

REPORT

**SOUTH KARORI BRIDGE REPLACEMENTS -
PHASE 1**

Prepared for Wellington Water





September 2016



This document has been prepared for the benefit of Wellington Water. No liability is accepted by this company or any employee or sub-consultant of this company with respect to its use by any other person.

This disclaimer shall apply notwithstanding that the report may be made available to other persons for an application for permission or approval to fulfil a legal requirement.

QUALITY STATEMENT

PROJECT MANAGER				PROJECT TECHNICAL LEAD			
Travis Wood				Nigel Beatson			
PREPARED BY							
Rohan Datar	.....		.....			02/09/2016	
CHECKED BY							
Nigel Beatson	.....		.....			07/09/2016	
REVIEWED BY							
Jeremy Walters	.....		.....			08/09/2016	
APPROVED FOR ISSUE BY							
David Hogg	.....		.....			09/09/2016	

WELLINGTON
 Level 13, 80 The Terrace, Wellington 6011
 PO Box 13-052, Armagh, Christchurch 8141
 TEL +64 4 381 6700, FAX +64 4 473 1982

REVISION SCHEDULE

Rev No.	Date	Description	Signature or Typed Name (documentation on file)			
			Prepared by	Checked by	Reviewed by	Approved by
1	9/9/2016	Draft – for comment	R Datar	N Beatson	J Walters	D Hogg

Executive Summary

MWH has been tasked with performing an inspection and condition assessment of seven bridges in order to develop a renewal strategy for Wellington Water. Six of the bridges are vehicle bridges and provide access to private properties. One bridge is a footbridge and is located at the rear of a private property.

None of the bridges meet the live load requirements of the NZTA Bridge Manual, however the requirement to meet this could be considered overly conservative for the location of these bridges. Four of the vehicle bridges meet the live load requirements for light and medium vehicles (up to 10,000kg) in accordance with NZS 1170, one meets the requirements for light vehicles (up to 2500kg) and one doesn't meet either requirement.

The following recommendations are made:

- The bridge at 46 South Karori Road currently has the lowest live load capacity but could be improved to meet the medium vehicle requirements of NZS1170.
- The bridge at 86 South Karori Road has a low live load capacity and should have the superstructure replaced.
- The footbridge at 56 South Karori Road has insufficient live load capacity and should be replaced.
- All the handrails on the vehicle bridges do not meet the height requirements of the NZ Building Code or the loading requirements from the NZTA Bridge Manual and should be replaced.
- The seating of the existing steel beams on the concrete abutments is insufficient and this should be improved on each of the vehicle bridges.
- The routine maintenance work listed in Table 5.1 should be carried out to avoid more expensive structural repairs.

Wellington Water

South Karori Bridge Replacements - Phase 1

CONTENTS

Executive Summary.....	i
1 Introduction.....	1
2 Site Inspection.....	1
3 Evaluation Methodology.....	2
4 Results.....	2
5 Recommendations.....	3
5.1 Structural Repairs / Replacements.....	3
5.2 Routine Maintenance.....	4

LIST OF TABLES

Table 1-1: Structures to be Assessed.....	1
Table 4-1: Vehicular Bridges Results Summary.....	2
Table 4-2: Footbridge Results Summary.....	3
Table 5-1: The following Routine Maintenance items are recommended.....	4

APPENDICES

Appendix A	Inspection Photos
------------	-------------------

1 Introduction

In 2010, CHP consulting engineers produced a structural assessment report for nine bridges in the suburb of Karori, Wellington. Since that time, two of the bridges at Karori West School and 3 Ranelagh Terrace, have been replaced. The remaining seven bridges make up the subject of this report (see Table 1-1). MWH has been tasked with performing a new, independent inspection and condition assessment of these seven bridges in order to develop a renewal strategy for Wellington Water for the 2016/17 financial year.

This report will assess, for each structure, the current condition, capacity, prioritisation for renewal and will provide a high level cost estimate for strengthening and renewal works.

