gravel layer 200mm thick (AP 65)	m ³	108	72.30	7,808.40
Adjusted cost of project (270m² treatment area)				\$ 111,761.68

540 m² \$ 206.97 /m²

Adjustments

Time reduction 540/1084 = 0.50

Piles 958 / 1084 = 0.884 No per m²

540m² x 0.884 = 478 piles

South Island Poles less \$15.97 each

Uglies less \$5.00 per pole

4.2m pile add \$10.50 per pole supply & cut to size

TENDER 6B - TIMBER PILES
CONTRACTOR 4
22 Speights

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,232.00	1,232.00
1.1.2 Contract administration	LS	1	4,336.00	4,336.00
1.1.3 Site cleanup and demobilisation	LS	1	616.00	616.00
1.1.4 Temporary fencing and signage	LS	1	217.28	217.28
1.1.5 Site entry protection, repair & traffic management	LS	1	280.00	280.00
1.1.6 Erosion & sediment and dust control	LS	1	304.64	304.64
1.1.7a Pre-construction condition survey	LS	1	2,660.00	2,660.00
1.1.8 Survey	LS	1	-	-
				9,645.92
1.3.1 Strip topsoil and stockpile.	m ²	609	-	-
Driven timber piles 3.6m long 250mm diam. 1.2m				
centres.	No	523	193.29	101,090.67
Site won material backfill over driven piles	No	523	-	-
Respread topsoil	m ²	609	-	-
Accepted Tender Value				\$ 110,736.59

TENDER 6B - Driven timber poles (MBIE ref. G5b).
CONTRACTOR 4
22 Speights

MBIE House Area + 2m

3.8m Pile 250mm SED 1.2m centres

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,232.00	1,232.00
1.1.2 Contract administration	LS	0.44	4,336.00	1,907.84
1.1.3 Site cleanup and demobilisation	LS	1	616.00	616.00
1.1.4 Temporary fencing and signage	LS	1	217.28	217.28
1.1.5 Site entry protection, repair & traffic management	LS	1	280.00	280.00
1.1.6 Erosion & sediment and dust control	LS	1	304.64	304.64
1.1.7a Pre-construction condition survey	LS	1	2,660.00	2,660.00
1.1.8 Survey	LS	1	-	-
				7,217.76
1.3.1 Strip topsoil and stockpile.	m ²	270	-	-
Driven timber poles (MBIE ref. G5b). s ex 4.2m long				
250mm diam 1.2m centres	No	232	183.68	42,613.76
Site won material backfill over driven piles	No	232	-	-
Respread topsoil	m ²	270	-	-
Gravel layer 200mm thick (AP 65)	m ³	54	72.30	3,904.20
Adjusted cost of project (270m² treatment area)				\$ 53,735.72

270 m² \$ 199.02 /m²

Adjustments

Time reduction 270/609 = 0.44

Piles 523 / 609 = 0.859 No per m²
 270m² x 0.859 = 232 piles

South Island Poles less \$15.97 each

Uglies less \$5.00 per pole

4.2m pile add \$10.50 per pole supply & cut to size

**TENDER 6B - TIMBER PILES
CONTRACTOR 4
Pages Rd**

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,232.00	1,232.00
1.1.2 Contract administration	LS	1	4,336.00	4,336.00
1.1.3 Site cleanup and demobilisation	LS	1	616.00	616.00
1.1.4 Temporary fencing and signage	LS	1	217.28	217.28
1.1.5 Site entry protection, repair & traffic management	LS	1	280.00	280.00
1.1.6 Erosion & sediment and dust control	LS	1	304.64	304.64
1.1.7a Pre-construction condition survey	LS	1	2,660.00	2,660.00
1.1.8 Survey	LS	1	-	-
				9,645.92
1.3.1 Strip topsoil and stockpile.	m ²	420	-	-
1.3.2 Driven timber piles 3.6m long 250mm diam	No	371	193.29	71,710.59
Site won material backfill over driven piles	No	371	-	-
Respread topsoil	m ²	420	-	-
Accepted Tender Value				\$ 81,356.51

