BRIDGE INSPECTION REPORT 2016/2017

Prepared for Manawatu and Rangitikei District Councils

May 2017

MWH

BUILDING A BETTER WORLD

QUALITY STATEMENT

PROJECT MANAGER	PROJECT TECHNICAL LEAD
Roger Hulme	Jeremy Walters

PREPARED BY		
David Keracher	....	12/05/2017
CHECKED BY		
Pouvi Sua	....	12/05/2017
REVIEWED BY		
Jeremy Walters	....	15/05/2017
APPROVED FOR ISSUE BY		
Roger Hulme	....	15/05/2017

HAWKES BAY
1st Floor, 100 Warren Street South, Hastings 4122
PO Box 1190, Hastings 4156
TEL +64 6 873 8900, FAX +64 6 873 8901

REVISION SCHEDULE

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1	28/04/17	Draft for Comment	DMK			
2	12/05/17	Internal Review	DMK	PS	JW	
3	16/05/17	Final	DMK	PS	JW	RH

1 Executive Summary

The 2016/17 general and principal bridge inspections undertaken by MWH New Zealand Ltd (MWH) on behalf of the Manawatu and Rangitikei District Councils (MDC & RDC) have been successfully completed. The findings of the inspections for both Councils are summarised in this report.

PART A - Manawatu District Council recommendations are:

1. Carry out routine and structural maintenance items listed in Appendices D & E.
2. Bridge S5A be surveyed and tell tales installed to monitor for any further movement.
3. An earth retaining headwall and concrete apron with cut-off wall be installed on the upstream side of bridge S141 (formerly 630).
4. NDT scanning be carried out on the deck of bridge S170 to confirm cover depths to reinforcing steel, deck capacity factor confirmed, posting/rating assessment of the bridge be undertaken with recommendations for deck strengthening.
5. Bridge S161 be propped, fill behind the abutment temporarily retained, weight restrictions advertised and speed restrictions applied to mitigate the risk of further collapse and improve road safety. Propping should be re-inspected following extreme weather events and following severe seismic activity.
6. A Special Inspection be undertaken at bridges S404, S405, S408B & S409B to measure up all bridge elements and map cracking to allow for a posting assessment to determine the capacity of each structure. The results of the posting assessment will provide recommendations for grout injection, concrete repairs and/or strengthening.
7. Transverse cracking on bridge S142A be sealed with a flexible bitumastic based product to prevent water ingress and mitigate damage to the deck reinforcement. A posting and rating reassessment of this structure should be carried out annually with specific focus on the deck capacity factor due to the slender slab design and transverse cracking.
8. The approaches for S144 are sealed and the deck kept clean. An appropriate joint sealant should be installed. Areas of the deck soffit where there is exposed rebar should be repaired with an appropriate cementitious repair product such as Sika Monotop. Unless there is a standard mould available for kerb units an alternative kerb detail should be considered which is simple and cost effective to replace when damaged, such as timber.
9. Any As Built details for S030 be sourced to provide an understanding of how the concrete structure is supported on the bank. The horizontal rail irons also require a posting assessment to determine their capacity for a wheel load in the edge of the deck.
10. For bridge S008, that a series of concrete tests be carried out including phenolphthalein (to test for carbonation), chloride and electrochemical potential tests. The results of these tests will enable the selection of an appropriate concrete repair system.
11. For bridge S288B, that the cavity be filled with a flowable grout or concrete mix to underpin the apron and rock armour be placed at the outlet to dissipate energy.
12. Bridges S142A and S250B be reassessed and posted annually to ensure they are able to carry the advertised loads.
13. Safe access be provided to bridges S204, S194, S194A and S48 to be included in the 2017/18 inspection programme.
14. Bridge S266A be removed from the bridge inventory and added to the retaining wall inventory.
15. Bridges S420 and S288A are removed from the bridge inspection programme and added to the road maintenance drainage database.
16. MDC install nameplates at each structure.
17. All unsealed approaches to bridges on the network be sealed 20m either side.
18. A material testing programme be developed to verify RUL of Armco and helical spun culverts across the network.

19. Council carry out an expansion joint replacement programme to limit asset depreciation across the network.
20. A bridge safety barrier assessment across the network is recommended to ensure adequate steps are being taken to protect road users.
21. MDC undertakes scour screening assessments of their bridge stock.
22. MDC undertakes seismic screening of their bridge stock.
23. In order to maximise efficiencies through logistics it is recommended to split the network into six geographic areas with similar numbers of structures in each.
24. Continuation of "most credible threat" and "likelihoods" for the remaining bridge stock.
25. Continue to provide "snooper access" updates in RAMM for the remaining bridge stock.
26. Continuation of the RAMM inventory updating and verification.

PART B - Rangitikei District Council recommendations are:

1. Carry out routine and structural maintenance items listed in Appendices D & E.
2. The foundation detail of bridge 42 true right abutment be determined by referencing as-built drawings and a ground model of the underlying geology be prepared to predict future regression to enable a suitable embankment protection detail.
3. Bridge 302 be reassessed following severe weather events and re-inspected during low flow to fully inspect.
4. Bridge 150 be re-inspected during low flow to confirm the extent of scour downstream. Consideration may be given to increasing the size of this structure due to the risk of overtopping and breaching.
5. Bridge 9 be re-inspected following flooding for scour and flood damage.
6. Boulders be place on the true right, downstream side of bridge 170 to mitigate the risk of scour and collapse of gabion baskets.
7. A Special Inspection be undertaken for bridge 73 by first sourcing As-Built details to assess the structural details of the half joint and matched against the exiting photo evidence. A capacity check is required to assess the corbel capacity. The half joint should be cleaned and all vegetation and sediment removed.
8. A Special Inspection of bridge 22 be undertaken to waterblast loose material off the superstructure and pier substructure steel elements followed by a detailed inspection to quantify the required re-coating extent.
9. A Special Inspection of bridge 41 be undertaken to assess the extent of corrosion to the steel elements. At the same time as the special inspection the logistics and cost of reapplying Gold seal could be evaluated to assess whether it is feasible to install the coating system at the same time as the special inspection. The frames and hangars should also be assessed for an appropriate paint coating system. The existing posting should be revaluated once the results of the special inspection are complete and an axle limitation introduced to reflect the deteriorated condition of the deck.
10. The As-Built drawings for the bridge 2 be located and a posting or HPMV assessment undertaken to assess the bridge capacity. If the bridge capacity is found to be understrength there are options for strengthening including FRP and bonded steel plates.
11. Survey tabs be installed, for bridge 75, at the top of the pier and annual checks made to assess whether the pier has settled or moved with respect to a known datum.
12. Bridges 180 and 294 are removed from the bridge inspection programme and added to the road maintenance drainage database.
13. The gravel surfacing be permanently removed and both timber decks temporarily removed to facilitate re-inspection of the steel substrate, sub-structure, superstructure elements and timber decking.
14. Bridges 11 and 131 be reassessed and posted annually to ensure they are able to carry the advertised loads.
15. Bridges 180 and 294 are removed from the bridge inspection programme and added to the road maintenance drainage database.
16. RDC install nameplates at each structure.

17. All unsealed approaches to bridges on the network be sealed 20m either side. This will minimise the cost of ongoing maintenance whilst protecting the remaining useful life of bridge decks and other affected components.
18. A material testing programme be developed to verify RUL of Armco and helical spun culverts across the network.
19. RDC carry out an expansion joint replacement programme to limit asset depreciation across the network. Further investigations to identify suitable joint systems should be carried out as part of this.
20. A bridge safety barrier assessment across the network is recommended to ensure adequate steps are being taken to protect road users.
21. RDC undertakes seismic screening of their bridge stock.
22. RDC undertakes scour screening assessments of their bridge stock.
23. In order to maximise efficiencies through logistics it is recommended to split the network into six geographic areas with similar numbers of structures in each.
24. Continuation of “most credible threat” and “likelihoods” for the remaining bridge stock.
25. Continue to provide “snooper access” updates in RAMM for the remaining bridge stock.
26. Continuation of the RAMM inventory updating and verification.

Manawatu & Rangitikei District Councils

2016/2017 Bridge Inspection Report

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2 Bridge Inspections Introduction

The Manawatu District Council (MDC) bridge inspection programme comprises a two-year and six-year rolling programme of general and principal inspections, respectively, in accordance with the bridge inspection policy set out in Table 1 of the NZTA S6: 2015: Bridges and Other Significant Highway Structures Inspection Policy.

Inspections are conducted by MWH NZ Ltd. on behalf of MDC, findings of the bridge inspections are summarised to assist Council in managing their bridge assets.

2.1 Bridge Inspection Method

This report summarises results of the 2016/17 bridge inspections, comprising of 93 general and 27 principal inspections, a total of 120 structures. The inventory provided in Appendix C of the Request for Tender document (see Appendix A) was subsequently amended following correspondence with Darryn Black and Jim Mestyanek, see Table 2-1 below. Principal and general inspection location plans for both Local Authorities are included in Appendix B.

Table 2-1: Revised Inventory

Road Name	Bridge No	Description	RP	Notes
FINNIS ROAD - URBAN	S48A	BOX	402	Box culvert 2.4m x 1.0m not a bridge, no bridge inspection required.
POHANGINA ROAD	S215	BOX/HEADWALL	22997	1M Diameter culvert not a bridge, no inspection necessary
POHANGINA VALLEY EAST ROAD	S211	ONE LANE BRIDGE	40433	1m x 1.2m Box culvert not a bridge, no inspection necessary
WESTWIND PLACE	S412	BOX	17	2.2 x 0.9 Box culvert, not a bridge, no inspection required
SADDLE ROAD	S251	TWO LANED BRIDGE		Responsibility of Palmerston City Council - remove from inventory

The bridge inspection report used during general and principal inspections is based on the NZTA S6:2015 (see Appendix C). The form groups each structure into specific elements being inspected, such as superstructure, load-bearing substructure, durability, safety, waterway, retaining and other. Each element is checked for defects and a marking code is assigned with comments where applicable. Additional information collected during inspections includes “most credible threat”, with associated likelihood, whether a special inspection is required and details of any proposed special inspections.

Individual bridge inspection reports were populated whilst on site, directly into pocket RAMM, and data synchronised into RAMM database at the end of each day. All routine and structural maintenance items identified were costed and prioritised as part of the inspection process to assist with maintenance scheduling.

Digital photographs were taken to record the condition of inspected elements at each structure and to allow further assessment of any defects identified. All digital photos have been uploaded into RAMM.

As outlined in our tender submission and discussed during the pre-start meeting, we intend to generate efficiencies by partnering with the maintenance contractor, whereby we propose the bridge inspector will be accompanied by the maintenance contractor during general and principal inspections. This is a proven efficiency with several other Local Authority professional services contracts and we are confident we can realise the same efficiencies in MDC/RDC Bridge Management PS Contract.

Below is a summary of the key benefits (applicable to all parties) of establishing a partnership and working concurrently with the maintenance contractor, which include but are not limited to:

- Fulfils the requirement of 'Routine surveillance inspection', as defined in Clause 5.1 of NZTA S6:2015 (Bridges and other significant highway structures inspection policy).
- Contractor undertakes routine maintenance items on site during each inspection - Clearing deck drainage, fixing new bridge end marker signs, sweeping deck, painting and repairing damaged timber sight rails and removal of flood debris from the watercourse are a few examples of works carried out by the contractor whilst on site during each bridge inspection.
- Fostering good communication and trust between all parties through partnership
- Minimise commuter disruption by carrying out inspections and maintenance during one site visit
- Improve safety of commuters/site staff by reducing number of visits to each site
- Implementing one TMP for combined works
- Up skill maintenance contractor to improve efficiencies of surveillance inspections.
- Maintenance contractor takes ownership of bridge stock, understanding critical defects to identify during surveillance inspections and raise them to the attention of the Bridge Inspection Engineer.
- Contractor becomes the eyes and ears for client and consultant mitigating the risk of defects being left unseen between scheduled structural inspections, typically 2 yearly
- Routine/structural maintenance cost estimates are provided on site by the network maintenance contractor
- This process can also provide a discrete and ongoing auditing process of the maintenance contractor's performance for the Client, if required.

Unfortunately, we were unable to co-ordinate with Higgins for the 2016/17 inspections however we intend to build a strong working relationship over the coming months in order to realise the benefits of partnering.

2.1.1 General Bridge Inspections

NZTA S6: 2015: Bridges and other significant highway structures inspection policy, defines a general inspection as follows:

> *The procedures required are described in* Inspection Manual for Highway Structures (Highways Agency, 2007 – Table C.3) *and shall include an assessment of structure condition. Visual inspection from the ground level. Report on the physical condition of all structural elements visible from the ground level.*

The general bridge inspections were carried out by David Keracher (MWH) and Campbell Young (MWH) during November 2016.

2.1.2 Principal Bridge Inspections

NZTA S6: 2015: Bridges and other significant highway structures inspection policy, defines a principal inspection as follows:

> *The procedures described in* Inspection Manual for Highway Structures (Highways Agency, 2007 – Table C.3) *shall be followed. Close visual examination, within touching distance; utilising, as necessary, suitable inspection techniques. Report on the physical condition of all inspectable structural parts.*

The principal bridge inspections were carried out by Pouvi Sua (MWH), assisted by NZ Bridge Access Ltd and TMNZ in February and April 2017.

2.2 Bridge Inspections - Maintenance Items

2.2.1 General

The aim/objective of the bridge inspections is to:

- Assist the effective asset management of bridges.
- Identify defects at an early stage to ensure public safety, investment protection and to minimise/optimise repair costs.

Maintenance items can be broadly classified into two main components: Routine and Structural.

These components are used to categorise defects when undertaking inspections in accordance with the "NZTA S6:2015 Bridges and other significant highway structures inspection policy" and form the basis of routine and structural maintenance schedules.

2.2.1.1 Routine Maintenance Items

Routine maintenance items can be further divided into two sub-components: periodic maintenance and reactive maintenance.

Routine maintenance is defined by Chapter 4.38 in DMRB BD62/07 (Volume 3, Section 2, Part 1)

- Removing graffiti;
- Removing undesirable vegetation, e.g. that blocks drainage, may cause structural damage or restricts access;
- Removing debris, bird droppings and other detritus that blocks drainage and promotes corrosion or other deterioration;
- Clearing and ensuring correct operation of drain holes, drainage channels and drainage systems;
- Repairing gap sealant to movement joints;
- Checking operation of flap valves and greasing where required;
- Checking and tightening where necessary any loose nuts and bolts to expansion joints, parapet supports and gantry holding down assemblies. Replacing nuts and bolts where appropriate;
- Replacing expansion joint gaskets where this is a specific requirement defined for the structure/ component;
- Removing general dirt and debris from bearings. Where appropriate, cleaning sliding and roller surfaces if accessible and re-greasing. Following any additional advice contained in the bearing manufacturer's instructions;
- Ensuring free flow of water through culverts;
- Ensuring correct operation of ancillary equipment (e.g. drainage pumps and associated sumps and pipework) and maintaining certification of lifting devices;
- Checking (and rectifying where necessary) seating of drainage gratings or covers, replacing any missing or defective items;
- Checking, cleaning and replacing pedestrian security measures (e.g. mirrors, handrails, nonslip surfaces);
- Checking for scour damage around training works;
- Checking holding down assemblies;
- Repairing superficial defects in surface protection systems;
- Ensuring special finishes are clean and perform to the appropriate standards.

Reactive maintenance activities are typically undertaken after a natural event such as an earthquake, flood or accident.

A full list of routine maintenance items, including Rough Order Costs (ROC), can be found in Appendix D.

2.2.1.2 Structural Maintenance Items

Structural maintenance items are generally defined as repair solutions which require design calculations, engineering design drawings or design specifications. Structural maintenance items are divided into three progressive sub-components as follows:

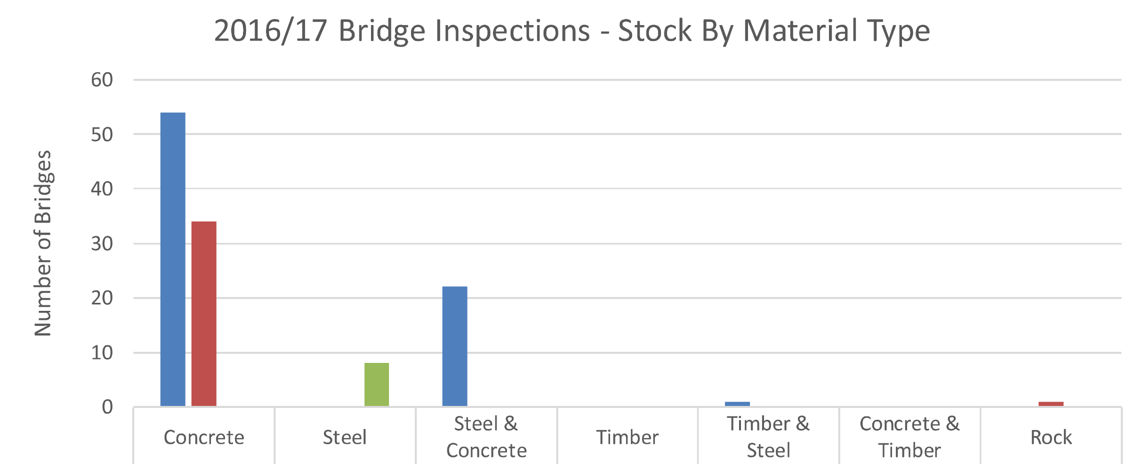
- Structural maintenance.
- Renewal of structural components.
- Renewal of structure.

Structural maintenance schedule items, including Rough Order Costs (ROC), can be found in Appendix E. This schedule details all structural maintenance items identified during the general and principal bridge inspections for 2016/17.

3 Bridge Inspection Results

3.1.1 Bridge Inspection Summary of Results

The 2016/17 MDC bridge inspection programme comprised 93 general and 27 principal bridge inspections, a total of 120 structures. Figure 3-1 below outlines structures inspected by type and includes 77 bridges, 43 bridge culverts (of which 8 are steel Armco/spun helical culverts).