Table 1-1: Structures to be Assessed

Bridge	Address	Clear Span	Type (All Vehicular Bridges Single Lane)
1	46 South Karori Road	8.3m	Steel Beam / Laminated Timber Deck
2	52 South Karori Road	5.6m	Timber Footbridge
3	76-78 South Karori Road	4.9m	Steel Beam / Laminated Timber Deck
4	80-84 South Karori Road	7.0m	Steel Beam / Laminated Timber Deck
5	86 South Karori Road	6.9m	Steel Beam / Concrete Deck
6	88 South Karori Road	7.1m	Steel Beam / Laminated Timber Deck
7	90-92 South Karori Road	7.2m	Steel Beam / Laminated Timber Deck

2 Site Inspection

Site inspections of all seven structures were carried out on August 16 2016 by MWH. Key dimensions were measured with tape measures, Vernier callipers and laser distance readers. The overall condition of various elements was also noted visually.

Key structural dimensions were obtained during the site inspections for the purpose of capacity calculations such as:

- Clear span between abutments
- Kerb to kerb width
- Spacing between beams
- Total depth, flange width and flange thickness of steel beams
- Deck cantilever dimension
- Deck plank cross section
- Kerb rail cross section
- Handrail post cross section and spacing
- Bearing area
- Holding down bolt details
- Substructure dimensions where possible

Various other qualitative factors relating to the condition of the structure were also noted where possible such as:

- Corrosion of steelwork

- Rotting or decay of timber
- Cracking of concrete substructure
- Scour of abutments
- Presence of excess vegetation
- Adequacy of bearing shelves

3 Evaluation Methodology

The six vehicular bridges have been evaluated in accordance with Chapter 7 of the New Zealand Bridge Manual 3rd Edition, Amendment 2 (Bridge Manual). The output of this evaluation is a gross vehicle tonnage for the beams and a maximum allowable axle load for the deck. The results of this analysis are also compared with the specific uses for Type F (light vehicle traffic areas) and Type G (medium vehicle traffic areas) as stated in Table 3.1 of AS/NZS 1170.1:2002.

Handrail posts have been assessed for bending strength in accordance with Appendix B of the Bridge Manual.

Where possible, bearing areas of the steel beams on the abutments have been assessed in compression.

The footbridge has been assessed as an access structure in accordance with SNZ HB 8630:2004 'Tracks and Outdoor Visitor Structures'. The output of this analysis is a pass/fail for the beams and a pass/fail determination of the deck. Handrails have been assessed as above.

4 Results

The evaluation results for the seven bridges are summarised in Table 4-1 and Table 4-2 below.

Table 4-1: Vehicular Bridges Results Summary

Bridge (Street No.)	Clear Span	Gross % Class 1	Gross Tonnage	Allowable Axle	Handrail Compliant?	Immediate Safety Concern?
1 (46)	8.3m	5%	1500kg	3500kg	No	Yes
3 (76-78)	4.9m	115%	24,000kg	2300kg	No	No
4 (80-84)	7.0m	73%	21,000kg	3900kg	No	No
5 (86)	6.9m	28%	7500kg	Unknown*	No	Yes
6 (88)	7.1m	69%	20,000kg	7000kg	No	No
7(90-92)	7.2m	72%	20,500kg	2700kg	No	No

*Strength of deck is unable to be determined due to lack of reinforcing details

Only one of the structures in the above table is capable of accommodating 100% Class 1 gross loading. None of the bridge decks are capable of taking a Class 1 axle (8200kg). However due to the use of the bridges, which currently only provide access to private residences, design to Class 1 loading may be considered overly conservative.

As mentioned in section 3 above, an alternative is to adopt AS/NZS 1170 loadings which specifies for Light Vehicles a gross mass of 2500kg and for Medium Vehicles a gross mass of 10,000kg. In accordance with this standard, Bridges 3, 4, 6 and 7 all have sufficient capacity to take light and medium vehicles. Bridges 1 and 5 only meet the requirements for Light vehicles and it is therefore recommended that their capacity be improved (strengthening of bridge 1 and replacement of beams and deck on bridge 5). Furthermore, the findings would also indicate that none of the bridges are currently capable of taking a full laden fire appliance with a rear axle load of 8200kg. Wellington Water will need to determine if this level of service (i.e. excluding emergency vehicles) is considered appropriate for the location and use of

these bridges. If Wellington Water require the bridges to meet the NZTA Bridge Manual then all bridges would need to have their superstructures replaced, furthermore the substructures

Table 4-2: Footbridge Results Summary

Bridge (Street No.)	Clear Span	Bridge beam capacity	Deck capacity	Handrail Compliant?	Immediate Safety Concern?
2 (52)	5.6m	Fail	Fail	No	Yes

Bridge 2 does not meet current best practice requirements as laid out in SNZ HB 8630:2004. It also fails the loading requirements for single person usage which is a point load of 3.6kN in accordance with the above standard. The most immediate safety concern is that of the handrails. The handrails are loose and have poor connection details meaning that they are currently unsafe.