**TENDER 6B - Driven timber poles (MBIE ref. G5b).
CONTRACTOR 4
Pages Rd**

MBIE House Area + 2m

3.8m Pile 250mm SED 1.2m centres

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,232.00	1,232.00
1.1.2 Contract administration	LS	0.64	4,336.00	2,775.04
1.1.3 Site cleanup and demobilisation	LS	1	616.00	616.00
1.1.4 Temporary fencing and signage	LS	1	217.28	217.28
1.1.5 Site entry protection, repair & traffic management	LS	1	280.00	280.00
1.1.6 Erosion & sediment and dust control	LS	1	304.64	304.64
1.1.7a Pre-construction condition survey	LS	1	2,660.00	2,660.00
1.1.8 Survey	LS	1	-	-
				8,084.96
1.3.1 Strip topsoil and stockpile.	m ²	270	-	-
Driven timber poles (MBIE ref. G5b). ex 4.2m long				
1.3.2 250mm diam 1.2m cc	No	239	183.68	43,899.52
Site won material backfill over driven piles	No	239	-	-
Respread topsoil	m ²	270	-	-
Gravel layer 200mm thick (AP 65)	m ³	54	72.30	3,904.20
Adjusted cost of project (270m² treatment area)				\$ 55,888.68

270 m² \$ 207.00 /m²

Adjustments

Time reduction 270/420 = 0.64

Piles 371 / 420 = 0.883 No per m²
270m² x 0.883 = 239 piles

South Island Poles less \$15.97 each

Uglies less \$5.00 per pole

4.2m pile add \$10.50 per pole supply & cut to size

**TENDER 8 - TIMBER PILES
CONTRACTOR 4
Hendon St**

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,904.00	1,904.00
1.1.2 Contract administration	LS	1	4,336.00	4,336.00
1.1.3 Site cleanup and demobilisation	LS	1	616.00	616.00
1.1.4 Temporary fencing and signage	LS	1	217.28	217.28
1.1.5 Site entry protection, repair & traffic management	LS	1	280.00	280.00
1.1.6 Erosion & sediment and dust control	LS	1	304.64	304.64
1.1.7a Pre-construction condition survey	LS	1	3,203.20	3,203.20
1.1.8 Survey	LS	1	-	-
				10,861.12
1.3.1 Strip topsoil and stockpile.	m ²	424	-	-
1.3.2 Driven timber piles 3.6m long 250mm diam x 1.2m cc	No	375	194.15	72,806.25
Site won material backfill over driven piles	No	375	-	-
Respread topsoil	m ²	424	-	-
Accepted Tender Value				\$ 83,667.37

**TENDER 8 - Driven timber poles (MBIE ref. G5b).
CONTRACTOR 4
Hendon St**

MBIE House Area + 2m
3.8m Pile 250mm SED 1.2m centres

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,904.00	1,904.00
1.1.2 Contract administration	LS	0.63	4,336.00	2,731.68
1.1.3 Site cleanup and demobilisation	LS	1	616.00	616.00
1.1.4 Temporary fencing and signage	LS	1	217.28	217.28
1.1.5 Site entry protection, repair & traffic management	LS	1	280.00	280.00
1.1.6 Erosion & sediment and dust control	LS	1	304.64	304.64
1.1.7a Pre-construction condition survey	LS	1	3,203.20	3,203.20
1.1.8 Survey	LS	1	-	-
				9,256.80
1.3.1 Strip topsoil and stockpile.	m ²	270	-	-
Driven timber poles (MBIE ref. G5b). ex 4.2m long				
1.3.2 250mm diam 1.2m cc	No	239	189.18	45,214.02
Site won material backfill over driven piles	No	239	-	-
Respread topsoil	m ²	270	-	-
Gravel layer 200mm thick (AP 65)	m ³	54	72.30	3,904.20
Adjusted cost of project (270m² treatment area)				\$ 58,375.02

270 m² \$ 216.20 /m²

Adjustments

Time reduction 270/424 = 0.63

Piles 375/ 424 = 0.884 No per m²
270m² x 0.884 = 239 piles

South Island Poles less \$15.97 each

Uglies less \$5.00 per pole

4.2m pile add \$10.50 per pole supply & cut to size

TENDER 8 - TIMBER PILES
CONTRACTOR 4
McFaddens Rd

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,904.00	1,904.00
1.1.2 Contract administration	LS	1	4,336.00	4,336.00
1.1.3 Site cleanup and demobilisation	LS	1	616.00	616.00
1.1.4 Temporary fencing and signage	LS	1	217.28	217.28
1.1.5 Site entry protection, repair & traffic management	LS	1	280.00	280.00
1.1.6 Erosion & sediment and dust control	LS	1	304.64	304.64
1.1.7a Pre-construction condition survey	LS	1	3,203.20	3,203.20
1.1.8 Survey	LS	1	-	-
				<u>10,861.12</u>
1.3				
1.3.1 Strip topsoil and stockpile.	m ²	404	-	-
Driven timber piles 3.6m long 250mm diam x 1.2m				
centres.	No	357	194.15	69,311.55
1.3.2 Site won material backfill over driven piles	No	357	-	-
Respread topsoil	m ²	404	-	-
Accepted Tender Value				<u><u>\$ 80,172.67</u></u>