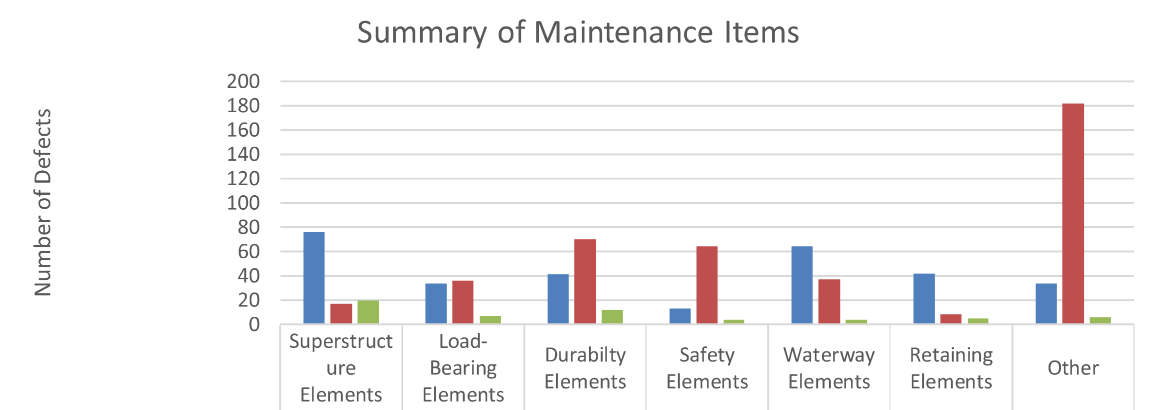


	Concrete	Steel	Steel & Concrete	Timber	Timber & Steel	Concrete & Timber	Rock
Bridge	54	0	22	0	1	0	0
Culvert	34	0	0	0	0	0	1
Arcmo	0	8	0	0	0	0	0

Figure 3-1: Type of structure and beam/deck composition of 2016/17 inspected bridges

3.1.2 Summary of Maintenance Items Identified

Figure 3-2 below summarises the maintenance items identified during the bridge inspections (see Appendices D & E for detailed results). The specific items assessed under each "Type" are defined on the NZTA S6: 2015 bridge inspection report (Appendix C).



	Superstructure Elements	Load-Bearing Elements	Durabilty Elements	Safety Elements	Waterway Elements	Retaining Elements	Other
Monitor	76	34	41	13	64	42	34
Routine Maintenance	17	36	70	64	37	8	182
Structural Maintenance	20	7	12	4	4	5	6

Figure 3-2: Summary of 2016/17 Inspection Defects by Type

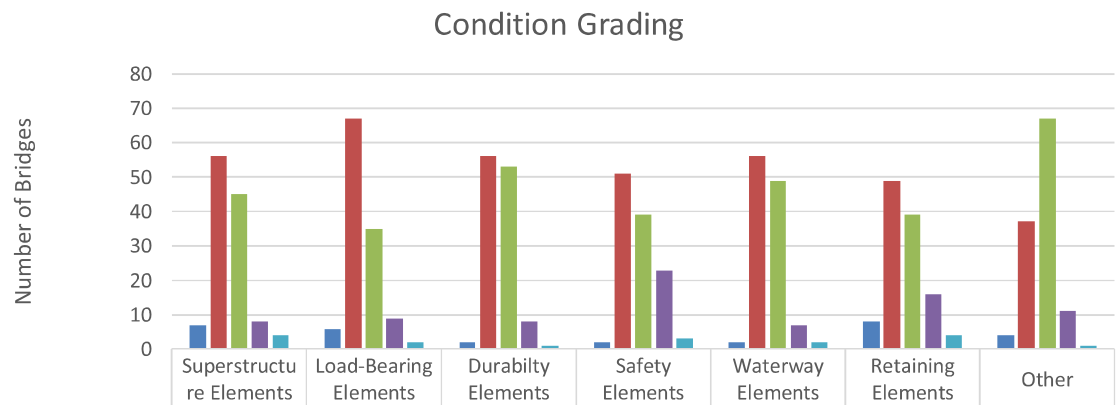
The “Other” category with 182 routine maintenance items noted in Figure 3-2 pertains to bridge approaches (30%), nameplates (50%) and vegetation clearance (20%).

3.1.3 Summary of Condition Grading

As part of MDC’s bridge lifecycle management, all structures inspected during 2016/17 have been assigned a condition grade specific to each element sub-heading (superstructure, load-bearing, durability etc.)

It is anticipated that this additional information will be used to further prioritise routine and structural maintenance items in the absence of extent and severity of observed defects.

A summary of condition gradings by element is shown below in Figure 3-3.



	Superstructure Elements	Load-Bearing Elements	Durabilty Elements	Safety Elements	Waterway Elements	Retaining Elements	Other
1 - Very Good	7	6	2	2	2	8	4
2 - Good	56	67	56	51	56	49	37
3 - Moderate	45	35	53	39	49	39	67
4 - Poor	8	9	8	23	7	16	11
5 - Very Poor	4	2	1	3	2	4	1

1 - Very Good 2 - Good 3 - Moderate 4 - Poor 5 - Very Poor

Figure 3-3: Summary of Bridge Condition Gradings by Element

The sum total of condition grading per element has been produced for each structure, this can also be used as an indicator for the general condition of bridges inspected in 2016/17. Totalling all element condition gradings to produce a bridge condition grading allows a snap shot summary of each structure inspected, Figure 3-4 below shows the distribution of 2016/17 inspections.

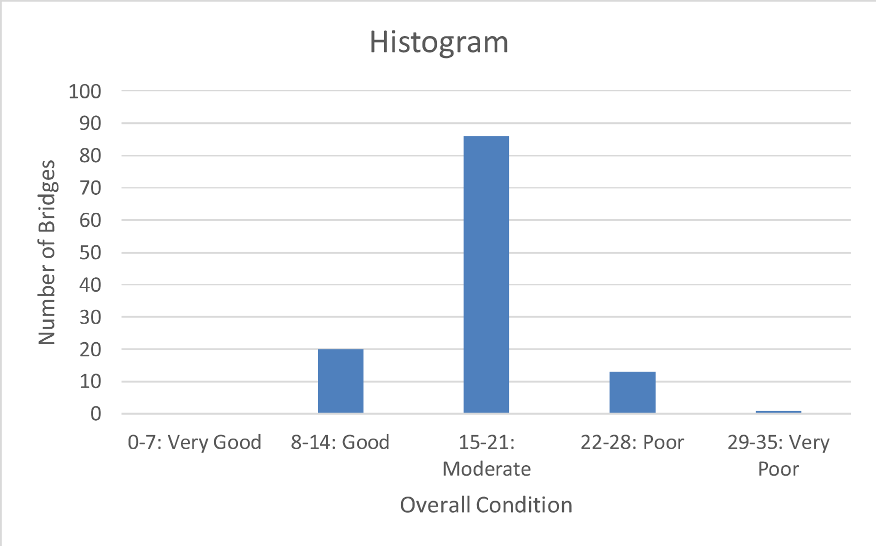


Figure 3-4: Distribution of Bridge Condition Gradings

3.2 Summary of Most Credible Threat and Likelihood Risks

During the inspection process, the most credible threat and associated likelihood for each of the 120 structures inspected was noted to provide a quick reference summary. A full breakdown of the most credible threat and associated likelihood of occurring are contained within Appendix F of this report.

Most credible threats with "extreme" likelihoods should be addressed as a matter of urgency, these are listed in Table 3-1 below.

Table 3-1: MDC Most Credible Threat and "Extreme" Likelihoods

Bridge No	Most Credible Threat	Likelihood
S28B	Scour	1 Extreme
S404	Non- compliant railing	1 Extreme
S44	Road safety	1 Extreme
S405	Non- compliant railings	1 Extreme
S51B	Road safety	1 Extreme
S104	Deck Joints	1 Extreme
S141	Washout of road	1 Extreme
S161	Collapse U/S	1 Extreme
S407	Non- compliant railings	1 Extreme
S194	Unable to inspect	1 Extreme
S204	Unable to access	1 Extreme
S408B	Cracking of beams	1 Extreme
S6C	Vegetation/ Poor air flow below deck	1 Extreme
S5A	Headwall collapse	1 Extreme
S235	Scour	1 Extreme

3.3 Structures Requiring Specialist Access

The following list of structures was identified during the General Inspections as requiring specialist Bridge Inspection Unit (BIU) access during their next Principal Inspection:

Structure ID	Bridge Name
52	S28B BRIDGE
55	S130 BRIDGE
380	S72 BRIDGE
47	S85 BRIDGE
28	S87 BRIDGE
327	S90 BRIDGE
322	S104 BRIDGE
13	S113 BRIDGE

Structure ID	Bridge Name
346	S143 BRIDGE
384	S172 BRIDGE
27	S176 BRIDGE
108	S185 BRIDGE
112	S189 BRIDGE
116	S193 BRIDGE
169	S228 BRIDGE
369	S10 BRIDGE

Structure ID	Bridge Name
365	S6C BRIDGE
363	S6A BRIDGE
293	S170 BRIDGE
373	S37 BRIDGE
98	S95 BRIDGE
61	S249A BRIDGE
270	S260 BRIDGE

4 Summary of Key Issues Arising from Inspections

The following summary is a selection of key issues arising from the 2016/17 general and principal bridge inspections. A full summary of inspection notes can be found on RAMM.

4.1 Proposed Special Inspections

Special inspections are requested by the Bridge Inspection Engineer for a variety of reasons. Table 4-1 below lists structures proposed for special inspections, the type of inspection proposed and details for their selection.

Table 4-1: MDC Structures Proposed for Special Inspections

Bridge No	Special Inspection Details
S404 BRIDGE	Map cracking in beams and recommend posting assessment
S405 BRIDGE	Map cracking on beams, undertake posting assessment
S108A CULVERT	DFT's, steel thickness and RUL
S113 BRIDGE	Seismic screening
S140 BRIDGE	Seismic assessment - provide shear keys at abutments?
S142A BRIDGE	Inspect saddles, piers, transoms and verify posting based on 30% deck cracking
S150 CULVERT	DFT, steel thickness and RUL
S159 CULVERT	Undertake DFT's and steel thickness to determine RUL and planned maintenance programme
S194 CULVERT	Return to inspect once clear and safe access has been provided
S204 CULVERT	Clear vegetation to allow access to inspect
S194A CULVERT	Check below water for scour/ cracking with diving gear. Assess full length of structure
S408B BRIDGE	Map cracks on beams, 4m ladder required - no snooper. Recommend posting assessment
S228 BRIDGE	Scour screening
S6A BRIDGE	Boat access
S5A CULVERT	Monitor cracks with tell tales, survey kerb/ railing to monitor movement of the headwall
S170 BRIDGE	Investigate deck capacity, cover depth to reinforcement and carry out posting/ rating assessment
S37 BRIDGE	Posting/ rating assessment
S250B BRIDGE	Reassess posting/ rating of bridge annually
S008	Material testing to assess appropriate repair product and methodology

4.1.1 Bridge S5A – Risk of Headwall Collapse

The 10m high concrete headwall of this cast in situ box culvert is exhibiting signs of bulging on the downstream side with cracks forming in the headwall face. Steel cross bracing has been installed to prevent further movement however it is unclear whether this is performing as intended. In addition to this, there are previously grout injected cracks within the culvert walls/soffit and translational cracking on the downstream concrete kerb.

Figure 4-1: Downstream wall of bridge S5A

It is recommended that bridge S5A be surveyed and tell tales installed to monitor for any further movement.

4.1.2 Bridge S141 (formerly 630) – Risk of Road Washout

The headwall on the upstream side of this helical spun culvert is formed by a single steel beam. The gravel road is at risk of washing out as it is currently not retained. In addition to this, water is passing below the culvert structure at the upstream side, this will eventually undermine the culvert and create settlement issues.

Figure 4-2: Upstream side of bridge S141

It is recommended that an earth retaining headwall and concrete apron with cut-off wall be installed on the upstream side of bridge S141.

4.1.3 Bridge S170 – Deck Capacity & Posting/Rating

The concrete deck of bridge S170, an integral cast in-situ concrete beam/deck structure, has hollow bossing on spans 1, 3 and 4. This suggests that the reinforcement is delaminating from the concrete which forms the finished surfacing of the deck.

The deck is exhibiting signs of heavy abrasion and cracking has formed in in transverse and longitudinal directions in a grid line pattern, inferred to be the reinforcement. In addition to this, span 4 has exposed steel bars resulting in zero cover depth to the concrete reinforcement.

The deck joint and nosing at the true left abutment has failed, resulting in water ingress at the abutment face.

Figure 4-3: Bridge deck and expansion joints at bridge S170

It is recommended that NDT scanning be carried out on the deck of bridge S170 to confirm cover depths to reinforcing steel, deck capacity factor confirmed, posting/rating assessment of the bridge be undertaken with recommendations for deck strengthening.

4.1.4 Bridge S161 – Risk of Further Collapse

The abutment on the upstream true left of bridge S161 has partially collapsed, possibly due to scouring or overtopping. Part of the upstream side of the road has been blocked off with a timber sight rail and traffic cones, however there has been no temporary remedial works to prevent further collapse of the abutment or loss of fill on the approach.

Signage on both ends of Nannestad Road has been erected warning motorists of that the bridge is closed to heavy traffic, however there is no posted limit or speed restriction stated on the signs.

Figure 4-4: Temporary road closure and affected abutment at bridge S161

It is recommended that bridge S161 be propped, fill behind the abutment temporarily retained, weight restrictions advertised and speed restrictions applied to mitigate the risk of further collapse and improve road safety. Propping should be re-inspected following extreme weather events and following severe seismic activity.

4.1.5 Bridges S404, S405, S408B & S409B – Cracking of Beam Soffits

The cast in situ concrete beam soffits on bridges S404, S405, S408B & S409B have longitudinal and transverse cracking throughout. Previous concrete repairs appear to have been carried out on the soffits of the concrete beams however, the repairs do not appear to have been carried particularly well. Due to the bridge's location in urban Fielding, it is possible that this is frequented by 50MAX and HPMV vehicles, thus increasing the live loading and potentially damaging the beams further.

Figure 4-5: Previous concrete repairs and longitudinal cracking on beam soffits of bridges S404, S405, S408B & S409B (Clockwise from top left)

It is recommended that a Special Inspection be undertaken at bridges S404, S405, S408B & S409B to measure up all bridge elements and map cracking to allow for a posting assessment to determine the capacity of each structure. The results of the posting assessment will provide recommendations for grout injection, concrete repairs and/or strengthening.

4.1.6 Bridge S142A – Precast Concrete Deck Units Cracking

It was noted on Bridge S142A, a weight and height restricted suspension bridge, that approximately 30% of the precast concrete deck slabs have transverse cracking. It appears that these may have been previously coated with a grout based product, however this has been abraded to expose the cracks.

The deck slabs have an unusual ribbed aluminium permanent formwork which forms the deck soffit. The result is a deck thickness which varies between 130-60mm and may be a contributing factor in the posting assessment of this bridge.

Figure 4-6: Transverse cracking on deck slabs, ribbed deck soffit detail and previous concrete repairs to deck on bridge S142A

It is recommended that transverse cracking on bridge S142A be sealed with a flexible sealant to prevent water ingress and mitigate damage to the deck reinforcement. A posting and rating reassessment of this structure should be carried out annually with specific focus on the deck capacity factor due to the slender slab design and transverse cracking.

4.1.7 Bridge S144 – Precast Concrete Kerb and Deck Unit Deterioration

There are a number of bridges within MDC which comprise the details shown in Figure 4-7 below. The tapered precast kerb detail appears to be frequently impacted and often damaged and/or moved out of alignment. The geometric shape of the kerb is also unlikely to be commonly available in standard moulds and would be expensive to cast replacement units. The precast deck units are all leaking at the joints and staining the deck soffit. This leakage and subsequent repeated wetting of the concrete soffit increases the rate of carbonation and deterioration of the concrete in this local area. Eventually this leads to corroded rebar and potential reduction in in structural capacity of the element. The leakage through the deck joints is due to deterioration of the sealant which is accelerated by gravel accumulating on the deck surface as a result of unsealed approaches.

Figure 4-7: Precast kerb detail damage and precast deck soffit deterioration at location of the joint

It is recommended that the approaches are sealed and the deck kept clean. An appropriate joint sealant should be installed. Areas of the deck soffit where there is exposed rebar should be repaired with an appropriate cementitious repair product such as Sika Monotop. Unless there is a standard mould available for kerb units an alternative kerb detail should be considered which is simple and cost effective to replace when damaged, such as timber.

4.1.8 Bridge S030 – Half Bridge

Bridge S030 is a half bridge that supports the carriageway on a steep embankment which is heavily vegetated. The structure, as observed, consisted of concrete wall elements which have steel railway irons cantilevering from the top of them and appear to have once supported a utility. The railway irons are corroding and do not appear to have any form of coating system. It is also unclear how far the wall elements extend below the ground. The bank is steep and potentially prone to ongoing erosion. Should the toe of the wall elements be exposed it could have a destabilising effect on the structure and embankment.

Figure 4-8: Precast kerb detail damage and precast deck soffit deterioration at location of the joint

It is recommended that any As Built details be sourced to provide an understanding of how the concrete structure is supported on the bank. The purpose of the railway irons should also be reviewed to make sure they aren't intended to perform a structural function e.g. act to support the deck.

4.1.9 Bridge S008 – Deterioration of concrete elements

Bridge S008 has multiple defects on the insitu concrete superstructure. The beams display regular diagonal cracking along their length approx. 0.2mm to 0.4mm wide. Areas of the deck soffit show spalling defects including areas where the concrete has delaminated. The majority of outriggers on the edge beams are in very poor condition with sections of concrete coming loose from light prying. It should be noted that the beams at true right abutment, which should be integral with the abutment, are no longer connected and a new abutment on piles has been formed.

Figure 4-9: Multiple defects on concrete superstructure including cracking on beams and spalling on beam elements.

It is recommended that a series of concrete tests be carried out including phenolphthalein (to test for carbonation), chloride and electrochemical potential tests. The results of these tests will enable the selection of an appropriate concrete repair system.

4.1.10 Bridge S288B – Cavity forming below downstream apron

Bridge S288B has a cavity forming below the outlet apron as a result of ongoing scour erosion. The cavity is near the true left abutment and appears to migrating towards the abutment. Unless the abutment is on piles or has a secondary wall along the toe the cavity could undermine the abutment resulting in collapse.

Figure 4-10: Cavity forming below outlet apron migrating towards the true left abutment

It is recommended that the cavity be filled with a flowable grout or concrete mix to underpin the apron and rock armour be placed at the outlet to dissipate energy.

4.1.11 Reassessment of Posted Bridges

Of the bridges inspected during 2016/17, the following structures have posted weight and speed restrictions advertised on approaches: S142A and S250B.

Figure 4-11: Bridges S142A and S250B

Any further deterioration of bridge elements may have an impact on the overall capacity of the structure, conversely any remedial works may increase the capacity and thus negate the requirement of a posted weight and speed restriction.

It is recommended that bridges S142A and S250B be reassessed and posted annually to ensure they are able to carry the advertised loads.