It is possible that the actual timber strength is higher than that assumed ($f_b = 7.5\text{MPa}$) however it is not possible to verify this from a visual inspection. Timber strength could be confirmed via appropriate testing such as Qualitative Resistography and Quantitive Resisto-Fractometry but this technology is in its infancy and deriving useable compressive, bending, and tensile strength values is problematic and involves samples that are substantial in number and dimension being processed at a remote testing facility. Resultant delays in reports, cost of testing, acceptability of damage to structures in obtaining samples and representivity of samples make this an unattractive option as the relative strength gains expected would be minimal. A search of the local authority building consent records is recommended.

5 Recommendations

5.1 Structural Repairs / Replacements

The following in order of priority are the recommended Structural Repairs and Replacements.

Bridge 1, 46 South Karori Road:

This bridge currently has a very low live load capacity due to the poor connection detail between the laminated timber deck and the steel beams. This live load capacity could be significantly improved if the existing clip-type fixings are replaced with new bolts that securely fix through the top flanges of beams to the deck, thus providing improved lateral restraint to the beams. Further improvement could be achieved by installing diaphragms.

Estimated Cost - \$15,000 excluding GST and professional fees (+/- 40%).

Bridge 5, 86 South Karori Road:

This bridge has a low live load capacity due to the high dead load that the existing concrete deck puts on the steel beams. These beams are smaller than the beams used on the other bridges but the dead load is higher. It is recommended to replace the existing steel beams and concrete deck with a new precast prestressed concrete deck designed for the appropriate live load.

Estimated Cost - \$40,000 excluding GST, professional fees and consents (+/- 40%).

Bridge 2, 52 South Karori Road:

This bridge is a timber footbridge that provides access to a small area in one corner of a private property. The main timber beams do not have any apparent identification marking to indicate what the timber grade is so for the purposes of assessment they have been conservatively assumed to be No. 1 framing grade, moisture condition 'green' (m/c=25%). With this assumption the bridge does not have the required capacity to meet the live load requirements in the SNZ HB 8630:2004 'Tracks and Outdoor Visitor Structures' guide. On this basis, it is considered that this bridge should be replaced with a new structure designed in accordance with the SNZ HB 8630:2004 'Tracks and Outdoor Visitor Structures' guide, unless drawings can be found to determine the original timber grade.

Estimated Cost - \$20,000 excluding GST, professional fees and consents. (+/- 40%)

Handrails on all vehicle bridges

The handrails on all the bridges do not meet the required height in the New Zealand Building Code. Also, due to the timber being of an unknown strength, a conservative assumption has been made. With this assumed timber strength the handrails do not have sufficient capacity to resist the loads recommended handrail loads in the NZTA Bridge Manual. It is recommended that all the handrails on the bridges are replaced.

Estimated Cost - \$20,000 excluding GST, professional fees and consents. (+/- 40%)

Bearing Shelves on vehicle bridges

The bearing shelves on all the vehicle bridges other than bridge at 76-78 South Karori Road have very short bearing sills. To make the bridges more resilient it is recommended to improve the length of the bearing sills by installing a steel corbel to the abutment under the end of each beam.

The bridge at 90-92 South Karori Road has honeycombed concrete underneath some beams and timber blocks underneath others. These bearing areas should be grouted with structural repair mortar.

Estimated Cost - \$10,000 excluding GST and professional fees. (+/- 40%)

Holding Down Bolts

The following issues have been identified with the holding down bolts: bent bolts, corroded bolts and bolts located near the front face. These should be upgraded to meet detailed design requirements.

Estimated Cost - \$3,000 per bridge excluding GST and professional fees. (+/- 40%). Based on bolting through new corbels.

5.2 Routine Maintenance

In addition to the structural work above, it is recommended that the following routine maintenance is carried out on the bridges. By carrying out regular inspections and routine maintenance, defects can be remedied before more serious structural maintenance issues arise thereby saving long-term maintenance costs and reducing whole of life costs.