TENDER 8 - Driven timber poles (MBIE ref. G5b).
CONTRACTOR 4
McFaddens Rd

MBIE House Area + 2m

3.8m Pile 250mm SED 1.2m centres

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,904.00	1,904.00
1.1.2 Contract administration	LS	0.67	4,336.00	2,905.12
1.1.3 Site cleanup and demobilisation	LS	1	616.00	616.00
1.1.4 Temporary fencing and signage	LS	1	217.28	217.28
1.1.5 Site entry protection, repair & traffic management	LS	1	280.00	280.00
1.1.6 Erosion & sediment and dust control	LS	1	304.64	304.64
1.1.7a Pre-construction condition survey	LS	1	3,203.20	3,203.20
1.1.8 Survey	LS	1	-	-
				<u>9,430.24</u>
1.3				
1.3.1 Strip topsoil and stockpile.	m ²	270	-	-
Driven timber poles (MBIE ref. G5b). ex 4.2m long				
250mm diam 1.2m cc	No	239	183.68	43,899.52
1.3.2 Site won material backfill over driven piles	No	239	-	-
Respread topsoil	m ²	270	-	-
Gravel layer 200mm thick (AP 65)	m ³	54	72.30	3,904.20
Adjusted cost of project (270m² treatment area)				<u><u>\$ 57,233.96</u></u>

270 m² \$ 211.98 /m²

Adjustments

Time reduction 270/404 = 0.67

Piles 357/ 404 = 0.884 No per m²

270m² x 0.884 = 239 piles

South Island Poles less \$15.97 each

Uglies less \$5.00 per pole

4.2m pile add \$10.50 per pole supply & cut to size

**TENDER 7 - TIMBER PILES
CONTRACTOR 4
Tavendale PI**

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,904.00	1,904.00
1.1.2 Contract administration	LS	1	8,671.99	8,671.99
1.1.3 Site cleanup and demobilisation	LS	1	1,904.00	1,904.00
1.1.4 Temporary fencing and signage	LS	1	434.56	434.56
1.1.5 Site entry protection, repair & traffic management	LS	1	560.00	560.00
1.1.6 Erosion & sediment and dust control	LS	1	609.28	609.28
1.1.7a Pre-construction condition survey	LS	1	6,406.40	6,406.40
1.1.8 Survey	LS	1	-	-
				20,490.23
1.3.1 Strip topsoil and stockpile.	m ²	1084	-	-
Driven timber piles 3.6m long 250mm diam 1.2m centres	No	958	194.15	185,995.70
Site won material backfill over driven piles	No	371	-	-
Respread topsoil	m ²	1084	-	-
Adjusted Tender Value				\$ 206,485.93
EOT payment	Sum			2,228.28
Additional piles to 1.0m centres	No	337	194.15	65,428.55
				\$ 274,142.76

**TENDER 7 - Driven timber poles (MBIE ref. G5b).
CONTRACTOR 4
Tavendale PI**

MBIE House Area + 2m

3.8m Pile 250mm SED 1.1m centres

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,904.00	1,904.00
1.1.2 Contract administration	LS	0.5	8,671.99	4,336.00
1.1.3 Site cleanup and demobilisation	LS	1	1,904.00	1,904.00
1.1.4 Temporary fencing and signage	LS	1	434.56	434.56
1.1.5 Site entry protection, repair & traffic management	LS	1	560.00	560.00
1.1.6 Erosion & sediment and dust control	LS	1	609.28	609.28
1.1.7a Pre-construction condition survey	LS	1	6,406.40	6,406.40
1.1.8 Survey	LS	1	-	-
				16,154.24
1.3.1 Strip topsoil and stockpile.	m ²	540	-	-
Driven timber poles (MBIE ref. G5b). ex 4.2m long	No	540	183.68	99,187.20
250mm diam 1.1m centres	No	540	-	-
Site won material backfill over driven piles	No	540	-	-
Respread topsoil	m ²	540	-	-
Gravel layer 200mm thick (AP 65)	m ³	108	72.30	7,808.40
Adjustment				
Extra time \$2228.23 x 540/958	Sum		\$	1,256.00
Adjusted cost of project (270m² treatment area)				\$ 130,812.24