4.1.12 Poor Access and Overgrown Vegetation

Access was either not possible or no structure was found at the locations provided in RAMM at the following bridges:

Table 4-2: List of structures unable to fully access

Bridge No	Access Issues	Photographs
S266A	Unable to locate. The road is supported by a timber crib retaining structure with a watercourse approximately 20m below the road level	
S204	Unable to locate bridge – no nameplates. Vegetation overgrown on both sides of the road. No safe access to abutments	
S194	Unable to locate bridge – no nameplates. Vegetation overgrown on both sides of the road. No safe access to abutments	
S194A	Unable to access downstream side of bridge due to heavily overgrown vegetation and steep embankment	

Bridge No	Access Issues	Photographs
S48	Bridge was submerged due to aggradation of watercourse or has been removed	
S004B	Steep banks at both the inlet and outlet points. Overgrown vegetation hinders access.	
Ruahine Road (Not in RAMM)	Steep banks at both the inlet and outlet points. Access may be achievable at the inlet side but only after vegetation is cleared.	

It is recommended that safe access be provided to bridges S204, S194, S194A, S48, S004B and the bridge on Ruahine Road prior to their inclusion on the 2017/18 inspection programme.

It is recommended that bridge S266A be removed from the bridge inventory and added to the retaining wall inventory.

4.1.13 Structures to be Removed from Bridge Inspection Inventory

NZTA S6: 2015: Bridges and Other Significant Highway Structures Inspection Policy, defines a bridge structure as including culverts and multiple culverts with a total waterway area greater than 3.4 square metres.

The following structures were identified as having a waterway area less than 3.4 square metres.

Table 4-3: List of structures cross sectional area <3.4m²

Bridge No	Photographs
S420	
S288A	

It is recommended that bridges S420 and S288A are removed from the bridge inspection programme and added to the road maintenance drainage database.

4.1.14 Install Nameplates

It was noted during the inspection that IDs or nameplates were not present on the structures included in the 2016/17 inventory. This may be in the form of a mountable nameplate on the guardrail or sight rail, stencilled ID on the abutments/beams or delineator complete with the bridge ID and name.

It is recommended that MDC install nameplates at each structure.

4.1.15 Unsealed Approaches

It was noted during the 2016/17 that 7 bridges have unsealed approaches, listed below. One of the main defects on bridges with unsealed approaches is deck abrasion, caused by loose gravels wearing away the surfacing of the bridge deck.

This is particularly problematic with concrete decks as it abrades the deck and compromises the durability by reducing the cover depth to reinforcement steel. Similarly, loose gravels also abrade timber bridge decks but more vigorously as the material strength of timber is less than that of concrete, resulting in a high replacement rate of timber decking components. In addition to deck abrasion, the retention of moisture on timber decks is also an issue where gravels and fines accumulate on the deck surface and on elements below the deck thereby accelerating the timber decay and steel corrosion processes, respectively.

In order to maintain these performance issues, the maintenance contractor is required to sweep bridge decks on a regular basis and remove deleterious material from around the bearing shelves and beams.

It is recommended that all unsealed approaches to bridges on the network be sealed 20m either side. This will minimise the cost of ongoing maintenance whilst protecting the remaining useful life of bridge decks and other affected components.

Table 4-4: List of 2016/17 bridges with unsealed approaches

Structure ID	Road Name
S130	Mangahuia Road
S90	Kew Road
S140	Mangapapa Road
S42	Creamery Road
S48B	Forest Road
S95	Lagoon Road
S237	Reu Reu Road
S144	Mangarere Road
S299B	

4.1.16 Material Testing of Armco and Helical Spun Culverts

Armco culvert structures generally raise design life issues due to their vulnerability to corrosion not only from the watercourse but also due to groundwater penetrating through the structural fill zone surrounding the culvert. Typical failure mechanisms of Armco structures are sudden and unpredictable (non-ductile).

Several possible contributing factors for the reduced design life include, but are not limited to:

- Corrosion forming along the longitudinal bolted joint connection within the wet/dry zone. This in turn results in a breakdown of the corrosion protection system and subsequent loss of section forming a hinge below the longitudinal bolted connection. This failure mechanism occurred in 2014 at Junction culvert.
- Aggressive soil pH values penetrating through the compacted fill zone, on the outside face of the corrugated steel sections.
- Poorly compacted, engineered granular fill layers during construction, integral to the overall strength of the culvert, resulting in differential settlement of soil and deformation of the culvert.
- Non-granular, non-engineered soil substituted for the compacted, engineered fill layers during construction, resulting in differential settlement of soil and deformation of steel plates.

- Abrasion of the invert of the culvert due to transportation of river gravels which removes the protective galvanised coating and ultimately leads to corrosion and compromising of structural integrity.

The typical design life for galvanised steel structures of this type is approximately 50 years. It is recommended that material testing of steel plates be carried out using Non-Destructive Testing (NDT), with destructive testing to calibrate results, on selected structures, based on remaining design life and condition assessments from previous inspection records. Dimensional checks on culverts and steel plates shall also be recorded and reported upon. This will provide council with a qualitative risk assessment and remaining useful life for their culvert stock, based on NDT, destructive testing results and extrapolated annual corrosion rates.

Results from such a testing programme can be used to manage a planned culvert replacement/refurbishment programme, optimising intervention by “sweating the asset” without compromising the safe operation of the network.

It is recommended that a material testing programme be developed to verify RUL of Armco and helical spun culverts across the network.

4.1.17 Expansion Joints Maintenance

It was noted during the 2016/17 bridge inspections that the condition of expansion joints were generally found to be moderate. These essential components serve as a barrier to debris and water ingress through deck joints.

Given the temperature extremes within MDC’s geographical spread, it is essential to select the most suitable type of expansion joint to accommodate thermal expansion/contraction, ranging from sub-zero to $+30^{0}$C temperature variance. In addition to this wind loading, traffic loading and seismic loading all contribute to the movement envelope between deck and abutments.

The prevention of water ingress at deck level is crucial in preserving the condition of the superstructure, substructure and associated bridge hardware. The cost of a durable expansion joint system is typically less than:

- Replacing perished bearings;
- Providing localised concrete repairs due to moisture retention in concrete, leading to carbonation and corrosion;
- Weld repairs to steel components due to failed corrosion protective systems, crevice corrosion, pitting and delamination;
- Providing additional corrosion protection to steel before planned maintenance;
- Erection of scaffolding or provision of specialist access platforms to undertake repairs; and
- Damage to substructures from ‘locked-up’ joints.

Common expansion joint types noted during the 2016/17 bridge inspections were compression seals, narrow sealant joints and mechanical steel plate joints. Typical failures in these expansion joints are attributed to:

- Compression set.
- Adhesion failure.
- Failure of expansion joint material.
- Poor transition between substrate, especially if the substrate is irregular and gap width varies over the joint.
- Loose plates and/or missing nuts.

Sealant joints can be suitable in the right conditions but are restricted to narrow gaps less than 25mm where there is very little or no movement and also requires precise installation to achieve durability.

It is recommended that council carry out an expansion joint replacement programme to limit asset depreciation across the network. Further investigations to identify suitable joint systems should be carried out as part of this.

4.1.18 Bridge Safety Barrier Assessments

The condition of road safety barriers on bridge approaches and bridge decks across the network is considered to be poor. A combination of sight rail timber fencing and safety barriers exists on the network. Non-compliant safety barrier components include end terminals, fishtails, blockouts, installation heights, insufficient length of need and damage to existing barrier components.

Figure 4-12: Bridge S42 guardrailing of insufficient length

A bridge safety barrier assessment across the network is recommended to ensure adequate steps are being taken to protect road users. Bridges can present a hazard to road users, as well as the features the structures are bridging e.g. waterways, railway lines, other roads etc.

The provision of adequate roadside barriers on bridge structures and on their approaches is part of maintaining a safe road system.

The aim/objective of a bridge safety barrier assessment is to:

- Assess condition and design standard for existing barriers
- Confirm that the existing barrier has adequate approach length and provide the required containment
- Assess required upgrade, maintenance or repairs

Assessments will need to be prioritised, it is recommended that this is based upon:

- Accident history
- Traffic volumes; and
- Lowest containment levels

4.1.19 Seismic Screening

During the 2016/17 inspections it was noted that some bridges had narrow bearing shelves and lacked seismic hardware (linkages or shear keys).

NZTA's Manual for Seismic Screening of Bridges (SM110, Revision 2) provides guidance on the seismic screening processes. The outcomes of seismic screening includes a prioritised list of structures requiring detailed assessment, design and retrofitting of hardware to enable a suitable level of service during a seismic event.

It is recommended that MDC undertakes seismic screening of their bridge stock.

4.1.20 Scour Screening

It is recommended that council undertakes scour screening assessments of their bridge stock. This will allow for a prioritised list of at risk structures which may exhibit the following attributes:

- Specific scour issues identified during previous inspections
- Erosion or aggradation risks
- Highly exposed piles
- Structures sited on or immediately downstream of bends
- Bridges on braided or semi-braided rivers
- Bridges on alluvial fans

Large catchment areas and high water flows were observed across MDC's network during the inspection programme. These attributes present a higher risk of scour, therefore the requirement to carry out scour screening allows for a prioritised forward physical works programme as well as better planning for emergency response to at risk structures following severe weather events.

NZTA's Bridge Scour Screening Report No. 196 provides a background to scour, guidance on screening and templates to carry out bridge scour screening inspections.

4.1.21 Revision of Bridge Inspection Programme

The current inspection programme has a number of inefficiencies which could be greatly reduced by splitting the network into discreet geographical areas thus reducing travel time, disbursement costs and associated expenses. During the 2016/17 inspection programme, bridge inspectors travelled the length and breadth of the RDC and MDC networks three times: once for generals, once for the principals which required specialist access and once for the balance of the principals.

The minimum frequency, as defined by NZTA S6: 2015 Bridges and other significant highway structures inspection policy (Appendix A), for general and principal inspections is two years and six years, respectively. In order to maximise efficiencies through logistics it is recommended to split the network into six geographic areas with similar numbers of structures in each. This would allow for 1/6 of the network to be inspected each year under the principal inspections and 1/3 under general inspections within a smaller geographical boundary.

5 Recommendations

MWH recommend Manawatu District Council carry out the following:

1. Carry out routine and structural maintenance items listed in Appendices D & E.
2. Bridge S5A be surveyed and tell tales installed to monitor for any further movement.
3. An earth retaining headwall and concrete apron with cut-off wall be installed on the upstream side of bridge S141 (formerly 630).
4. NDT scanning be carried out on the deck of bridge S170 to confirm cover depths to reinforcing steel, deck capacity factor confirmed, posting/rating assessment of the bridge be undertaken with recommendations for deck strengthening.
5. Bridge S161 be propped, fill behind the abutment temporarily retained, weight restrictions advertised and speed restrictions applied to mitigate the risk of further collapse and improve road safety. Propping should be re-inspected following extreme weather events and following severe seismic activity.
6. A Special Inspection be undertaken at bridges S404, S405, S408B & S409B to measure up all bridge elements and map cracking to allow for a posting assessment to determine the capacity of each structure. The results of the posting assessment will provide recommendations for grout injection, concrete repairs and/or strengthening.
7. Transverse cracking on bridge S142A be sealed with a flexible bitumastic based product to prevent water ingress and mitigate damage to the deck reinforcement. A posting and rating reassessment of this structure should be carried out annually with specific focus on the deck capacity factor due to the slender slab design and transverse cracking.
8. The approaches for S144 are sealed and the deck kept clean. An appropriate joint sealant should be installed. Areas of the deck soffit where there is exposed rebar should be repaired with an appropriate cementitious repair product such as Sika Monotop. Unless there is a standard mould available for kerb units an alternative kerb detail should be considered which is simple and cost effective to replace when damaged, such as timber.
9. Any As Built details for S030 be sourced to provide an understanding of how the concrete structure is supported on the bank. The horizontal rail irons also require a posting assessment to determine their capacity for a wheel load in the edge of the deck.
10. For bridge S008, that a series of concrete tests be carried out including phenolphthalein (to test for carbonation), chloride and electrochemical potential tests. The results of these tests will enable the selection of an appropriate concrete repair system.
11. For bridge S288B, that the cavity be filled with a flowable grout or concrete mix to underpin the apron and rock armour be placed at the outlet to dissipate energy.
12. Bridges S142A and S250B be reassessed and posted annually to ensure they are able to carry the advertised loads.
13. Safe access be provided to bridges S204, S194, S194A and S48 to be included in the 2017/18 inspection programme.
14. Bridge S266A be removed from the bridge inventory and added to the retaining wall inventory.
15. Bridges S420 and S288A are removed from the bridge inspection programme and added to the road maintenance drainage database.
16. MDC install nameplates at each structure.
17. All unsealed approaches to bridges on the network be sealed 20m either side.
18. A material testing programme be developed to verify RUL of Armco and helical spun culverts across the network.
19. Council carry out an expansion joint replacement programme to limit asset depreciation across the network.
20. A bridge safety barrier assessment across the network is recommended to ensure adequate steps are being taken to protect road users.
21. MDC undertakes scour screening assessments of their bridge stock.
22. MDC undertakes seismic screening of their bridge stock.

23. In order to maximise efficiencies through logistics it is recommended to split the network into six geographic areas with similar numbers of structures in each.
24. Continuation of “most credible threat” and “likelihoods” for the remaining bridge stock.
25. Continue to provide “snooper access” updates in RAMM for the remaining bridge stock.
26. Continuation of the RAMM inventory updating and verification.

PART B - RANGITIKEI DISTRICT COUNCIL

6 Bridge Inspections Introduction

The Rangitikei District Council (RDC) bridge inspection programme comprises a two-year and six-year rolling programme of general and principal inspections, respectively, in accordance with the bridge inspection policy set out in Table 1 of the NZTA S6: 2015: Bridges and Other Significant Highway Structures Inspection Policy.

Inspections are conducted by MWH NZ Ltd. on behalf of RDC, findings of the bridge inspections are summarised to assist Council in managing their bridge assets.

6.1 Bridge Inspection Method

This report summarises results of the 2016/17 bridge inspections, comprising of 85 general and 37 principal inspections, a total of 121 structures. The inventory provided in Appendix C of the Request for Tender document (See Appendix A) formed the basis of the inspection programme for principal and general inspections. Location plans for both Local Authorities are included in Appendix B.

The bridge inspection report used during general and principal inspections is based on the NZTA S6:2015 (see Appendix C). The form groups each structure into specific elements being inspected, such as superstructure, load-bearing substructure, durability, safety, waterway, retaining and other. Each element is checked for defects and a marking code is assigned with comments where applicable. Additional information collected during inspections includes "most credible threat", with associated likelihood, whether a special inspection is required and details of any proposed special inspections.

Individual bridge inspection reports were populated whilst on site, directly into pocket RAMM, and data synchronised into RAMM database at the end of each day. All routine and structural maintenance items identified were costed and prioritised as part of the inspection process to assist with maintenance scheduling.

Digital photographs were taken to record the condition of inspected elements at each structure and to allow further assessment of any defects identified. All digital photos have been uploaded into RAMM.

As outlined in our tender submission and discussed during the pre-start meeting, we intend to generate efficiencies by partnering with the maintenance contractor, whereby we propose the bridge inspector will be accompanied by the maintenance contractor during general and principal inspections. This is a proven efficiency with several other Local Authority professional services contracts and we are confident we can realise the same efficiencies in MDC/RDC Bridge Management PS Contract.
Below is a summary of the key benefits (applicable to all parties) of establishing a partnership and working concurrently with the maintenance contractor, which include but are not limited to:

- Fulfils the requirement of 'Routine surveillance inspection', as defined in Clause 5.1 of NZTA S6:2015 (Bridges and other significant highway structures inspection policy).
- Contractor undertakes routine maintenance items on site during each inspection - Clearing deck drainage, fixing new bridge end marker signs, sweeping deck, painting and repairing damaged timber sight rails and removal of flood debris from the watercourse are a few examples of works carried out by the contractor whilst on site during each bridge inspection.
- Fostering good communication and trust between all parties through partnership
- Minimise commuter disruption by carrying out inspections and maintenance during one site visit
- Improve safety of commuters/site staff by reducing number of visits to each site
- Implementing one TMP for combined works
- Up skill maintenance contractor to improve efficiencies of surveillance inspections.

- Maintenance contractor takes ownership of bridge stock, understanding critical defects to identify during surveillance inspections and raise them to the attention of the Bridge Inspection Engineer.
- Contractor becomes the eyes and ears for client and consultant mitigating the risk of defects being left unseen between scheduled structural inspections, typically 2 yearly
- Routine/structural maintenance cost estimates are provided on site by the network maintenance contractor
- This process can also provide a discrete and ongoing auditing process of the maintenance contractor's performance for the Client, if required.

Unfortunately, we were unable to co-ordinate with Higgins for the 2016/17 inspections however we intend to build a strong working relationship over the coming months in order to realise the benefits of partnering.

6.1.1 General Bridge Inspections

NZTA S6: 2015: Bridges and other significant highway structures inspection policy, defines a general inspection as follows:

> *The procedures required are described in* Inspection Manual for Highway Structures (Highways Agency, 2007 – Table C.3) *and shall include an assessment of structure condition. Visual inspection from the ground level. Report on the physical condition of all structural elements visible from the ground level.*

The general bridge inspections were carried out by David Keracher (MWH) and Campbell Young (MWH) during November 2016.

6.1.2 Principal Bridge Inspections

NZTA S6: 2015: Bridges and other significant highway structures inspection policy, defines a principal inspection as follows:

> *The procedures described in* Inspection Manual for Highway Structures (Highways Agency, 2007 – Table C.3) *shall be followed. Close visual examination, within touching distance; utilising, as necessary, suitable inspection techniques. Report on the physical condition of all inspectable structural parts.*

The principal bridge inspections were carried out by Pouvi Sua (MWH), assisted by NZ Bridge Access Ltd and TMNZ in February and April 2017.

6.2 Bridge Inspections – Maintenance Items

6.2.1 General

The aim/objective of the bridge inspections is to:

- Assist the effective asset management of bridges.
- Identify defects at an early stage to ensure public safety, investment protection and to minimise/optimise repair costs.

Maintenance items can be broadly classified into two main components: Routine and Structural.

These components are used to categorise defects when undertaking inspections in accordance with the "NZTA S6:2015 Bridges and other significant highway structures inspection policy" and form the basis of routine and structural maintenance schedules.

6.2.1.1 Routine Maintenance Items

Routine maintenance items can be further divided into two sub-components: periodic maintenance and reactive maintenance.

Routine maintenance is defined by Chapter 4.38 in DMRB BD62/07 (Volume 3, Section 2, Part 1)

- Removing graffiti;
- Removing undesirable vegetation, e.g. that blocks drainage, may cause structural damage or restricts access;
- Removing debris, bird droppings and other detritus that blocks drainage and promotes corrosion or other deterioration;
- Clearing and ensuring correct operation of drain holes, drainage channels and drainage systems;
- Repairing gap sealant to movement joints;
- Checking operation of flap valves and greasing where required;
- Checking and tightening where necessary any loose nuts and bolts to expansion joints, parapet supports and gantry holding down assemblies. Replacing nuts and bolts where appropriate;
- Replacing expansion joint gaskets where this is a specific requirement defined for the structure/ component;
- Removing general dirt and debris from bearings. Where appropriate, cleaning sliding and roller surfaces if accessible and re-greasing. Following any additional advice contained in the bearing manufacturer's instructions;
- Ensuring free flow of water through culverts;
- Ensuring correct operation of ancillary equipment (e.g. drainage pumps and associated sumps and pipework) and maintaining certification of lifting devices;
- Checking (and rectifying where necessary) seating of drainage gratings or covers, replacing any missing or defective items;
- Checking, cleaning and replacing pedestrian security measures (e.g. mirrors, handrails, nonslip surfaces);
- Checking for scour damage around training works;
- Checking holding down assemblies;
- Repairing superficial defects in surface protection systems;
- Ensuring special finishes are clean and perform to the appropriate standards.