Table 5-1: The following Routine Maintenance items are recommended.

Bridge (Street No.)	Routine Maintenance
1 (46)	
2 (52)	
3 (76-78)	1. Clean moss off deck and handrails 2. Replace missing nut on bolt fixing deck to beam 3. Replace badly corroded bolt holding deck to beam 4. Reinstate missing section of chicken wire netting on deck
4 (80-84)	1. Clean dirt off bearing sills and bottom flange of beams 2. Remove grass that is growing through deck on shady side of bridge
5 (86)	1. Clean moss off handrails 2. Remove excess vegetation under bridge
6 (88)	1. Clean moss off deck 2. Clean dirt off bearing sills and bottom flange of beams
7(90-92)	1. Replace corroded bolts 2. Grout bearing sills with structural repair mortar.

Appendices

Appendix A Inspection Photos

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 1	
Photo Location: 90-92 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: General photo - handrails are not high enough	

Photograph ID: 2	
Photo Location: 90-92 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments:	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 3	
Photo Location: 90-92 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Some bolts corroded	

Photograph ID: 4	
Photo Location: 90-92 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Boney concrete underneath some beams	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 5	
Photo Location: 90-92 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Timber block wedged in underneath beams	

Photograph ID: 6	
Photo Location: 88 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: General photo - handrails are not high enough	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 7	
Photo Location: 88 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments:	

Photograph ID: 8	
Photo Location: 88 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Bearing sills covered in dirt	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 9

Photo Location:
88 South Karori Road

Direction:

Survey Date:
16/08/2016

Comments:
Moss growing on deck



Photograph ID: 10

Photo Location:
86 South Karori Road

Direction:

Survey Date:
16/08/2016

Comments:
General photo - handrails are not high enough



Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 11	
Photo Location: 86 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Moss growing on handrails	

Photograph ID: 12	
Photo Location: 86 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Very short bearing dimension	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road
Photograph ID: 13			
Photo Location: 86 South Karori Road			
Direction:			
Survey Date: 16/08/2016			
Comments: Beams are permanently deflected under dead load only			
Photograph ID: 14			
Photo Location: 86 South Karori Road			
Direction:			
Survey Date: 16/08/2016			
Comments:			

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 15	
Photo Location: 86 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Excess vegetation surrounding the abutments	

Photograph ID: 16	
Photo Location: 86 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Minor scour on upstream true left abutment	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 17

Photo Location:
80-84 South Karori Road

Direction:

Survey Date:
16/08/2016

Comments:
General photo - handrails are not high enough



Photograph ID: 18



Photo Location:
80-84 South Karori Road

Direction:

Survey Date:
16/08/2016

Comments:



Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road
Photograph ID: 19			
Photo Location: 80-84 South Karori Road			
Direction:			
Survey Date: 16/08/2016			
Comments: Bearing sills full of dirt around beams			
Photograph ID: 20			
Photo Location: 80-84 South Karori Road			
Direction:			
Survey Date: 16/08/2016			
Comments: Short bearing sills			

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 21	
Photo Location: 80-84 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Grass growing through the deck	

Photograph ID: 22	
Photo Location: 76-78 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: General photo - handrails are not high enough	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road
Photograph ID: 23			
Photo Location: 76-78 South Karori Road			
Direction:			
Survey Date: 16/08/2016			
Comments: Moss growing on the deck			
Photograph ID: 24			
Photo Location: 76-78 South Karori Road			
Direction:			
Survey Date: 16/08/2016			
Comments: Moss growing in handrail joints			