540 m² \$ 242.24 /m²

Time 540/1084 = 0.50

Piles (958+ 1295)/2/ 1127 = 1.0 No per m²
540m² x 1.0 = 540

South Island Poles less \$15.97 each

Uglies less \$5.00 per pole

4.2m pile add \$10.50 per pole supply & cut to size

4.2m pile add \$10.50 per pole supply & cut to size

**TENDER 7 - TIMBER PILES
CONTRACTOR 4
Tavendale PI**

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,904.00	1,904.00
1.1.2 Contract administration	LS	1	8,671.99	8,671.99
1.1.3 Site cleanup and demobilisation	LS	1	1,904.00	1,904.00
1.1.4 Temporary fencing and signage	LS	1	434.56	434.56
1.1.5 Site entry protection, repair & traffic management	LS	1	560.00	560.00
1.1.6 Erosion & sediment and dust control	LS	1	609.28	609.28
1.1.7a Pre-construction condition survey	LS	1	6,406.40	6,406.40
1.1.8 Survey	LS	1	-	-
				20,490.23
1.3.1 Strip topsoil and stockpile.	m ²	1084	-	-
Driven timber piles 3.6m long 250mm diam 1.2m centres	No	958	194.15	185,995.70
Site won material backfill over driven piles	No	371	-	-
Respread topsoil	m ²	1084	-	-
Adjusted Tender Value				\$ 206,485.93
EOT payment	Sum			2,228.28
Additional piles to 1.0m centres	No	337	194.15	65,428.55
				\$ 274,142.76

**TENDER 7 - Driven timber poles (MBIE ref. G5b).
CONTRACTOR 4
Tavendale PI**

MBIE House Area + 2m

3.8m Pile 250mm SED 1.0m centres

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1 Site establishment	LS	1	1,904.00	1,904.00
1.1.2 Contract administration	LS	0.67	8,671.99	5,810.23
1.1.3 Site cleanup and demobilisation	LS	1	1,904.00	1,904.00
1.1.4 Temporary fencing and signage	LS	1	434.56	434.56
1.1.5 Site entry protection, repair & traffic management	LS	1	560.00	560.00
1.1.6 Erosion & sediment and dust control	LS	1	609.28	609.28
1.1.7a Pre-construction condition survey	LS	1	6,406.40	6,406.40
1.1.8 Survey	LS	1	-	-
				17,628.47
1.3.1 Strip topsoil and stockpile.	m ²	540	-	-
Driven timber poles (MBIE ref. G5b). ex 4.2m long				
250mm diam 1.0m centres	No	645	183.68	118,473.60
Site won material backfill over driven piles	No	719	-	-
Respread topsoil	m ²	540	-	-
Gravel layer 200mm thick (AP 65)	m ³	108	72.30	7,808.40
Adjustment				
Extra time \$2228.23 x 645/958	Sum		\$	1,500.22
Adjusted cost of project (270m² treatment area)				\$ 145,410.69

540 m² \$ 269.28 /m²

Time 645/958 = 0.67

Piles 1295/ 1084 = 1.195 No per m²
540m² x 1.195 = 645 piles

South Island Poles less \$15.97 each

Uglies less \$5.00 per pole

4.2m pile add \$10.50 per pole supply & cut to size

TENDER 6B - TIMBER PILES
CONTRACTOR 4
Speight Rd

Tendered Area

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1	LS	1	1,232.00	1,232.00
1.1.2	LS	1	4,336.00	4,336.00
1.1.3	LS	1	616.00	616.00
1.1.4	LS	1	217.28	217.28
1.1.5	LS	1	280.00	280.00
1.1.6	LS	1	304.64	304.64
1.1.7a	LS	1	2,660.00	2,660.00
1.1.8	LS	1	-	-
				9,645.92
1.3.1	m ²	609	-	-
1.3.2	No	523	193.29	101,090.67
	No	523	-	-
	m ²	609	-	-
Accepted Tender Value				\$ 110,736.59
EOT payment	Sum			1,701.75
Additional piles to 1.0m centres	No	217	193.29	41,943.93
				\$ 154,382.27