Reactive maintenance activities are typically undertaken after a natural event such as an earthquake, flood or accident.

A full list of routine maintenance items, including Rough Order Costs (ROC), can be found in Appendix D.

2.2.1.2 Structural Maintenance Items

Structural maintenance items are generally defined as repair solutions which require design calculations, engineering design drawings or design specifications. Structural maintenance items are divided into three progressive sub-components as follows:

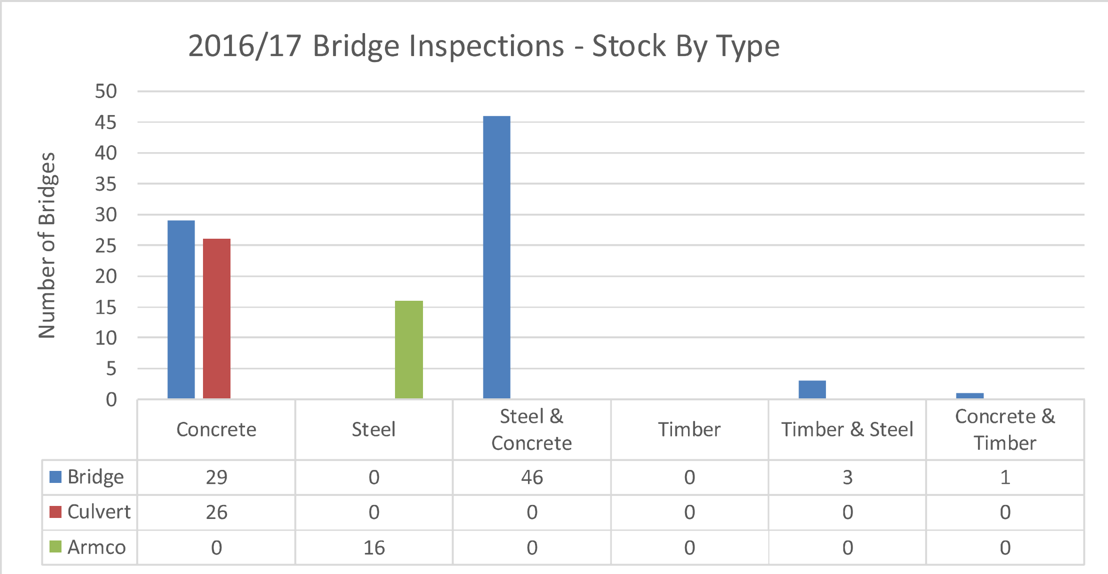
- Structural maintenance.
- Renewal of structural components.
- Renewal of structure.

Structural maintenance schedule items, including Rough Order Costs (ROC), can be found in Appendix E. This schedule details all structural maintenance items identified during the general and principal bridge inspections for 2016/17.

7 Bridge Inspection Results

7.1.1 Bridge Inspection Summary of Results

The 2016/17 RDC bridge inspection programme comprised 84 general and 37 principal bridge inspections, a total of 121 structures. Figure 7-1 below outlines structures inspected by type and includes 79 bridges, 42 bridge culverts (of which 16 are steel Armco/spun helical culverts).

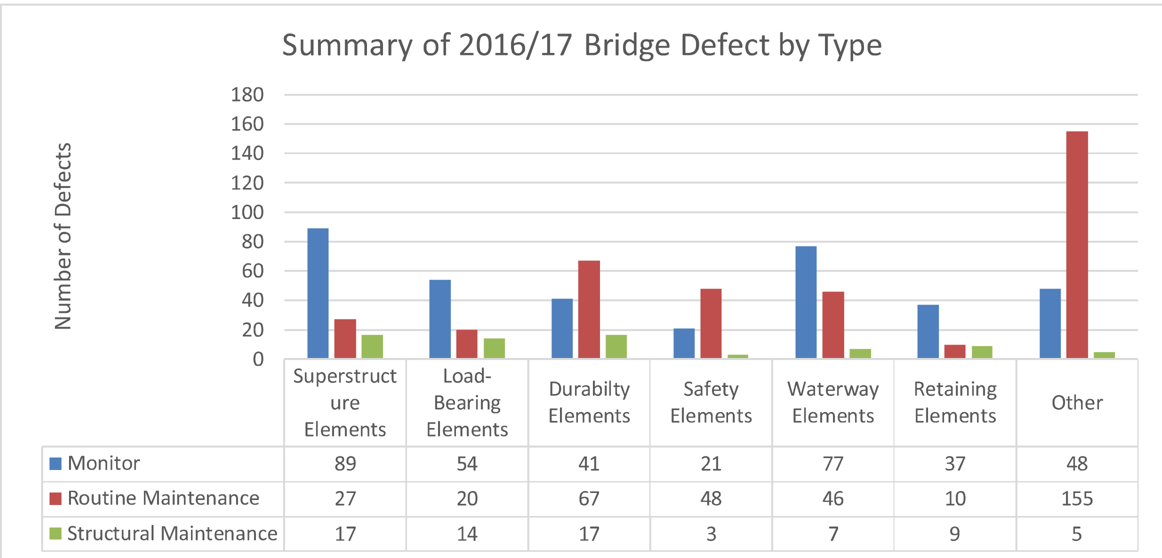


	Concrete	Steel	Steel & Concrete	Timber	Timber & Steel	Concrete & Timber
Bridge	29	0	46	0	3	1
Culvert	26	0	0	0	0	0
Armco	0	16	0	0	0	0

Figure 7-1: Type of structure and beam/deck composition of 2016/17 inspected bridges

7.1.2 Summary of Maintenance Items Identified

Figure 7-2 below summaries the maintenance items identified during the bridge inspections (see Appendices D & E for detailed results). The specific items assessed under each "Type" are defined on the NZTA S6: 2015 bridge inspection report (Appendix C).



	Superstructure Elements	Load-Bearing Elements	Durabilty Elements	Safety Elements	Waterway Elements	Retaining Elements	Other
Monitor	89	54	41	21	77	37	48
Routine Maintenance	27	20	67	48	46	10	155
Structural Maintenance	17	14	17	3	7	9	5

Figure 7-2: Summary of 2016/17 Inspection Defects by Type

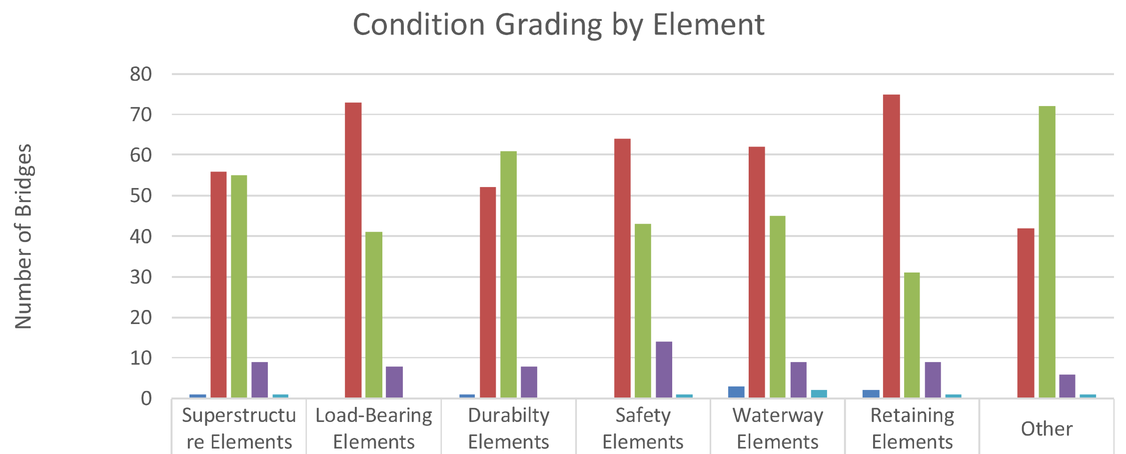
The “Other” category with 155 routine maintenance items noted in Figure 7-2 pertains to bridge approaches (30%), nameplates (50%) and vegetation clearance (20%).

7.1.3 Summary of Condition Grading

As part of RDC’s bridge lifecycle management, all structures inspected during 2016/17 have been assigned a condition grade specific to each element sub-heading (superstructure, load-bearing, durability etc).

It is anticipated that this additional information will be used to further prioritise routine and structural maintenance items in the absence of extent and severity of observed defects.

A summary of condition gradings by element is shown below in Figure 7-3.



	Superstructure Elements	Load-Bearing Elements	Durabilty Elements	Safety Elements	Waterway Elements	Retaining Elements	Other
1 - Very Good	1	0	1	0	3	2	0
2 - Good	56	73	52	64	62	75	42
3 - Moderate	55	41	61	43	45	31	72
4 - Poor	9	8	8	14	9	9	6
5 - Very Poor	1	0	0	1	2	1	1

Figure 7-3: Summary of Bridge Condition Gradings by Element

The sum total of condition grading per element has been produced for each structure, this can also be used as an indicator for the general condition of bridges inspected in 2016/17. Totalling all element condition gradings to produce a bridge condition grading allows a snap shot summary of each structure inspected, Figure 7-4 shows the distribution of 2016/17 inspections.

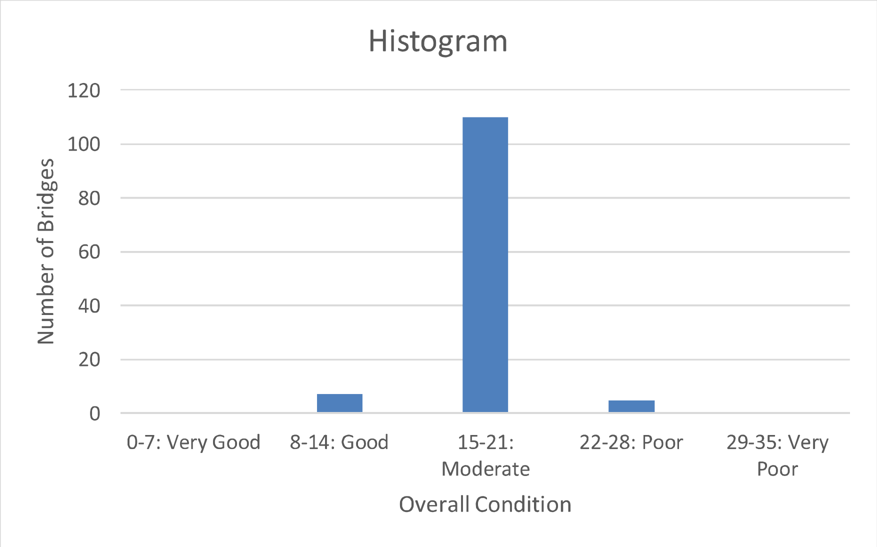


Figure 7-4: Distribution of Bridge Condition Gradings

7.2 Structures Requiring Specialist Access

The following list of structures was identified during the General Inspections as requiring specialist Bridge Inspection Unit (BIU) access during their next Principal Inspection:

Note that bridge 27 on Pugatawa Road was programmed for a BIU inspection this financial year, however due to high winds at the site it was decided to defer this to the next round of BIU inspections.

Bridges 25 and 134 were proposed to be assessed on foot as part of the 2016/17 principal inspections but require BIU to access the superstructure soffit areas.

Bridge 103 was programmed to be inspected using the BIU for the 2016/17 financial year. However due the bridge having an axle posting below BIU axle weight it was decided to undertake this inspection on foot. However access to the central portion of the span and one abutment was limited. It is recommended that an alternative BIU vehicle be employed which has axle weights that match the required bridge posting and thereby enable a more detailed inspection of the superstructure. Alternatively, abseiling techniques could be utilised.

Structure ID	Bridge Name
149	KAWERA
111	BATLEYS NO2
33	CHURNSIDES
16	TOTMANS
22	GORDON
14	PAPAKAI
67	PAULINS
41	PUKEROA
147	KAWHATAU A
25	COLLINS

Structure ID	Bridge Name
105	MAUNGARAUPI NO2
61	MCKINNONS
190	TAIHAPE NAPIER NO3
77	TRICKERS
37	PUKETOI (ALSO DUNCANS)
48	LILBURN (BLACKS)
78	BRAEMORE
80	OTIWHITI
84	BIRDS
27	PUNGATAWA

134	MAKINO NO 1	103	

7.3 Summary of Most Credible Threat and Likelihood Risks

During the inspection process, the most credible threat and associated likelihood for each of the 123 structures inspected was noted to provide a quick reference summary. A full breakdown of the most credible threat and associated likelihood of occurring are contained within Appendix F of this report.

Most credible threats with the highest likelihoods should be addressed as a matter of urgency, these are listed in Table 7-1 below.

Table 7-1: RDC Most Severe Likelihood

Structure ID	Most Credible Threat	Likelihood
73	Undercutting of abutments	1 Extreme
3	Vegetation, silt & debris obscuring abutments	1 Extreme
22	Road Safety	1 Extreme
230	Corrosion on invert	1 Extreme
194	Over topping/ scour	1 Extreme
104	HD bolts	1 Extreme
121	Unable to inspect	1 Extreme
48	Road safety T/R	1 Extreme
248	Culvert overtopping/ washout	1 Extreme
210	Scour	1 Extreme
98	Substructure drainage	2 High
149	Drainage	2 High
132	Scour	2 High
111	Safety – Sight rails	2 High
100	Overtopping	2 High
169	Erosion of road through poor deck	2 High
20	Road safety	2 High
9	Insufficient hydraulic capacity / over topping	2 High
41	Vegetation	2 High
61	Scour at true right abutment	2 High
185	Delamination/ Spalling	2 High
263	Scour	2 High
225	Invert corrosion	2 High
232	Safety	2 High
77	Seismic	2 High
37	Exposed T/R abutment	2 High
80	Scour	2 High
147	Deck joints	2 High
84	Deck abrasion	2 High
244	Corrosion	2 High

8 Summary of Key Issues Arising from Inspections

The following summary is a selection of key issues arising from the 2016/17 general and principal bridge inspections. A full summary of inspection notes can be found on RAMM.

8.1 Proposed Special Inspections

Special inspections are requested by the Bridge Inspection Engineer for a variety of reasons. Table 8-1 below lists structures proposed for special inspections, the type of inspection proposed and details for their selection.

Table 8-1: RDC Most Severe Likelihood

Bridge No	Special Inspection Details
8	DFT's, steel thickness & RUL of armco
152	DFT's, steel thickness & RUL
1	Carry out DFT testing on main elements and recommend maintenance coating
139	It is unlikely that a principal inspection has been carried out due to overhead electrified rail lines. Recommend rail closure and isolate power to access with cherry picker.
140	Isolate live wires and request rail closure to carry out special. Cherry picker required. It is unlikely that this bridge has had a full principal inspection
33	Map cracking of deck soffit using snooper, undertake posting assessment
135	Inspect underside of bridge with ladders/ waders when water levels reduce
20	Abseil inspection, DFT's, torque test bolts
265	NDT with steel thickness gauge to prove RUL
9	Inspect following flooding for damage
16	Seismic Assessment
38	Abseil inspection, PFT's, torque tests and condition assessment
14	Seismic assessment
105	Re-post annually
11	Carry out re-posting
25	RUL using NDT steel thickness gauge
225	RUL and NDT with Steel thickness gauge
230	DFT's, steel thicknessess and determine RUL
194	Once water levels have been reduced inspect D/S and check for scour
232	Full walk through with kiwirail permit and track protection. NDT thickness gauge testing with to determine RUL.
77	Seismic screening, design of linkages at abutments
104	Measure up, assessment of HD bolts and design augmented solution
121	Remove both timber decks and reassess
127	Abseil/ cherry picker to carry out DFT's & torque tests, re-post bridge
272	Special to verify DFT's steel thicknesses and RUL
37	Seismic assessment & inspection of T/R abutment
48	Seismic assessment
78	Verify foundation type and whether pier 1 is exposed, recommend remedial works

Bridge No	Special Inspection Details
252	Bridge inspection requires waders due to low freeboard level
147	Seismic screening
74	Regular post/ rating assessment of bridge
244	Special inspection to confirm steel thickness and verify RUL
73	Confirm As Built Structural details of beam half joint and extent of deterioration
22	Quantify quantity of coating spot repairs to steep superstructure and substructure piers
41	Assess condition of cable at tops of frames and extent of corrosion to superstructure steel elements at the soffit level

8.1.1 Bridge 42 (Puketoi) – Exposed Abutment

The true right embankment of this pre-cast hollowcore bridge has been undercut through erosion, resulting in exposure of the true right concrete abutment. It is not clear whether the abutment is founded with piles or a shallow seating arrangement.

Historically, it has been noted that the watercourse at bridge 42 has overtopped the deck following severe weather events.

Figure 8-1: Erosion of true right embankment and exposed concrete abutment at bridge 42

It is recommended that the foundation detail of bridge 42 true right abutment be determined by referencing as-built drawings and a ground model of the underlying geology be prepared to predict future regression to enable a suitable embankment protection detail.

8.1.2 Bridge 302 – Hydraulic Capacity

The hydraulic capacity of bridge 302, a galvanised steel armco culvert was nearing its limit following heavy rain during the 2016/17 inspection. The watercourse downstream was so torrent that the embankment was eroding during the inspection.

Figure 8-2: Bridge 302 watercourse in spate

It is recommended that bridge 302 be reassessed following severe weather events and re-inspected during low flows.

8.1.3 Bridge 150 – Hydraulic Capacity

Bridge 150 comprises of a helical spun galvanised culvert with no headwall or wingwalls. It was not possible to measure the diameter of the culvert due to less than 200mm freeboard, therefore it is not certain whether this is a bridge culvert or a drainage structure.

During the time of inspection, the pipe culvert was close to overtopping. The flow rate downstream was torrent and vegetation prevented from inspecting the outlet. There is a risk of scour downstream due to the ferocity of water discharging.

Figure 8-3: Upstream and downstream of bridge 150

It is recommended that bridge 150 be re-inspected during low flow to confirm the extent of scour downstream. Consideration may be given to increasing the size of this structure due to the risk of overtopping and breaching.