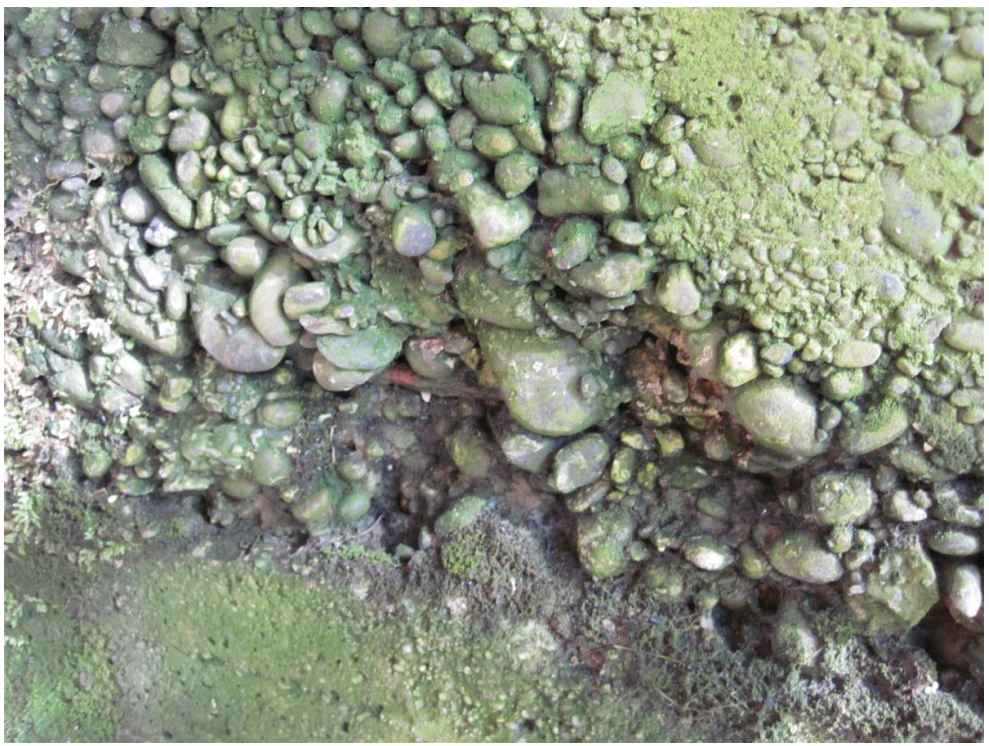
Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road



Photograph ID: 25	
Photo Location: 76-78 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments:	

Photograph ID: 26	
Photo Location: 76-78 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments:	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 27	
Photo Location: 76-78 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Beams supported on concrete block	

Photograph ID: 28	
Photo Location: 76-78 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Boney concrete below water outlet in abutment	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road
Photograph ID: 29			
Photo Location: 76-78 South Karori Road			
Direction:			
Survey Date: 16/08/2016			
Comments:			
Photograph ID: 30			
Photo Location: 76-78 South Karori Road			
Direction:			
Survey Date: 16/08/2016			
Comments: Some bolts are badly corroded			

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

<p>Photograph ID: 31</p> <p>Photo Location: 46 South Karori Road</p> <p>Direction:</p> <p>Survey Date: 16/08/2016</p> <p>Comments: General photo - handrails are not high enough</p>	
---	---

<p>Photograph ID: 32</p> <p>Photo Location: 46 South Karori Road</p> <p>Direction:</p> <p>Survey Date: 16/08/2016</p> <p>Comments: Handrail top rail heavily weathered</p>	
---	--

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road


Photograph ID: 33
Photo Location: 46 South Karori Road
Direction:
Survey Date: 16/08/2016
Comments: Heavily corroded clamps



Photograph ID: 34
Photo Location: 46 South Karori Road
Direction:
Survey Date: 16/08/2016
Comments: Heavily corroded clamps



Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road



Photograph ID: 35	
Photo Location: 46 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments:	

Photograph ID: 36	
Photo Location: 46 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Very short seated bearing dimensions due to straight cut beams placed on skew abutment	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road

Photograph ID: 37	
Photo Location: 46 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments: Extra bracing member in skewed triangular areas near abutments	

Photograph ID: 38	
Photo Location: 52 South Karori Road	
Direction:	
Survey Date: 16/08/2016	
Comments:	

Client:	Wellington Water	Project:	South Karori Bridge Replacements
Site Name:	South Karori Road	Site Location:	South Karori Road
Photograph ID: 39			
Photo Location: 52 South Karori Road			
Direction:			
Survey Date: 16/08/2016			
Comments: Handrails connected only by a single bolt, this is unstable			
Photograph ID: 40			
Photo Location: 52 South Karori Road			
Direction:			
Survey Date: 16/08/2016			
Comments: Handrails are flimsy and can be deflected easily			

Wellington

Level 13, 80 The Terrace
Wellington 6011
PO Box 13-052, Armagh
Christchurch 8141
Tel +64 4 381 6700
Fax +64 4 473 1982
www.mwhglobal.com