TENDER 6B - Driven timber poles (MBIE ref. G5b).
CONTRACTOR 4
Speight Rd

MBIE House Area + 2m

3.8m Pile 250mm SED 1.0m centres

	Unit	Quant	Rate	Amount
1.1 Preliminaries and General				
1.1.1	LS	1	1,232.00	1,232.00
1.1.2	LS	0.63	4,336.00	2,731.68
1.1.3	LS	1	616.00	616.00
1.1.4	LS	1	217.28	217.28
1.1.5	LS	1	280.00	280.00
1.1.6	LS	1	304.64	304.64
1.1.7a	LS	1	2,660.00	2,660.00
1.1.8	LS	1	-	-
				8,041.60
1.3.1	m ²	270	-	-
1.3.2	No	330	183.68	60,614.40
	No	330	-	-
	m ²	270	-	-
	m ³	54	72.30	3,904.20
	Sum			1,242.28
Adjusted cost of project (270m² treatment area)				\$ 73,802.48

270 m² \$ 273.34 /m²

Adjustments

Time 330/523 = 0.67

Piles 740/609 = 1.22 No per m²

270m² x 1.22 = 330 piles

South Island Poles less \$15.97 each

Uglies less \$5.00 per pole

4.2m pile add \$10.50 per pole supply & cut to size

EARTHQUAKE COMMISSION

GROUND IMPROVEMENT COMPILATION SUMMARY FOR
ROTOVATED MIXED EX-SITU (MBIE ref. G2a)

CLEARED SITES - NON-HAIL
WORK ABOVE WATER TABLE

Treatment Area 1.0m Surrounding Structure

Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	Cost of Treated Area (\$/m ²)	Treatment Cost
<u>Rotovated mixed ex-situ</u> Excavate 1100mm deep, stabilise and compact 100mm in-situ layer, replace excavated material and cement stabilise in position with 8% cement ratio (No retention or dewatering required)	Keller St 2	642	204	\$156.42	\$31,909.68
	Keller St 1	642	204	\$211.04	\$43,052.16
	Average			\$183.73	\$37,480.92

Rates exclude GST.

ROTOVATED MIXED EX-SITU (MBIE ref. G2a)
Keller St 2
CONTRACTOR 12

Work above water table

		Unit	Quantity	Rate	Amount
Site Establishment					
1.1.1a	All plant required for the works	LS	1	750.00	750.00
1.1.1b	Welfare facilities - toilet & lockable site office	LS	1	850.00	850.00
1.1.1c	Lockable storage for plant, materials, equipment	LS	1 incl		
1.1.2	Contract administration	LS	1	900.00	900.00
1.1.3	Site clean up and demobilisation	LS	1	725.00	725.00
1.1.4	Site fencing (2m high mesh with palstic sheeting)	LS	1	1,080.00	1,080.00
1.1.5	Fencing of site compound	LS	1	520.00	520.00
1.1.6	Site entry protection, repair, signage & tm	LS	1	450.00	450.00
1.1.7	Provision for skip and disposal	LS	1 incl		
1.1.8	Erosion & sediment and dust control	LS	1	650.00	650.00
	Sub Total				\$ 5,925.00
Earthworks					
1.2.1	Strip topsoil to 100mm depth over treatment area & dispose	m ³	20.4	33.25	678.30
1.2.2	Excavate in-situ to 1.1m below NGL & stockpile	m ³	183.6	7.92	1,454.11
1.2.3	Import sand/silt for cement stabilising to replace disposed	m ³	20.4	48.25	984.30
	Sub Total				\$ 3,116.71
ROTOVATED MIXED EX-SITU (RSM)					
1.3.1	Supply cement, place, spread & mix in-situ (8% 128kg/m ³) & compact 1st lift.	m ³	20.4	93.42	1,905.77
1.3.2	Place 100mm compacted depth of silty in-situ soils from stockpile, supply cement, place, spread & mix in-situ (8% 128kg/m ³) second lift & compact	m ³	20.4	93.42	1,905.77
1.3.3	Supply & place two layers of Triax TX160 on top of second lift.	m ²	408	5.48	2,235.84
1.3.4	Place 100mm compacted depth of silty in-situ soils from stockpile onto geogrid, supply cement, place, spread & mix in-situ (8% 128kg/m ³) & compact.	m ³	20.4	93.42	1,905.77
1.3.5	Place 100mm compacted depth of silty in-situ soils from stockpile, supply cement, place, spread & mix in-situ (8% 128kg/m ³) and compact to ground level.	m ³	183.6	75.79	13,915.04
	Testing	sum			1,000.00
	Sub Total				\$ 22,868.19
	Total				\$ 31,909.90

204 \$156.42 per m²

ROTOVATED MIXED EX-SITU (MBIE ref. G2a)