8.1.4 Bridge 9 – Insufficient Hydraulic Capacity

The freeboard level to the steel beam soffits at bridge 9 was approximately 200mm, therefore it was not possible to fully inspect the beams and deck soffit due to high water levels at the time of the inspection. This structure is at risk of overtopping and subject to damage flood debris damage due to insufficient hydraulic capacity.

Figure 8-4: Freeboard level at bridge 9

It is recommended that bridge 9 be re-inspected following flooding for scour and flood damage.

8.1.5 Bridge 170 – Scour Risk

The true right, downstream side of bridge 170 has been undercut and is susceptible to scour damage. The gabion baskets placed behind the wingwall to retain the carriageway are at risk of collapsing due to fines being washed out from surface water run-off.

Figure 8-5: Scour risk at bridge 170

It is recommended that boulders be place on the true right, downstream side of bridge 170 to mitigate the risk of scour and collapse of gabion baskets.

8.1.6 Bridge 155 – Decayed timber decking and rotational failure of beams

The original timber deck on bridge 155 has been overlain with a second timber deck and gravel road. This configuration significantly increases the dead load of the structure whilst retaining moisture, which in turn promotes decay. It was not possible to access the underside of this structure due to the steep drop off on the downslope of the half bridge. It was noted during the inspection that the outside beams are subject to rotational failure. It was not possible to confirm whether the beams are restrained with diaphragms nor was it possible to confirm the condition of the corrosion protective system applied to the substrate.

Figure 8-6: Bridge 155 deck and downslope

It is recommended that the gravel surfacing be permanently removed and both timber decks temporarily removed to facilitate re-inspection of the steel substrate, sub-structure, superstructure elements and timber decking.

8.1.7 Bridge 73 – Deterioration of Beam Half Joints

The central span of bridge 73 is supported on half joints in the form of corbel elements. Water and sediment become trapped within this joint promoting growth of vegetation, retention of moisture and ongoing deterioration of the concrete and steel bearing plates and fixings. The half joint at both ends of the bridge displayed leakage along most of the bridge width. There are diagonal cracks present on the external face of the bottom corbel element, up to 0.3mm wide, which could be the region of a cold joint or suggestive of a structural defect such as shear cracking due to inadequate detailing and strength. There is also relative movement between the bearing plates indicating movement of the bridge in the longitudinal direction. The bearing plates display surface corrosion. On the downstream face of the half joint there is a neoprene pad instead of plates.

Figure 8-7: Concrete half joint detail showing leakage, vegetation growth and diagonal cracking

It is recommended that a special inspection be undertaken by first sourcing As-Built details to assess the structural details of the half joint and matched against the existing photo evidence. A capacity check is required to assess the corbel capacity. The half joint should be cleaned and all vegetation and sediment removed.

8.1.8 Bridge 22 – Deterioration of galvanised steel coating system

The galvanised coating on the superstructure truss and pier elements is deteriorating. There is a large amount of staining to the steel elements which makes it difficult to assess the extent of the re-coating required but it is likely that after a low pressure waterblast to remove loose material the total quantity of spot coating repair will be less than 10% of the total bridge steel surface. Where there are clear signs of corrosion progressing is on the bottom gusset plates which, being flat, retain moisture and salts for longer.

Figure 8-8: Deterioration of galvanised coating system to superstructure and pier steel elements – spot repairs recommended

It is recommended that a special inspection be undertaken to waterblast loose material off the superstructure and pier substructure steel elements followed by a detailed inspection to quantify the required re-coating extent.

8.1.9 Bridge 41 – Assessment of structure condition

Bridge 41 is posted with a Gross of 18000kg and speed 30km/hr. The Goldseal coating on the superstructure steel elements has failed including the paint coating on the hangars and cable frames. The majority of the superstructure could not be assessed in detail as a BIU cannot be mobilised onto a suspension bridge. Where elements could be observed closely was near the banks which showed moderate corrosion to areas of the stringer beams and moderate to severe corrosion of the timber spiking board linkage bolts. It is assumed that the remainder of the stringers and linkage bolts display similar levels of corrosion. There are several transverse timber deck planks which have severe levels of rot present, probing with a survey staff suggested over half the depth of the timber was decayed. The timber spiking board is also not connected to the transverse planks and various locations along the bridge length. It is unknown how long the posting has been in place but the lack of an axle restriction to reflect the deteriorated deck condition suggests the posting needs re-evaluation.

Figure 8-9: Failure of gold seal system, corrosion of main steel elements and deterioration of timber elements

It is recommended that a special inspection be undertaken to assess the extent of corrosion to the steel elements. At the same time as the special inspection the logistics and cost of reapplying Gold seal could be evaluated to assess whether it is feasible to install the coating system at the same time as the special inspection. The frames and hangars should also be assessed for an appropriate paint coating system. The existing posting should be revaluated once the results of the special inspection are complete and an axle limitation introduced to reflect the deteriorated condition of the deck.

8.1.10 Bridge 2 – Cracks on pile cap of abutment and pier elements

There are multiple cracks present on the pile cap of both the abutment and pier elements. The size of the cracks near the pile/pile capping beam interface are approximately 0.4mm in width. There also appears to be a noticeable hog in the pile cap over the abutment piles. The pier caps have had crack repairs undertaken previously but this illustrates the large extent of cracking. The bridge is not posted and during the inspection it was noted there was a large frequency of heavy commercial vehicles that used the bridge.

Figure 8-10: Multiple repaired and existing cracks on the pile cap elements for both the abutment and piers

It is recommended that the As-Built drawings for the bridge be located and a posting or HPMV assessment undertaken to assess the bridge capacity. If the bridge capacity is found to be understrength there are options for strengthening including FRP and bonded steel plates.

8.1.11 Bridge 75 – Settlement of Pier

At the pier location there appears to have been settlement illustrated by a visible low point along the bridge span, particularly in the handrails. However this could also be a result of hogging at the pier, with the dip occurring immediately away from the hogging point (which is at the pier).

Figure 8-11: Visual low point along bridge at approximate pier location

It is recommended that survey tabs be installed at the top of the pier and annual checks made to assess whether the pier has settled or moved with respect to a known datum.

8.1.12 Poor Access and Overgrown Vegetation

Access was not possible at the location provided in RAMM for the following bridge:

Table 8-2: List of structures unable to fully access

Bridge No	Access Issues	Photographs
30	Unable to locate the entry or exit of the tunnel. Area is heavily vegetated and unable to determine how far the stream is below the road. Clearance of vegetation to an entry point and rope access is required.	

8.1.13 Reassessment of Posted Bridges

Of the bridges inspected during 2016/17, the following structures have posted weight and speed restrictions advertised on approaches: 11 and 131.

Figure 8-12: Bridges 11 and 131

Any further deterioration of bridge elements may have an impact on the overall capacity of the structure, conversely any remedial works may increase the capacity and thus negate the requirement of a posted weight and speed restriction.

It is recommended that bridges 11 and 131 be reassessed and posted annually to ensure they are able to carry the advertised loads. As outlined in Section 8.1.9, bridge 41 also requires re-evaluation of the posting to reflect the deteriorated timber deck condition.

8.1.14 Structures to be Removed from Bridge Inspection Inventory

NZTA S6: 2015: Bridges and Other Significant Highway Structures Inspection Policy, defines a bridge structure as including culverts and multiple culverts with a total waterway area greater than 3.4 square metres.

The following structures were identified as having a waterway area less than 3.4 square metres.

Table 8-3: List of structures cross sectional area <3.4m²

Bridge No	Photographs
180	

Bridge No	Photographs
294	

It is recommended that bridges 180 and 294 are removed from the bridge inspection programme and added to the road maintenance drainage database.

8.1.15 Install Nameplates

It was noted during the inspection that ID's or nameplates were not present on the structures included in the 2016/17 inventory. This may be in the form of a mountable nameplate on the guardrail or sight rail, stencilled ID on the abutments/beams or delineator complete with the bridge ID and name.

It is recommended that RDC install nameplates at each structure.

8.1.16 Unsealed Approaches

It was noted during the 2016/17 that four bridges have unsealed approaches, these are listed below. One of the main defects on bridges with unsealed approaches is deck abrasion, caused by loose gravels wearing away the surfacing of the bridge deck.

This is particularly problematic with concrete decks as it compromises the durability by reducing the cover depth to reinforcement steel. Furthermore, loose gravels abrade timber bridge decks more vigorously as the material strength of timber is less than that of concrete, resulting in a high replacement rate of timber decking components. In addition to deck abrasion, the retention of moisture on timber decks is also an issue where gravels and fines accumulate on and below the deck accelerating the decay and corrosion process, respectively.

In order to maintain these performance issues, the maintenance contractor is required to sweep bridge decks on a regular basis and remove deleterious material from around the bearing shelves and beams.

It is recommended that all unsealed approaches to bridges on the network be sealed 20m either side. This will minimise the cost of ongoing maintenance whilst protecting the remaining useful life of bridge decks and other affected components.

Table 8-4: List of 2016/17 bridges with unsealed approaches

Structure ID	Structure Name
111	BATLEYS NO2
149	KAWERA
252	PRIVATE BRIDGE
74	WEST ROAD

8.1.17 Material Testing of Armco and Helical Spun Culverts

Armco culvert structures generally raise design life issues due to their vulnerability to corrosion not only from the watercourse but also due to groundwater penetrating through the inside face of the culvert, within the structural fill zone. Typical failure mechanisms of Armco structures are sudden and unpredictable (non-ductile).

Several possible contributing factors for the reduced design life include, but are not limited to:

- Corrosion forming along the longitudinal bolted joint connection within the wet/dry zone. This in turn results in a breakdown of the corrosion protection system and subsequent loss of section forming a hinge below the longitudinal bolted connection. This failure mechanism occurred in 2014 at Junction culvert.
- Aggressive soil pH values penetrating through the compacted fill zone, on the outside face of the corrugated steel sections
- Poorly compacted, engineered granular fill layers during construction, integral to the overall strength of the culvert, resulting in differential settlement of soil and deformation of the culvert
- Non-granular, non-engineered soil substituted for the compacted, engineered fill layers during construction, resulting in differential settlement of soil and deformation of steel plates
- Abrasion of the invert of the culvert due to transportation of river gravels which removes the protective galvanised coating and ultimately leads to corrosion and compromising of structural integrity

The typical design life for these type of structures is 50. It is recommended that material testing of steel plates be carried out using Non-Destructive Testing (NDT), with destructive testing to calibrate results, on selected structures, based on remaining design life and condition assessments from previous inspection records. Dimensional checks on culverts and steel plates shall also be recorded and reported upon. This will provide council with a qualitative risk assessment and remaining useful life for their culvert stock, based on NDT, destructive testing results and extrapolated annual corrosion rates.

Results from such a testing programme can be used to manage a planned culvert replacement/refurbishment programme, optimising intervention by “sweating the asset” without compromising the safe operation of the network.

It is recommended that a material testing programme be developed to verify RUL of Armco and helical spun culverts across the network.

8.1.18 Expansion Joints Maintenance

It was noted during the 2016/17 bridge inspections that the condition of expansion joints were generally found to be moderate. These essential components serve as a barrier to debris and water ingress through deck joints.

Given the temperature extremes within RDC’s geographical spread, it is essential to select the most suitable type of expansion joint to accommodate thermal expansion/contraction, ranging from sub-zero to +30^{0}C temperature variance. In addition to this wind loading, traffic loading and seismic loading all contribute to the movement envelope between deck and abutments.

The prevention of water ingress at deck level is crucial in preserving the condition of the superstructure, substructure and associated bridge hardware. The cost of a durable expansion joint system is typically less than:

- Replacing perished bearings;

- Providing localised concrete repairs due to moisture retention in concrete, leading to carbonation and corrosion;
- Weld repairs to steel components due to failed corrosion protective systems, crevice corrosion, pitting and delamination
- Providing additional corrosion protection to steel before planned maintenance; and
- Erection of scaffolding or provision of specialist access platforms to undertake repairs
- Damage to substructures from 'locked-up' joints.

Common expansion joint types noted during the 2016/17 bridge inspections were compression seals, narrow sealant joints and mechanical steel plate joints. Typical failures in these expansion joints are attributed to:

- Compression set
- Adhesion failure
- Failure of expansion joint material
- Poor transition between substrate, especially if the substrate is irregular and gap width varies over the joint.
- Loose plates and/or missing nuts

Sealant joints can be suitable in the right conditions but are restricted to narrow gaps less than 25mm where there is very little or no movement and also requires precise installation to achieve durability.

It is recommended that council carry out an expansion joint replacement programme to limit asset depreciation across the network. Further investigations to identify suitable joint systems should be carried out as part of this.

8.1.19 Bridge Safety Barrier Assessments

The condition of road safety barriers on bridge approaches and bridge decks across the network is considered to be poor. A combination of sight rail timber fencing and safety barriers exists on the network. Non-compliant safety barrier components include end terminals, fishtails, blockouts, installation heights, insufficient length of need and damage to existing barrier components.

Figure 8-13: Bridge 26 – Non-compliant height and end terminals

A bridge safety barrier assessment across the network is recommended to ensure adequate steps are being taken to protect road users. Bridges can present a hazard to road users, as well as the features the structures are bridging e.g. waterways, railway lines, other roads etc.

The provision of adequate roadside barriers on bridge structures and on their approaches is part of maintaining a safe road system.

The aim/objective of a bridge safety barrier assessment is to:

- Assess condition and design standard for existing barriers.
- Confirm that the existing barrier has adequate approach length and provide the required containment.
- Assess required upgrade, maintenance or repairs.

Assessments will need to be prioritised, it is recommended that this is based upon:

- Accident history;
- Traffic volumes; and
- Lowest containment levels.

8.1.20 Seismic Screening

During the 2016/17 inspections it was noted that some bridges had narrow bearing shelves and lacked seismic hardware (linkages or shear keys).

NZTA's Manual for Seismic Screening of Bridges (SM110, Revision 2) provides guidance on the seismic screening processes. The outcomes of seismic screening includes a prioritised list of structures requiring detailed assessment, design and retrofitting of hardware to enable a suitable level of service during a seismic event.

It is recommended that RDC undertakes seismic screening of their bridge stock.

8.1.21 Scour Screening

It is recommended that council undertakes scour screening assessments of their bridge stock. This will allow for a prioritised list of at risk structures which may exhibit the following attributes:

- Specific scour issues identified during previous inspections
- Erosion or aggradation risks
- Highly exposed piles
- Structures sited on or immediately downstream of bends
- Bridges on braided or semi-braided rivers
- Bridges on alluvial fans

Large catchment areas and high water flows were observed across RDC's network during the sinpection programme. These attributes present a higher risk of scour, therefore the requirement to carry out scour screening allows for a prioritised forward physical works programme as well as better planning for emergency response to at risk structures following severe weather events.

NZTA's Bridge Scour Screening Report No. 196 provides a background to scour, guidance on screening and templates to carry out bridge scour screening inspections.

8.1.22 Revision of Bridge Inspection Programme

The current inspection programme has a number of inefficiencies which could be greatly reduced by splitting the network into discreet geographical areas thus reducing travel time, disbursement costs and associated expenses. During the 2016/17 inspection programme, bridge inspectors travelled the length and breadth of the RDC and MDC networks three times: once for generals, once for the principals which required specialist access and once for the balance of the principals.

The minimum frequency, as defined by NZTA S6: 2015 Bridges and other significant highway structures inspection policy (Appendix A), for general and principal inspections is two years and six years, respectively. In order to maximise efficiencies through logistics it is recommended to split the network into six geographic areas with similar numbers of structures in each. This would allow for 1/6 of the network to be inspected each year under the principal inspections and 1/3 under general inspections within a smaller geographical boundary.

9 Recommendations

Rangitikei District Council recommendations are:

1. Carry out routine and structural maintenance items listed in Appendices D & E.
2. The foundation detail of bridge 42 true right abutment be determined by referencing as-built drawings and a ground model of the underlying geology be prepared to predict future regression to enable a suitable embankment protection detail.
3. Bridge 302 be reassessed following severe weather events and re-inspected during low flow to fully inspect.
4. Bridge 150 be re-inspected during low flow to confirm the extent of scour downstream. Consideration may be given to increasing the size of this structure due to the risk of overtopping and breaching.
5. Bridge 9 be re-inspected following flooding for scour and flood damage.
6. Boulders be place on the true right, downstream side of bridge 170 to mitigate the risk of scour and collapse of gabion baskets.
7. A Special Inspection be undertaken for bridge 73 by first sourcing As-Built details to assess the structural details of the half joint and matched against the exiting photo evidence. A capacity check is required to assess the corbel capacity. The half joint should be cleaned and all vegetation and sediment removed.
8. A Special Inspection of bridge 22 be undertaken to waterblast loose material off the superstructure and pier substructure steel elements followed by a detailed inspection to quantify the required re-coating extent.
9. A Special Inspection of bridge 41 be undertaken to assess the extent of corrosion to the steel elements. At the same time as the special inspection the logistics and cost of reapplying Gold seal could be evaluated to assess whether it is feasible to install the coating system at the same time as the special inspection. The frames and hangars should also be assessed for an appropriate paint coating system. The existing posting should be revaluated once the results of the special inspection are complete and an axle limitation introduced to reflect the deteriorated condition of the deck.
10. The As-Built drawings for the bridge 2 be located and a posting or HPMV assessment undertaken to assess the bridge capacity. If the bridge capacity is found to be understrength there are options for strengthening including FRP and bonded steel plates.
11. Survey tabs be installed, for bridge 75, at the top of the pier and annual checks made to assess whether the pier has settled or moved with respect to a known datum.
12. Bridges 180 and 294 are removed from the bridge inspection programme and added to the road maintenance drainage database.
13. The gravel surfacing be permanently removed and both timber decks temporarily removed to facilitate re-inspection of the steel substrate, sub-structure, superstructure elements and timber decking.
14. Bridges 11 and 131 be reassessed and posted annually to ensure they are able to carry the advertised loads.
15. Bridges 180 and 294 are removed from the bridge inspection programme and added to the road maintenance drainage database.
16. RDC install nameplates at each structure.
17. All unsealed approaches to bridges on the network be sealed 20m either side. This will minimise the cost of ongoing maintenance whilst protecting the remaining useful life of bridge decks and other affected components.
18. A material testing programme be developed to verify RUL of Armco and helical spun culverts across the network.
19. RDC carry out an expansion joint replacement programme to limit asset depreciation across the network. Further investigations to identify suitable joint systems should be carried out as part of this.
20. A bridge safety barrier assessment across the network is recommended to ensure adequate steps are being taken to protect road users.
21. RDC undertakes seismic screening of their bridge stock.
22. RDC undertakes scour screening assessments of their bridge stock.

23. In order to maximise efficiencies through logistics it is recommended to split the network into six geographic areas with similar numbers of structures in each.
24. Continuation of “most credible threat” and “likelihoods” for the remaining bridge stock.
25. Continue to provide “snooper access” updates in RAMM for the remaining bridge stock.
26. Continuation of the RAMM inventory updating and verification.

Appendix A Appendix C of the Request for Tender Document (Bridges to be Inspected)

Manawatu District Council Bridge Inspection Programme

G=General
P=Principal

Roadname	Bridge	Bridge No	Description	2016/2017	2017/2018
AORANGI ROAD	81	S1A	UNDERPASS		P
APITI RD	293	S170	TWO LANE BRIDGE	G	
ARANUI ROAD	470	S2A	ONE LANED BRIDGE		G
ARAPATA ROAD	362	S3A	one lane bridge		G
AUPUTA ROAD	83	S4B	NAT DRIVE	P	
AUPUTA ROAD	82	S4A	TWIN CIRC		P
AWAHOU STH ROAD	30	S5A	BOX/ BRDGE/ HEADWALL	G	G
AWAHOU STH ROAD	31	S5B	ONE LANED BRIDGE	P	
AWAHOU STH ROAD	32	S5C	ARCH/ BOX	G	
AWAHURI FEILDING ROAD	363	S6A	TWO LANED BRIDGE	G	
AWAHURI FEILDING ROAD	365	S6C	TWO LANED BRIDGE	G	
BANKS ROAD	366	S7	BOX	G	
BEACONSFIELD VALLEY ROAD	367	S8	Two lane bridge	P	
BEACONSFIELD VALLEY ROAD	368	S9	TWIN CIRC	G	
BEACONSFIELD VALLEY ROAD	369	S10	One Lane Bridge	G	
BEATTIE ST	142	S401	TWO LANED BRIDGE	G	
BELL WEST ROAD	360	S11	ONE LANE BRIDGE		G
BONESS ROAD	359	S13	ONE LANE BRIDGE		G
BREWSTERS ROAD	357	S14	One Lane Bridge		G
CAMPBELLS ROAD	84	S18	TWIN CIRC		G
CAWOOD ROAD	556	S211A	BOX	G	
CEMETERY ROAD	351	S25B	TWO LANED BRIDGE		G
CHURCH ST	141	S402	TWO LANED BRIDGE	G	
CHURCHILL ROAD	51	S28A	ONE LANE BRIDGE	P	
CHURCHILL ROAD	52	S28B	ONE LANE BRIDGE	G	
COLYTON ROAD	337	S30	TWO LANED BRIDGE	P	
COLYTON ROAD	210	S35	BOX	G	
COLYTON ROAD	554	S30A	BOX		P
COLYTON ROAD	339	S33	BOX		P
COLYTON ROAD	209	S34	ONE LANED BRIDGE		P
COLYTON ROAD	212	S36			P
COLYTON ROAD		S30A	UNDERPASS	G	
COULTER LINE	#N/A	S37B	BOX	G	
COULTER LINE	373	S37	ONE LANED BRIDGE	G	
COULTER LINE	374	S38	ONE LANED BRIDGE	G	
COULTER LINE	584	S37A	BOX		P
COUPERS ROAD	428	S39A	BOX		G
CREAMERY ROAD	334	S42	BOX	G	
DENBIGH ST	140	S403	TWO LANED BRIDGE		P
DERBY ST	139	S404	TWO LANED BRIDGE	G	
DIXONS LINE	89	S44	BOX	G	
DIXONS LINE	88	S43	ONE LANED BRIDGE	G	
DIXONS LINE		S428	UNDERPASS	G	
DUKE ST	138	S405	TWO LANED BRIDGE	G	
FAGAN ROAD	207	S47	TWO LANED BRIDGE		G
FAIRFIELD ROAD	569	S47A			G
FINNIS ROAD	580	S48	ARCH	G	
FINNIS ROAD - URBAN	91	S48A	BOX	G	
FOREST ROAD	332	S48B	ONE LANED BRIDGE	G	
FORLONG ROAD	330	S49A	ONE LANE BRIDGE		P
GILLESPIES LINE	376	S51B	ARCH	G	
GODLEY		S56			G
GREEN ROAD	204	S58A	BOX		G
GREEN ROAD	205	S58B	BOX		P
GREENAWAY ROAD	329	S57	TWIN CIRC		G
GREY ST	135	S406A	BOX	G	
HALCOMBE ROAD	59	S59B	TWO LANE BRIDGE		P
HALCOMBE ROAD	60	S60	TWO LANE BRIDGE		G
HALCOMBE ROAD	53	S61	TWO LANE BRIDGE		G
HALCOMBE ROAD	5	S63	TWO LANE BRIDGE OVER RAILWAY LINES		P
HALCOMBE ROAD	6	S64	TWO LANE BRIDGE		G
HALCOMBE ROAD	575	S64A	TWO LANE BRIDGE		G
HALLS ROAD	416	S419	ONE LANED BRIDGE	P	
HAMILTON LINE	328	S66	ARCH		
HAMMOND ROAD	429	S66A	BOX		P
HAMMOND ROAD	570	S66B	BOX		P
HAYNES LINE	202	S67A	ONE LANED BRIDGE	G	
HIGHDEN ROAD	564	S68A	CIRC	G	G
HIGHDEN ROAD	228	S68	Armco Circ Arch	G	G
HIGHWAY 56	419	S416	BOX		G
HIGHWAY 56	417	S414	TWO LANED BRIDGE		G
HIGHWAY 56	418	S415	TWO LANED BRIDGE		P
HIGHWAY 56	427	S418	BOX		G
HIMATANGI BEACH ROAD	576	S69B	BOX		G
HIMATANGI BEACH ROAD	566	S69A	BOX		G
HOIHERE ROAD	226	S70	ONE LANED BRIDGE		G
HURST ROAD	578	S70A	ARMCO		G
JACKYTOWN	225	S71	BOX		G
JACKYTOWN	572	S71A	BOX		G

Manawatu District Council Bridge Inspection Programme

G=General
P=Principal

Roadname	Bridge	Bridge No	Description	2016/2017	2017/2018
JENS ROAD	380	S72	ONE LANE BRIDGE	G	
JUNCTION ROAD	200	S73A	ONE LANE BRIDGE		G
JUNCTION ROAD	199	S75	ONE LANED BRIDGE		G
KAIMATARAU ROAD	222	S77A	BOX		G
KAIMATARAU ROAD	430	S78	ONE LANE BRIDGE		P
KARERE ROAD	219	S83A	TWO LANED BRIDGE		G
KARERE ROAD	220	S83B	ARCH		P
KAREWAREWA ROAD	47	S85	ONE LANE BRIDGE	G	
KAREWAREWA ROAD	46	S84	BOX		P
KAWAKAWA ROAD	197	S86C	TWO LANED BRIDGE		G
KAWHATAU VALLEY ROAD	28	S87	ONE LANED BRIDGE	G	
KELLOW ROAD	559	S88A	BOX		G
KEW ROAD	327	S90	ONE LANE BRIDGE	G	
KIMBOLTON ROAD NORTH	192	S91	BOX	G	
KIMBOLTON ROAD NORTH	193	S92	BOX	G	
KIMBOLTON ROAD NORTH	194	S93	BOX	G	
LAGOON ROAD	98	S95	ONE LANE BRIDGE	G	
LAKE ROAD	568	S95A	BOX		G
LAKE ROAD		S95A (to be renumbered)	UNDERPASS	G	
LEEN ROAD	217	S96	ONE LANE BRIDGE		P
LETHBRIDGE ST	136	S406B	BOX		G
LEVETT LINE	597	S100C	UNDERPASS		P
LIMESTONE ROAD	56	S266A	NATURAL DRIVE	G	
LIMESTONE ROAD	57	S266B	ONE LANED BRIDGE		P
LOCKWOOD ROAD	583	S101A	BOX		G
LOCKWOOD ROAD	216	S101B			G
LOCKWOOD ROAD	598	S101C	UNDERPASS		P
LOCKWOOD ROAD	215	S101	TWO LANED BRIDGE		P
LOCKWOOD ROAD	213	S102	TWO LANED BRIDGE		G
LOCKWOOD ROAD	214	S103	TWO LANED BRIDBE		P
LONDONS FORD ROAD	322	S104	ONE LANE BRIDGE	G	
LOWER PAKIHIKURA ROAD	349	S107B	ONE LANE BRIDGE	P	
LOWER PAKIHIKURA ROAD	347	S106	ONE LANE BRIDGE		P
MAIN DRAIN ROAD	319	S108A	TWIN CIRC Armco	G	G
MAIN DRAIN ROAD	431	S108	BOX		G
MAIN DRAIN ROAD	599	S109A	UNDERPASS	P	
MAIN DRAIN ROAD	316	S110	TWO LANED BRIDGE		G
MAIN DRAIN ROAD	600	S111A	UNDERPASS	P	
MAIN SOUTH ROAD	13	S113	ONE LANE BRIDGE	G	
MAIN SOUTH ROAD	14	S114A	ONE LANE BRIDGE		G
MAKINO ROAD	312	S116A	BOX PORTAL		G
MAKINO ROAD	309	S120	TWO LANED BRIDGE		P
MAKINO ROAD	310	S121	TWO LANED BRIDGE		G
MAKINO ROAD	188	S125	TWIN_CIRC		G
MAKINO ROAD	184	S127	BOX		G
MAKOURA ROAD	78	S129B	ONE LANE BRIDGE	P	
MANCHESTER ST	128	S406C	TWO LANED BRIDGE	G	
MANGAHUIA ROAD	55	S130	ONE LANE BRIDGE	G	
MANGAMAKO ROAD	100	S133	ONE LANE BRIDGE	G	
MANGAMAKO ROAD	101	S134	ONE LANE BRIDGE	G	
MANGAMAKO ROAD	102	S135	ONE LANE BRIDGE	G	
MANGAMAKO ROAD	103	S136	ONE LANE BRIDGE	P	
MANGAMAKO ROAD	104	S137	ONE LANE BRIDGE	P	
MANGAMAKO ROAD	99	S132	ONE LANE BRIDGE		P
MANGAONE ROAD	183	S138	BOX		G
MANGAPAPA ROAD	381	S139	ONE LANE BRIDGE	G	
MANGAPAPA ROAD	382	S140	ONE LANE BRIDGE	G	
MANGAPIPI WEST ROAD	4	S141	Armco CIRC	G	
MANGARERE ROAD	346	S143	ONE LANE BRIDGE	G	
MANGARERE ROAD	41	S144	ONE LANE BRIDGE	P	
MANGARERE ROAD	42	S145	ONE LANE BRIDGE	P	
MANGARERE ROAD	344	S142A	SUSPENSION	G	P
MANGATIEKA ROAD	105	S147	TWIN_BOX	P	
MANGAWHATA ROAD	306	S149	TWO LANED BRIDGE		P
MANGAWHATA ROAD	307	S150	ARMCO Pipe Arch	G	G
MANGOIRA ROAD	23	S152	TWIN_BOX	G	
MANGOIRA ROAD	22	S151	ONE LANED BRIDGE		P
MCBETH ROAD	305	S154	BRIDGE	G	
MCKAY ROAD	182	S155B	two lane bridge		P
MCKENZIE SETTLEMENT	601	S426	UNDERPASS		P
MILL	304	S156	ARCH		G
MILNER ROAD	571	S156A			G
MINGAROA ROAD	#N/A	S158A			G
MINGAROA ROAD	302	S159	TWIN ARMCO Arch	G	G
MINGAROA ROAD	553	S160	BOX		G
MINGAROA ROAD	585	S160A	BOX		G
NANNESTAD ROAD	106	S161	TWO LANED BRIDGE	G	
NEWBURY LINE	296	S163	BOX		P
NORTH ST	129	S407	TWO LANED BRIDGE	G	

Manawatu District Council Bridge Inspection Programme

G=General
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Roadname	Bridge	Bridge No	Description	2016/2017	2017/2018
OMANUKA	602	S425	UNDERPASS	G	
OROUA VALLEY ROAD	291	S171	TWIN CIRC	G	
OROUA VALLEY ROAD	565	S171A	BOX	G	
OTARA ROAD	384	S172	ONE LANE BRIDGE	G	
OTARA ROAD	387	S173C	ONE LANED BRIDGE SUSPENSION		P
PARARORANGI ROAD	180	S175	ONE LANE BRIDGE		P
PEEP-O-DAY ROAD	27	S176	One lane bridge	G	
PENNY ROAD	178	S177	ARCH BOX		G
PENNY ROAD	179	S178	ARCH BOX		G
PENNY ROAD	558	S178A	BOX		G
PLEASANTS ROAD	177	S181	One lane bridge		P
POHANGINA ROAD	408	S213E	BOX	G	
POHANGINA ROAD	120	S213F	ONE LANE BRIDGE	P	
POHANGINA ROAD	122	S214	ONE LANE BRIDGE	P	
POHANGINA ROAD	123	S215	BOX/HEADWALL	G	
POHANGINA VALLEY EAST ROAD	108	S185	TWO LANED BRIDGE	G	
POHANGINA VALLEY EAST ROAD	112	S189	TWO LANED BRIDGE	G	
POHANGINA VALLEY EAST ROAD	116	S193	TWO LANED BRIDGE	G	
POHANGINA VALLEY EAST ROAD	#N/A	S193A	BOX	G	
POHANGINA VALLEY EAST ROAD	117	S194	Armco CIRC	G	G
POHANGINA VALLEY EAST ROAD	499	S194A	BOX	G	
POHANGINA VALLEY EAST ROAD	118	S195	BRIDGE/BOX	G	
POHANGINA VALLEY EAST ROAD	119	S196	TWO LANED BRIDGE	P	
POHANGINA VALLEY EAST ROAD	390	S199	TWO LANED BRIDGE	P	
POHANGINA VALLEY EAST ROAD	392	S201	TWO LANED BRIDGE	P	
POHANGINA VALLEY EAST ROAD	393	S202	ONE LANE BRIDGE	P	
POHANGINA VALLEY EAST ROAD	394	S203	ONE LANE BRIDGE	G	
POHANGINA VALLEY EAST ROAD	395	S204	CIRC/ARCH BOX	G	
POHANGINA VALLEY EAST ROAD	396	S205	ONE LANE BRIDGE	P	
POHANGINA VALLEY EAST ROAD	10	S207	ONE LANE BRIDGE	G	
POHANGINA VALLEY EAST ROAD	400	S209	ONE LANE BRIDGE	P	
POHANGINA VALLEY EAST ROAD	401	S210	ONE LANE BRIDGE	P	
POHANGINA VALLEY EAST ROAD	402	S211	ONE LANE BRIDGE	G	
POHANGINA VALLEY EAST ROAD	111	S188	TWO LANED BRIDGE		P
POHANGINA VALLEY EAST ROAD	389	S198	TWO LANED BRIDGE		P
PUKIPUKI ROAD	552	S216	BOX		G
RATA ST	134	S408B	TWO LANED BRIDGE	G	
REID LINE	171	S226B	BOX	G	
REID LINE	169	S228	ONE LANED BRIDGE	G	
REID LINE	567	S229D	BOX	P	
REID LINE WEST	409	S230	BOX		P
REID LINE WEST	410	S231	TWO LANED BRIDGE		G
RESERVE ROAD	#N/A	S233A	BOX		G
RESERVE ROAD		S233B			G
REU REU ROAD	164	S235	ONE LANED BRIDGE	G	
REU REU ROAD	162	S237	ONE LANED BRIDGE	G	
REU REU ROAD	163	S234	ONE LANED BRIDGE		P
RONGOTEA ROAD	#N/A	S241C			G
RONGOTEA ROAD	275	S241A	Armco TWIN ARCH	G	G
RONGOTEA ROAD	276	S241B	BOX PORTAL		G
RONGOTEA ROAD	277	S242	TWO LANED BRIDGE		G
RONGOTEA ROAD	272	S243B	TWO LANED BRIDGE		P
RONGOTEA ROAD	274	S243D	ARCH / BOX		G
RONGOTEA ROAD	252	S243E	BOX		G
RONGOTEA ROAD	254	S243G	TWO LANED BRIDGE		G
RONGOTEA ROAD	253	S243F	BOX / CIRC		P
RONGOTEA ROAD	251	S244	ARCH / BOX		G
RONGOTEA ROAD	249	S245A	TWO LANED BRIDGE		G
ROWE RD	555	S246B	BOX		G
ROWE RD	433	S246A	BOX		G
ROWE RD	248	S246	TWIN CIRC		G
RUAHINE ROAD	12	S248	BOX	G	
RUAHINE ROAD	61	S249A	ONE LANED BRIDGE	G	
RUAHINE ROAD	434	S249C	BOX	P	
RUAHINE ROAD	44	S250B	ONE LANED BRIDGE	G	P
SADDLE ROAD	412	S251	TWO LANED BRIDGE	P	
SANDON RD	133	S409A	BOX/ CIRC		G
SANDON ROAD	278	S252	TWO LANED BRIDGE		G
SANSONS ROAD	246	S253A	BOX		G
SANSONS ROAD	247	S253B	BOX		G
SOUTH ST	132	S409B	TWO LANED BRIDGE	G	
SPEEDY ROAD	157	S258	TWIN BOX		G
SPEEDY ROAD	158	S259	ONE LANED BRIDGE		G
SPUR ROAD	270	S260	ONE LANED BRIDGE	G	
STANWAY ROAD	154	S262B	TWO LANED BRIDGE		P
STANWAY ROAD	155	S263	ONE LANED BRIDGE		G
STEWART ROAD	152	S264	BOX		G
STEWART ROAD	557	S264A	BOX		G
TAIKOREA ROAD	551	S267A	BOX		G