Keller St 1

Work above water table

CONTRACTOR 13

	Unit	Quantity	Rate	Amount
Site Establishment				
1.1.1a	LS	1	1,000.00	1,000.00
1.1.1b	LS	1	500.00	500.00
1.1.1c	LS	1	500.00	500.00
1.1.2	LS	1	1,775.00	1,775.00
1.1.3	LS	1	1,500.00	1,500.00
1.1.4	LS	1	300.00	300.00
1.1.5	LS	1	1,000.00	1,000.00
1.1.6	LS	1	300.00	300.00
1.1.7	LS	1	300.00	300.00
1.1.8	LS	1		-
		Sub Total		7,175.00
Earthworks				
1.2.1	m ³	20.4	24.00	489.60
1.2.2	m ³	183.6	17.00	3,121.20
1.2.3	m ³	20.4	59.00	1,203.60
		Sub Total		4,814.40
ROTOVATED MIXED EX-SITU (RSM)				
1.3.1	m ³	20.4	209.80	4,279.92
1.3.2	m ³	20.4	209.80	4,279.92
1.3.3	m ²	408	5.20	2,121.60
1.3.4	m ³	20.4	209.80	4,279.92
1.3.5	m ³	183.6	82.25	15,101.10
Testing	sum			1,000.00
		Sub Total		\$ 31,062.46
		Total		\$ 43,051.86

204 \$211.04 per m²

EARTHQUAKE COMMISSION

GROUND IMPROVEMENT COMPILATION SUMMARY FOR
ROTOVATED MIXED EX-SITU (MBIE ref. G2a)

CLEARED SITES - NON-HAIL
WORK BELOW WATER TABLE

Treatment Area 1.0m Surrounding Structure

Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	Cost of Treated Area (\$/m ²)	Treatment Cost
<u>Rotovated Mixed Ex-situ</u> Excavate 1100mm deep, place 200mm layer crushed concrete, lay geogrid, replace excavated material and cement stabilise in position with 8% cement ratio 1m outside building footprint (no retention or dewatering required)	Keller St 1	642	204	\$233.63	\$47,660.52
	Keller St 2	642	204	\$185.04	\$37,748.16
	Average			\$209.33	\$42,704.34

Rates exclude GST.

ROTOVATED MIXED EX-SITU (MBIE ref. G2a)

Keller St 2

CONTRACTOR 12

Work below water table

		Unit	Quantity		
Site Establishment					
1.1.1a	All plant required for the works	LS	1	750.00	750.00
1.1.1b	Welfare facilities - toilet & lockable site office	LS	1	850.00	850.00
1.1.1c	Lockable storage for plant, materials, equipment	LS	1 incl		
1.1.2	Contract administration	LS	1	900.00	900.00
1.1.3	Site clean up and demobilisation	LS	1	725.00	725.00
1.1.4	Site fencing (2m high mesh with palstic sheeting)	LS	1	1,080.00	1,080.00
1.1.5	Fencing of site compound	LS	1	520.00	520.00
1.1.6	Site entry protection, repair, signage & tm	LS	1	450.00	450.00
1.1.7	Provision for skip and disposal	LS	1 incl		
1.1.8	Erosion & sediment and dust control	LS	1	650.00	650.00
Sub Total				\$	5,925.00
Earthworks					
1.2.1	Strip topsoil to 100mm depth over treatment area & dispose	m ³	20.4	33.25	678.30
1.2.2	Excavate in-situ to 1.0m below NGL & stockpile	m ³	183.6	7.92	1,454.11
	Excavate in-situ to 1.2m below NGL & dispose	m ³	40.8	33.25	1,356.60
	Supply and place A19 geo textile	m ²	204	3.80	775.20
	Supply and place AP40 M4 and compact in layers 200mm thick.	m ³	40.8	75.00	3,060.00
	Stabilise 200mm thick hardfill with 10% cement	m ³	40.8	97.00	3,957.60
1.2.3	Import sand/silt for cement stabilising to replace disposed topsoil	m ³	20.4	48.25	984.30
	Provide dewatering pump	sum			500.00
Sub Total				\$	12,766.11
ROTOVATED MIXED EX-SITU (MBIE ref. G2a)					
1.3.3	Supply & install two layers Triax TX160 on top of crushed concrete.	m ²	408	5.48	2,235.84
1.3.4	Place 100mm compacted depth of silty in-situ soils from stockpile onto geogrid, supply cement, place, spread & mix in-situ (8% 128kg/m ³) & compact.	m ³	20.4	93.42	1,905.77
1.3.5	Place layers of 100mm compacted depth of silty in-situ soils from stockpile, supply cement, place, spread & mix in-situ (8% 128kg/m ³) and compact to ground level.	m ³	183.6	75.79	13,915.04
	Testing	sum			1,000.00
Sub Total				\$	19,056.65
Total				\$	37,747.76

204 \$185.04 per m²

ROTOVATED MIXED EX-SITU (MBIE ref. G2a)

Keller St 1

CONTRACTOR 13

Work below water table

		Unit	Quantity	Rate	Amount
Site Establishment					
1.1.1a	All plant required for the works	LS	1	1,000.00	1,000.00
1.1.1b	Welfare facilities - toilet & lockable site office	LS	1	500.00	500.00
1.1.1c	Lockable storage for plant, materials, equipment	LS	1	500.00	500.00
1.1.2	Contract administration	LS	1	1,775.00	1,775.00
1.1.3	Site clean up and demobilisation	LS	1	1,500.00	1,500.00
1.1.4	Site fencing (2m high mesh with palstic sheeting)	LS	1	300.00	300.00
1.1.5	Fencing of site compound	LS	1	1,000.00	1,000.00
1.1.6	Site entry protection, repair, signage & tm	LS	1	300.00	300.00
1.1.7	Provision for skip and disposal	LS	1	300.00	300.00
1.1.8	Erosion & sediment and dust control	LS	1 Incl		
Sub Total				\$	7,175.00
Earthworks					
1.2.1	Strip topsoil to 100mm depth over treatment area & dispose	m ³	20.4	24.00	489.60
1.2.2	Excavate in-situ to 1.0m below NGL & stockpile	m ³	183.6	17.00	3,121.20
	Excavate in-situ to 1.2m below NGL & dispose	m ³	40.8	24.00	979.20
	Supply and place A19 geo textile	m ²	204	5.20	1,060.80
	Supply and place AP40 M4 and compact in layers 200mm thick.	m ³	40.8	50.68	2,067.74
	Stabilise 200mm thick hardfill with 10% cement	m ³	40.8	209.80	8,559.84
1.2.3	Import sand/silt for cement stabilising to replace disposed topsoil	m ³	20.4	59.00	1,203.60
	Provide dewatering pump	sum			500.00
Sub Total				\$	17,981.98
ROTOVATED MIXED EX-SITU (MBIE ref. G2a)					
1.3.3	Supply & install two layers Triax TX160 on top of crushed concrete.	m ²	408	5.20	2,121.60
1.3.4	Place 100mm compacted depth of silty in-situ soils from stockpile onto geogrid, supply cement, place, spread & mix in-situ (8% 128kg/m ³) & compact.	m ³	20.4	209.80	4,279.92
1.3.5	Place layers of 100mm compacted depth of silty in-situ soils from stockpile, supply cement, place, spread & mix in-situ (8% 128kg/m ³) and compact to ground level.	m ³	183.6	82.25	15,101.10
	Testing	sum			1,000.00
Sub Total				\$	22,502.62
Total				\$	47,659.60

204 \$233.63 per m²

EARTHQUAKE COMMISSION

**GROUND IMPROVEMENT COMPILATION SUMMARY
FOR REINFORCED GRAVEL RAFT (MBIE ref. G1b)**

**CLEARED SITES - NON-HAIL
WORK ABOVE WATER TABLE**

Treatment Area 1.0m Surrounding Structure

Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	Cost of Treated Area (\$/m ²)	Treatment Cost
Reinforced gravel raft Excavate 1200mm deep, replace with imported hardfill (no retention or dewatering required)	Keller St 1 (theoretical)	642	204	\$190.01	\$38,761.24
	Keller St 2 (theoretical)	642	204	\$161.27	\$32,899.80
	Average			\$175.64	\$35,830.52

The costing and constructability of this method are theoretical and have not been proven by tender and site trials.

Rates exclude GST.