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G=General
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Roadname	Bridge	Bridge No	Description	2016/2017	2017/2018
TAIKOREA ROAD	577	S267B	BOX		G
TAIKOREA ROAD		S267C	UNDERPASS		G
TAIKOREA ROAD	242	S267	ONE LANED BRIDGE		P
TAIPO ROAD	240	S268A	CIRC ARMCO	G	G
TAIPO ROAD	241	S268B	ARCH BOX		P
TANGIMOANA ROAD	239	S269	TWO LANED BRIDGE		G
TANGIMOANA ROAD	441	S270	BOX		G
TAONUI	268	S275B	TRIPLE CIRC	G	
TAONUI ROAD	561	S273	BOX		G
TAONUI ROAD	266	S274	TWO LANED BRIDGE		G
TAONUI ROAD	563	S275	BOX		G
TAONUI ROAD	267	S275A	ONE LANED BRIDGE		G
TAYLOR ROAD	236	S276A	ONE LANED BRIDGE		P
TAYLOR ROAD	238	S277	ONE LANED BRIDGE		P
TAYLOR ROAD	437	S276	BOX		G
TE RAKEHOU ROAD	259	S286	ONE LANED BRIDGE		G
TERRACE ROAD	256	S287	ONE LANED BRIDGE	P	
TERRACE ROAD	257	S288A	CIRC	G	
TERRACE ROAD	258	S288B	ONE LANED BRIDGE	P	
TOKORANGI ROAD	151	S290	TWO LANED BRIDGE		P
TOKORANGI ROAD	145	S291	TWO LANED BRIDGE		P
TOKORANGI ROAD	146	S292	ONE LANED BRIDGE		P
TOKORANGI ROAD	147	S293	ONE AND HALF LANED BRIDGE		G
TOKORANGI ROAD	148	S294	TWO LANED BRIDGE		G
TUNIPO ROAD	19	S420	BOX/HEADWALL	G	
ULYSSES ROAD	579	S298A	BOX	G	
UMUTOI NORTH ROAD	415	S299B	ONE LANED BRIDGE	P	
UPPER PAKIHIKURA ROAD	299	S302	TWIN CIRC	G	G
VALLEY ROAD	64	S308	TWO LANED BRIDGE	G	
WAITOHI ROAD	229	S314A			G
WAITOHI ROAD	231	S315A			G
WARWICK ST	125	S410	TWO LANED BRIDGE		P
WATERSHED ROAD	455	S326	BOX	G	
WAUGHS ROAD	33	S318	TWIN CIRC		G
WESTWIND PLACE	127	S412	BOX	G	
WILLOUGHBY STREET	574	S289B	CIRC/BOX		G
WILSON ROAD	143	S324	TRIPLE CIRC		G
WILSON ROAD	144	S325	TRIPLE CIRC		G
WILSON ROAD	#N/A	S325A			G
WILSON ROAD	#N/A	S324A			G
CAMPION ROAD		S272	UNDERPASS		P
ALAMDALE RESERVE			Pedestrian		P
MAKINO PARK			Pedestrian		P

Rangitikei District Council Bridge Inspection Programme

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ROADNAME	BRIDGE No	BRIDGE NAME	2016/17	2017/18
Brandon Hall Road	1	Brandon Hall	G	
Makirikiri Road	2	Crofton	P	
Mangahoe Road	3	Mc Donalds	G	
Calico Line	4	Calico Line		G
Onepuhi Road	5	Porewa		G
Silverhope Road	6	Silverhope	G	
Aldworth Road	7	Aldworth No3		G
Aldworth Road	8	Aldworth No2	G	G
Murimotu Road	9	Kaikarangi	G	
Pukekoa Road	10	Husbands		G
Scotts Road	11	Scotts	G	G
Toe Toe Road	12	Toe Toe		G
Gorge Road	14	Knights	P	
Papakai Road	16	Papakai	G	
Rongoiti Road	19	School	P	
Omatane South Road	20	Totmans	G	
Omatane South Road	21	O`Keefes	G	
Gorge Road	22	Omatane	P	
Torere Road	23	Taoroa	P	
Mokai Road	24	Mokai	G	
Moawhango Valley Road	25	Collins	P	
Otuarei Road	26	Gordon	G	
Pungatawa Road	27	Pungatawa	P	
Te Moehau Road	28	Moawhango		P
Taihape-Napier Road 1	29	Whittles	G	G
Taihape-Napier Road 1	30	Hangmans	P	
Omatane North Road	31	Catchment Board	P	
Turakina Beach Road	32	Koitiata		G
Makirikiri Road	33	Schultz		G
Turakina Beach Road	34	Camerons		G
Mangahoe Road	36	Galpins	G	
Turakina Valley Road 2	37	Mangara		G
Mangatipona Road	38	Churnsides	G	
Mangahoe Road	39	Simpsons Road		G
Turakina Valley Road 2	41	Public Trust (suspension)	P	G
Turakina Valley Road 3	42	Puketoi	G	
Ongo Road	43	Blundells	G	
Turakina Valley Road 3	44	Hautawa	P	
Turakina Valley Road 3	45	Concrete Ford		G
Pohonui Road	46	Pukeroa	G	
Wairepu West Road	47	O`Callaghans		G
Wairepu West Road	48	Weekes	P	
Tiriraukawa Road	49	Mangaone		G
Pukemapou Road	50	Hodders	P	
Whaka Road	51	Hintz	P	
Whaka Road	52	Mickleson	P	
Turakina Valley Road 3	53	Lilburn	G	
Bald Hill Road	54	Bald Hill	P	
Turakina Valley Road 4	55	Colliers		P
Kaimatawi Road	56	Mc Donnell	P	
Waiaruhe Road	57	Bells		P
Koukoupo Road	59	Koukoupo	P	
Te Kapua Road	60	Greens	P	
Manui Road	61	Healeys	P	
Taihape-Napier Road 2	62	Taruarau	P	
Potaka Road	70	Mc Kinnons	G	
Kauangaroa Road	73	Kauangaroa (Bdy)	P	
Mangaohane Road	74	Mangaohane		G
Taihape-Napier Road 1	75	Springvale	P	

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ROADNAME	BRIDGE No	BRIDGE NAME	2016/17	2017/18
Parewanui Road	77	Paulins	G	
Wellington Road	78	Curls Bridge	P	
Somersal Lane	79	Somersal	G	
Galpins Road	80	Galpins	G	
Porewa Road	81	Maungaraupi No.1	P	G
Te Hou Hou Road	82	Rata		G
Agnews Road	90	Agnews	G	
West Road	91	West Road	G	
Spooners Hill Road	93	Taihape		G
Mokai Road	95	Sherriffs	P	
Trickers Road	97	Trickers	G	
Turakina Valley Road 3	99	Braemore	G	
Turakina Valley Road 2	100	Sutherlands	G	G
Jeffersons Line	101	Maungaraupi	P	
Turakina Valley Road 3	102	Otiwhiti	G	
Waikakahi Road	103	Pokaka	P	G
Burridges Road	104	Burridges	P	
Colenso Road (Makino)	105	Colenso	P	G
Waikakahi Road	107	Birds	G	
Taihape-Napier Road 1	108	Woolshed	G	P
Taihape-Napier Road 1	108A	Whittles		G
Taihape-Napier Road 2	109	Kakakino	G	P
Hereford Street Marton	110	Hereford Street		G
Pohonui Road	111	Mataiaponga		P
Turakina Valley Road 4	112	Mc Hardies		G
Turakina Valley Road 2	113	Playles		G
Koeke Road	114	Lowries		P
Abattoir Road	115	Jacobsens	P	
Okirae Road	116	Bairds		G
Dalvey Road	117	Dalvey		G
Rangitane Road	118	Twin No 1	P	
Upper Kawhatau Road	119	Twin No. 2	P	
Gorge Road	121	Dry Gorge		P
Omatane North Road	122	Omatane North	P	
Owhakura Road	123	Baines	P	
Kaimatawi Road	124	Kaimatawi	G	
Koeke Road	125	Mc Carthys	P	
Mangahoe Road	126	Forrests Gate	G	
Te Moehau Road	127	Chrystalls	P	
Moawhango Valley Road	128	Duncans		G
Bruce Road	129	Omaha	G	
Turakina Valley Road 1	130	Waimutu	G	
Porewa Road	131	Maungaraupi No.2	G	G
Parewanui Road	132	Amons	G	
Rangitane Road	133	Rangitane	P	
Colenso Road (Makino)	134	Makino No1	P	
Mokai Road	135	Makino N02	P	
Mokai Road	136	Broughs	G	P
Turakina Valley Road 4	137	Rangiwai	P	
Makokomiko West Road	138	Batleys No 1		G
Makokomiko West Road	139	Batleys No 2	G	
Ruanui Road	140	Mataroa Over-Bridge		G
Ruanui Road	141	Ruanui Over-Bridge		P
Ruatangata Road	142	Ruatangata O-Bridge		G
Wanganui Road	143	Bonny Glen O-Bridge		G
Gibbs Road	145	O` Taihape		P
Mangahoe Road	146	Forrest	G	
Aldworth Road	147	Aldworth No 1	G	G
Koukoupo Road	149	Koukoupo No 2		G

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ROADNAME	BRIDGE No	BRIDGE NAME	2016/17	2017/18
Te Kapua Road	150	Te Kapua	G	G
Santoft Road	151	Santoft No 1	G	
Santoft Road	152	Santoft No 2	G	
Mataroa Road	153	Bradleys		P
Leedstown Road	154	Leedstown		G
Turakina Valley Road 2	155	Whareroa 1/2 Bridge	G	
Pohonui Road	156	Taheke		P
Kakariki Road (Taihape)	157	Williams		P
Raumaewa Road	160	Raumaewa		P
Robbie Smith Road	161	Robbie Smiths		P
Gleeson Road	164	Ben Nevis		G
Whangaehu Beach Road	165	Connors	G	G
Turakina Valley Road 2	166	Mc Leays	G	G
Wellington Road	168	Curls Floodway Culvert	G	
Union Line	169	Union Line	G	
Wellington Road	170	Wellington Road No.2	G	
Wales Line	171	Whales Line No.1	G	
Wales Line	172	Whales Line No.2	G	
Wales Line	173	Whales Line No.3	G	
Santoft Road	174	Santoft Road	G	
Williamson Line	175	Williamson Line	G	
Union Line	176	Union Line No.1		G
Makirikiri Road	177	Makirikiri Road No.1	G	
Wellington Road	178	Wellington Rd No1	G	
Pukepapa Road	179	Pukepapa Road		G
Makirikiri Road	180	Makirikiri Road No.2	G	
Makirikiri Road	181	Makirikiri Road No.3		G
Onepuhi Road	182	Onepuhi No.1		P
Calico Line	183	Calico Line		P
Union Road	186	Union Line No.3		P
Bruce Road	187	Bruce		G
Bruce Road	188	Briants	G	G
Turakina Valley Road 2	189	Turakina Road No.1		G
Ruatangata Road	190	Ruatangata		G
Turakina Valley Road 2	191	Turakina Valley		G
Jeffersons Line	192	Jeffersons Line		P
Leedstown Road	193	Leedstown No.2		P
Te Hou Hou Road	194	Te Hou Hou		P
Putorino Road	195	Putorino	G	G
Rangitira Road	196	Rangitira No.1	G	
Rangitira Road	197	Rangitira No.2	G	
Warrens Road Ext	198	Warrens		G
Ngaruru Road	200	Ngaruru		G
Main Street Hunterville	202	Main Street Hunterville	G	
High St Hunterville	203	High St Hunterville		P
Kotukutuku Road	205	Kotukutku Hunterville		G
Turakina Valley Road 3	206	Whakapuni		G
Turakina Valley Road 3	208	Nations		G
Micklesons Road	214	Micklesons	G	P
Dalgettys Road	215	Dalgety's		G
Gorge Road	216	Gorge		P
Turakina Valley Road 3	219	Waterfall		P
Te Kapua Road	222	Te Kapua R-O-Bridge	G	
Terrace Road	223	Terrarce Rd R-O-Bridge	P	
Moawhango Road	225	Moawhango Vly		G
Potaka Road	227	Potaka Hunterville		P
Ngaruru Road	230	Ngaruru No.2		G
Taheke Road	231	Taheke - Smalls		G
Turakina Valley Road 1	232		G	

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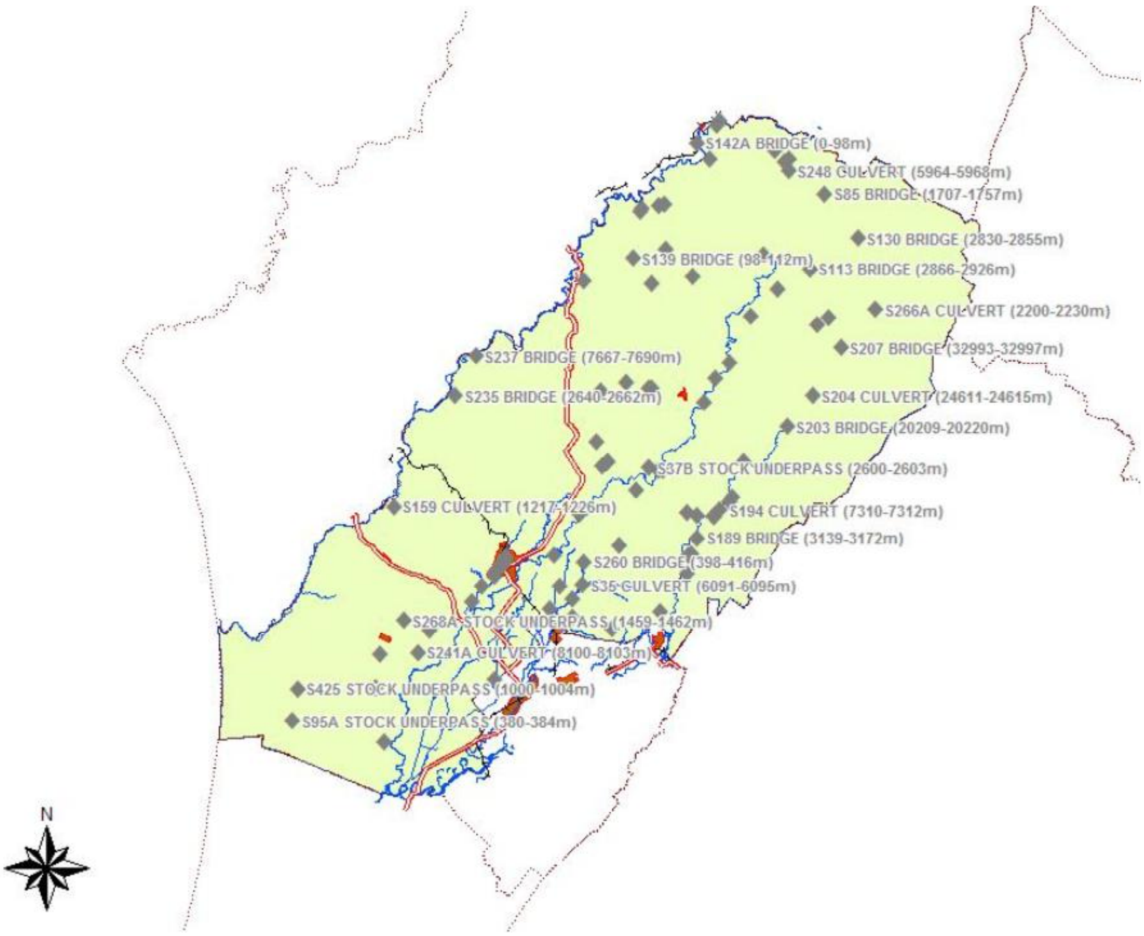
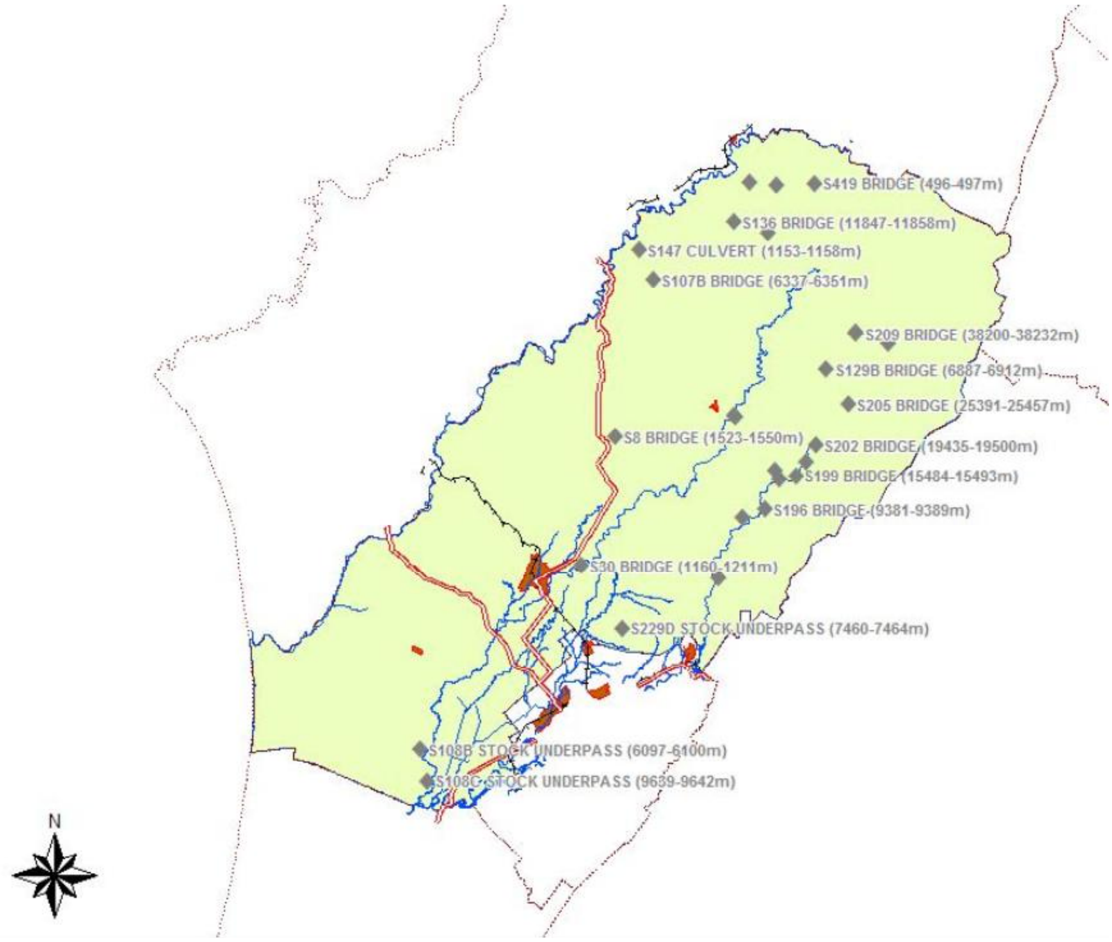
ROADNAME	BRIDGE No	BRIDGE NAME	2016/17	2017/18
Turakina Valley Road 3	307	Turakina - Omaha		G
Turakina Valley Road 4 (Papanui Road)	235	Papanui		G
Paraekaretu Street	236	Paraekaretu Street		P
Moawhango Valley Road	237	Anstis	G	P
Kaka Road	238	Kaka Road R-O-Bridge	G	
Kiwi Road	239	Kiwi Road R-O-Bridge	G	
Maruamru Street	240	Marumaru		G
Kensington Road	242	Kenisngton No. 1		G
Canteen Street	243	Canteen		G
Hammond Street Walkway	244	Hammond Foot Bridge		G
Station Road	246	Station		G
Kensington Road	247	Kensington No. 2		G
Hawkestone Road	248			G
Makuhou Road	249			G
Matawhero Road	253			G
Wanganui Road	254		G	
Galpins Road	256	Moa Creek	G	G
Turakina Valley Road 4	257	Colliers Junction		P
Taihape-Napier Road 1	258			G
Turakina Valley Road 2	259			G
Kawhatau Road	260			G
Kawhatau Road	261			G
Kawhatau Road	262	Dalzell's		G
Kawhatau Road	263		G	
Mangakukere Road	264			G
Auputa Road	265			P
Kawera Road	266		G	
Ruahine Road	268	Mangaweka No.2		P
Okaka Road	269	Okaka		G
Mataroa Road	270	Mataroa		P
Turakina Valley Road 3	271	(Cul 106)		G
Leedstown Road	272			G
Potaka Street Hunterville	273			G
Whangaehu Beach Road	274	Connors		G
Wairepu East Road	275			P
Kawhatau Road	276	Powerhouse (bdy)		P
Manui Road	277	Manui		G
Turakina Valley Road 2	281			G
Station Road (Marton)	282			G
Wellington Road	283			G
Turakina Valley Road 4	317	Turakina Valley Road	G	G
Lower Beaven Street	318	Lower Beaven Street		
Silverhope Bush Road	319		G	
Turakina Valley Road 4	302		G	G
Turakina Valley Road 3	321	Poplar and Gate (culvert 64)		G
Whangaehu Beach Road	274A		G	
Whangaehu Beach Road	274B		G	
Tutaenui Road	324A		G	
Taihape-Napier Road 1	TBC	Springvale Suspension Bridge	G	
Bryces Line	322		G	
Bryces Line	323		G	
Taihape-Napier Road 2	300		G	
Ruatangata Road	142A		G	
Jeffersons Line	101A		G	