Reinforced gravel rafts (MBIE ref. G1b)

Above Water Table

Keller St 1

CONTRACTOR 12

	Unit	Quant	Rate	Amount
<u>Preliminary & General</u>				
1				5,925.00
As Contractor 12 rotovated tender				
<u>Earthworks</u>				
8				
Excavate over the site to remove average 100mm thick layer of topsoil, cart off site site.				
	20.4	m3	33.25	678.30
				-
10				
Excavate to 1200mm deep below NGL and cart off-site.				
	224.4	m3	33.25	7,461.30
				-
11				
Supply and place AP40 M4 and compact in layers 200mm thick.				
	244.8	m3	87.80	21,493.44
				-
12				
Geogrid Triax TX160 or similar laid over first 200mm layer.				
	408	m2	5.40	2,203.20
				-
13				
Compaction tests on layer works.				
		sum		1,000.00
				\$ 38,761.24

204 190.01 /m²

Reinforced gravel rafts (MBIE ref. G1b)

Above Water Table

Keller St 2

CONTRACTOR 13

	Unit	Quant	Rate	Amount
<u>Preliminary & General</u>				
1				7,175.00
As Contractor 13 rotovated tender				
<u>Earthworks</u>				
8				
Excavate over the site to remove average 100mm thick layer of topsoil, cart off site site.				
	20.4	m3	17.00	346.80
				-
10				
Excavate to 1200mm deep below NGL and cart off-site.				
	224.4	m3	17.00	3,814.80
				-
11				
Supply and place AP40 M4 and compact in layers 200mm thick.				
	244.8	m3	75.00	18,360.00
				-
12				
Geogrid Triax TX160 or similar laid over insitu layer.				
	408	m2	5.40	2,203.20
				-
13				
Compaction tests on layer works.				
		sum		1,000.00
				\$ 32,899.80

204 161.27 /m²

EARTHQUAKE COMMISSION

GROUND IMPROVEMENT COMPILATION SUMMARY
FOR REINFORCED GRAVEL RAFTS (MBIE ref. G1b)

CLEARED SITES - NON-HAIL
WORK BELOW WATER TABLE

Treatment Area 1.0m Surrounding Structure

Treatment Method	Location	Lot Area (m ²)	Treatment Area (m ²)	Cost of Treated Area (\$/m ²)	Treatment Cost
<u>Hardfill Raft 1200mm Deep</u> Excavate 1200mm deep, replace with imported hardfill (No retention or dewatering required)	Keller St 1 (theoretical)	642	204	\$224.14	\$45,725.18
	Keller St 2 (theoretical)	642	204	\$184.92	\$37,724.60
	Average			\$204.53	\$41,724.89

Rates exclude GST.

**1200MM DEEP, REINFORCED GRAVEL
RAFTS (MBIE ref. G1b)
Keller St 1
CONTRACTOR 13**

Below Water table

	Unit	Quant	Rate	Amount	
<u>Preliminary & General</u>					
1				As Contractor 13 rotovated tender	5,925.00
<u>Earthworks</u>					
8				Excavate over the site to remove average 100mm thick layer of topsoil, cart off site site.	20.4 m3 33.25 678.30
10				Excavate to 1200mm deep below NGL and cart off-site.	183.6 m3 33.25 6,104.70
				Supply and place AP40 M4 and compact in layers 200mm thick.	40.8 m3 50.68 2,067.74
				Stabilise 200mm thick hardfill with 10% cement	40.8 m2 209.80 8,559.84
				Supply & place A19 geotextile	204 m2 3.80 775.20
11				Supply and place AP40 M4 and compact in layers 200mm thick.	204 m3 87.80 17,911.20
12				Geogrid Triax TX160 or similar laid over insitu layer.	408 m2 5.40 2,203.20
				Provide for sump and dewatering	sum 500.00
13				Compaction tests on layer works.	sum 1,000.00
				\$ 45,725.18	

204 224.14 /m²

**1200MM DEEP, REINFORCED GRAVEL
RAFTS (MBIE ref. G1b)
Keller St 2
CONTRACTOR 12**

Below Water table

	Unit	Quant	Rate	Amount	
<u>Preliminary & General</u>					
1				As Contractor 12 rotovated tender	7,175.00
<u>Earthworks</u>					
8				Excavate over the site to remove average 100mm thick layer of topsoil, cart off site site.	20.4 m3 17.00 346.80
10				Excavate to 1200mm deep below NGL and cart off-site.	183.6 m3 17.00 3,121.20
				Supply and place AP40 M4 and compact in layers 200mm thick.	40.8 m3 75.00 3,060.00
				Stabilise 200mm thick hardfill with 10% cement	40.8 m2 97.00 3,957.60
				Supply & place A19 geotextile	204 m2 5.20 1,060.80
11				Supply and place AP40 M4 and compact in layers 200mm thick.	204 m3 75.00 15,300.00
12				Geogrid Triax TX160 or similar laid over insitu layer.	408 m2 5.40 2,203.20
				Provide for sump and dewatering	sum 500.00
13				Compaction tests on layer works.	sum 1,000.00
				\$ 37,724.60	

204 184.92 /m²