Appendix B Bridge Location Plans for MDC and RDC

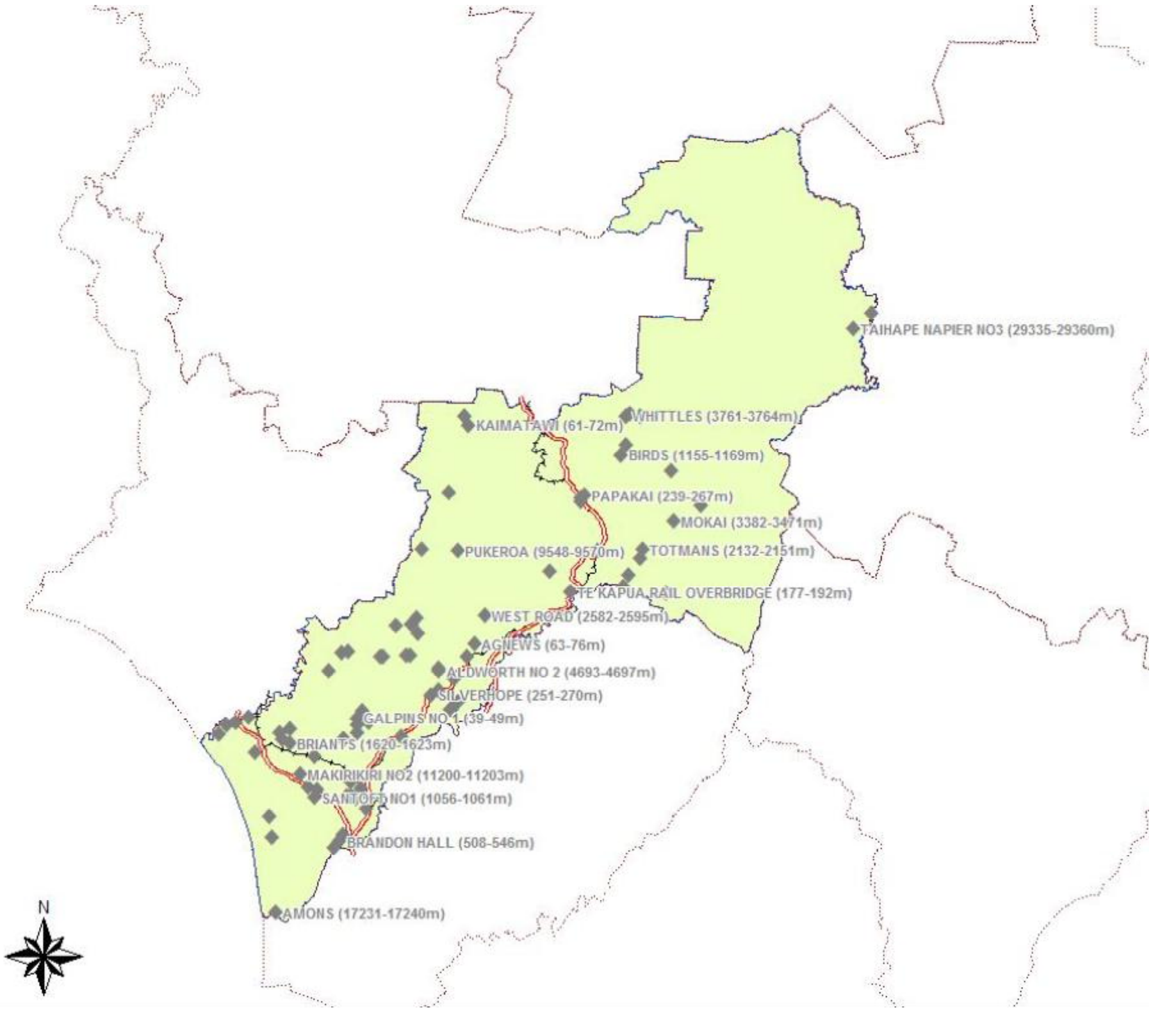
2016/17 MDC General Bridge Inspections



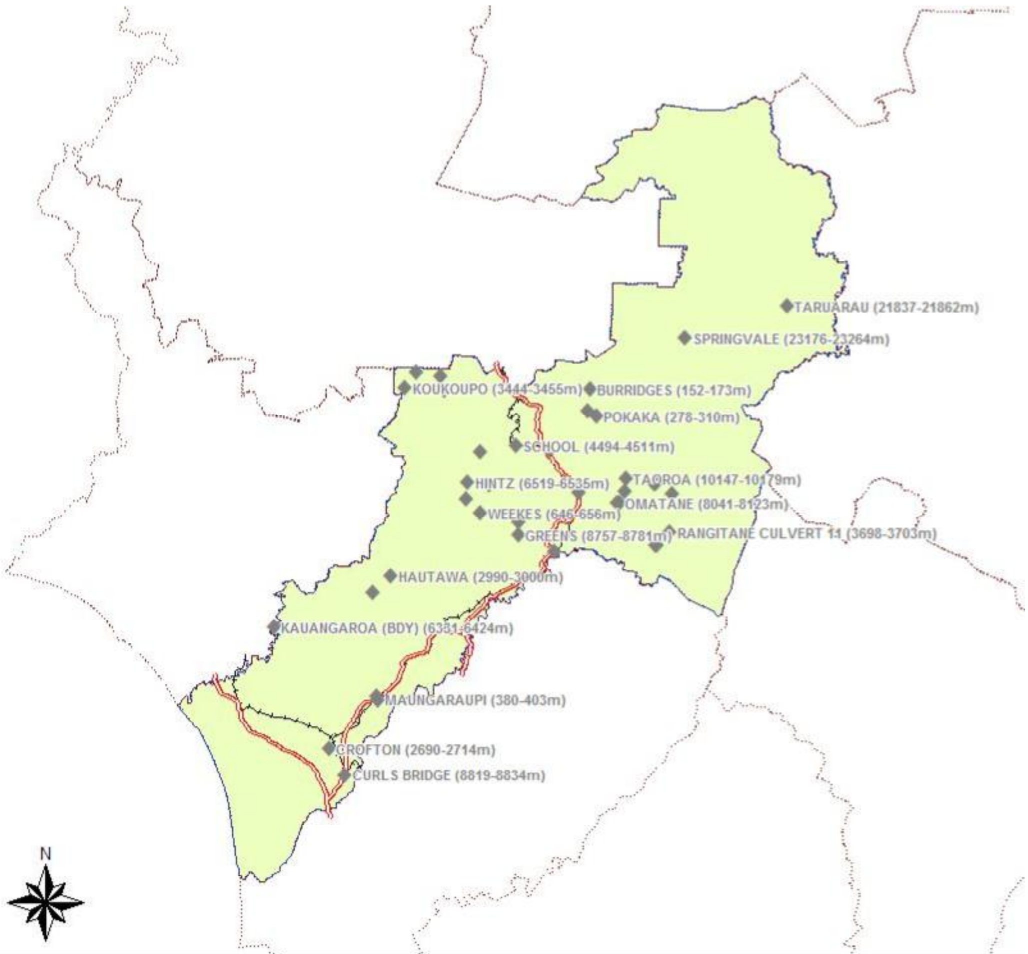
2016/17 MDC Principal Bridge Inspections



2016/17 RDC General Bridge Inspections



2016/17 RDC Principal Bridge Inspections



Appendix C NZTA S6: 2015 Bridges & Other Significant Highway Structures Inspection Policy

Bridges and other significant highway structures inspection policy

1. Introduction

This policy document sets out the requirements for the inspection of bridges and other significant highway structures on the state highway network. Note that tunnels are covered by NZTA S8 *Tunnels management and inspection policy*(1).

2. Definition of structures

"Bridge" shall include all bridge structures which directly support state highway traffic, including culverts and multiple culverts with a total waterway area greater than 3.4m², critical small culverts with a total waterway area less than or equal to 3.4m² and all stock underpasses and pedestrian subways.

"Other significant highway structures" shall include highway structures within the state highway corridor meeting any of the following criteria:

- highway structures where public safety or critical network function is likely to be significantly affected in the event of failure, irrespective of ownership
- highway structures of high value
- highway structures requiring specialised engineering inspection.

Examples of structures that may meet the above criteria:

- retaining walls >1.5m high
- noise walls
- footbridges/cycle bridges
- redundant bridges (accessible)
- large drainage structures
- large cantilever and gantry signs/signals
- bridges over or adjacent to state highways
- slope protection works
- critical river protection works
- major coastal protection works
- critical small culverts
- large stabilised slopes/batters
- large lighting masts
- CCTV masts

An inventory of bridges and an inventory of other significant highway structures shall be maintained by the Bridge Inspection Engineer. Any changes to the inventories shall be agreed with the Principal (the NZ Transport Agency's Project Manager or their agent).

3. Standard of structure inspection

The standard to which inspections shall be carried out is defined in the publication *Inspection manual for highway structures*(2). This manual shall be adopted for highway structure inspections except as modified by this policy. Where there may be conflict between the manual and policy, the policy shall take precedence. All references in the manual to "Supervising Engineer" and "Inspector" shall be read as "Bridge Inspection Engineer" and "Bridge Inspector" respectively.

4. Responsibilities for structure inspection

4.1 Routine surveillance inspections

These shall be carried out by staff who are competent to identify and report on superficial faults that may occur. They shall be personnel with either five years of experience in the maintenance of highway structures or with relevant qualifications.

4.2 General, principal and special inspections

These shall be carried out under the control of the Bridge Inspection Engineer.

4.2.1 For each of the NZ Transport Agency's state highway bridges and other structures management contracts an individual shall be designated the Bridge Inspection Engineer. This engineer shall have experience of supervision of bridge and other significant highway structure construction, inspection and maintenance, and shall be able to interpret condition in terms of structural action. As a minimum, the Bridge Inspection Engineer shall be a Chartered Professional Engineer with at least 10 years of relevant experience.

The Bridge Inspection Engineer shall:

(a) maintain overall management and technical supervision of the structure inspection and maintenance programme for those highway structures scheduled by the Principal

(b) take responsibility for the technical competence of all personnel involved in inspections

(c) take responsibility for the structural safety of all highway structures advised by the Principal

(d) take responsibility for consulting with specialist staff when necessary

(e) ensure that the schedule of highway structures and the inspection requirements are appropriate and comply with this policy

(f) either review or appoint a Design Engineer to review all inspection reports

(g) approve all inspection reports

(h) undertake an on-site review and reconciliation of at least three inspection reports representative of the types of inspections the inspector is carrying out (but no less than 2%) for each inspector annually unless agreed otherwise with the NZ Transport Agency National Structures Manager.

4.2.2 Other personnel who shall undertake inspection are defined as follows:

(a) Bridge Inspector

A Bridge Inspector shall be experienced in construction, inspection and maintenance of bridges and other significant highway structures. A Bridge Inspector may be either a professional engineer or a person who, from extensive practical experience, is competent to judge the condition of highway structures. A Bridge Inspector shall have a minimum of five years of relevant inspection experience, and/or have been assessed through audit by the Bridge Inspection Engineer of actual inspections, as having commensurate knowledge and skills.

Bridge Inspectors must also have completed a NZ Transport Agency endorsed inspection training course unless agreed otherwise by the National Structures Manager.

(b) Specialist staff

(i) Design Engineer

A Design Engineer who is responsible for inspection shall be experienced in the design of bridges and other significant highway structures, and shall be able to interpret observations in terms of structural action.

(ii) Other specialist staff

In any situation where identification of faults in the particular material or structure is considered by the Bridge Inspection Engineer to be outside the competence of the normal inspection staff, a specialist shall be engaged to advise them. Specialist staff shall be used for the following situations, but shall not be limited to them:

- highway structures showing significant deterioration of structural steel members and fixings (cracking, corrosion, distortion), or significant breakdown of protective coatings
- highway structures showing significant decay of timber members
- highway structures showing alkali/aggregate reaction, spalling of concrete, corrosion of concrete reinforcement, or other concrete defects.

5. Categories and frequencies of inspection

The various categories of inspection and the frequency with which they are to be undertaken for bridges and other significant highway structures are listed in tables 1 and 2 respectively in appendix A, and described below. Where specific personnel are referred to, they shall be as defined in section 4. For the purposes of scheduling inspections, general inspections shall substitute for routine surveillance inspections and principal inspections shall substitute for general inspections.

The frequency of general and principal inspections for certain types of other significant highway structures detailed in table 2 may be reduced. The frequency of these inspections shall be determined through risk analysis and agreed between the Bridge Inspection Engineer and the Principal. Suitable guidance for determining which structures may have reduced inspection frequencies may be obtained from IAN 171 *Risk based principal inspection intervals*[3].

The inspection frequency for the other significant highway structures detailed in table 2 may not be reduced if they display any of the following attributes:

- located in a severe (marine) environment
- at moderate/high risk of scour
- at moderate/high risk of flooding
- structure is substandard under load assessment
- condition is poor or unknown
- signs of concrete deterioration (eg alkali aggregate reaction)
- collapse of the structure would affect a railway
- noise walls that are subject to fatigue.

5.1 Routine surveillance inspection

Routine surveillance inspections shall be carried out in accordance with the relevant requirements of the *Inspection manual for highway structures*[2], *State highway maintenance contract proforma manual* (SM032)[4] and *State highway professional services contract proforma manual* (SM030)[5]. The inspections shall identify any obvious defect which may affect the safety of highway users or anything else needing urgent attention, such as those items listed below:

- impact damage from vehicles, especially to structural elements, guardrails and handrails
- build-up of flood debris
- adequacy of signs and road marking
- erosion damage
- deck drainage function
- approach settlement and condition of road and deck surfacing
- expansion joint function.

Defects shall be reported immediately to the Principal, with a copy to the Bridge Inspection Engineer.

5.2 General inspection

The procedures required are described in *Inspection manual for highway structures*[2]. During a general inspection, personnel shall verify that the descriptive data recorded for each highway structure in the NZ Transport Agency's database system is correct, or note any necessary changes.

For highway structures which have no history of maintenance problems and are considered by the Bridge Inspection Engineer to present no specific difficulty, the inspection may be carried out by a Bridge Inspector.

Where a need is identified by the Bridge Inspection Engineer, the inspection shall be carried out by a Bridge Inspector and/or a Design Engineer or other specialist staff as the Bridge Inspection Engineer may direct.

5.3 Principal inspection

The procedures described in *Inspection manual for highway structures*[2] shall be followed. The inspection shall be carried out at close quarters of all external surfaces and features, and where appropriate, all internal surfaces and underwater features.

Where specific access requirements or features requiring specific or unusual inspection or specialist staff are identified, they shall be recorded.

Where a need is identified by the Bridge Inspection Engineer, the inspection shall be carried out by a Bridge Inspector and/or a Design Engineer or other specialist staff as the Bridge Inspection Engineer may direct.

5.4 Special inspection

The procedures required are described in *Inspection manual for highway structures*[2]. Special inspections involve particular types of structure or particular circumstances. The Bridge Inspection Engineer shall identify structures requiring special inspections and maintain a schedule of structures requiring special inspections which defines the specific inspection requirements including frequency.

5.4.1 Posted bridge inspection

This is for posted bridges, and for those which have been identified as able to operate without a posted restriction, but at a stress level or load factor other than the standard values specified in the *Bridge manual*[6]. It shall be undertaken at a frequency to be determined by the Bridge Inspection Engineer.

The inspection shall include close observation of locations likely to sustain damage under traffic overload. Any deterioration in such locations shall be noted.

The inspection shall be carried out by a Bridge Inspector and/or such other specialist staff as the Bridge Inspection Engineer may direct.

5.4.2 Bailey bridge inspection

This is in addition to the general inspection, and shall be carried out annually by the Bailey bridge contractor.

The inspection shall be carried out in accordance with appendix B and the SM061 *Bailey bridge manual*[7].

The Bridge Inspection Engineer shall liaise with the Principal to agree responsibilities for inspection.

5.4.3 Large or complex structure inspection

This is for structures for which, due to size or complexity, the frequency or the scope of the general or principal inspection are not appropriate.

The inspection shall be carried out by personnel as the Bridge Inspection Engineer may direct.

5.4.4 Earthquake event inspection

This shall be carried out following an earthquake which is likely to have caused damage to structures in the affected area. The inspection shall be carried out as for a general inspection, on those structure members susceptible to earthquake damage.

The criteria and the extent of the inspection shall be agreed between the Bridge Inspection Engineer and the Principal.

The inspection shall be carried out by a Bridge Inspector and/or such other specialist staff as the Bridge Inspection Engineer may direct.

5.4.5 Flood event inspection

This shall be carried out following a flood which is likely to have caused damage to structures at sites known to have a history of instability or are likely to have been at significant risk. The criteria and the extent of the inspection shall be agreed between the Bridge Inspection Engineer and the Principal.

The inspection shall be as for a general inspection of the waterway and all members susceptible to flood damage.

The inspection shall be carried out by a Bridge Inspector and/or such other specialist staff as the Bridge Inspection Engineer may direct.

5.4.6 Overload damage inspection

This shall be carried out on any bridge during passage of an overload vehicle which may cause damage to the structure. It shall also be carried out on any bridge where it is known or suspected that an illegal overload vehicle has caused damage to the structure. The criteria and the extent of the inspection shall be as agreed between the Bridge Inspection Engineer and the Principal.

The inspection shall concentrate on those members susceptible to damage by traffic overload.

The inspection shall be carried out by a Bridge Inspector and/or such other specialist staff as the Bridge Inspection Engineer may direct.

5.4.7 Vulnerable structure inspection

This is required for structures and structure types which are known from previous performance to be at higher than normal risk of failure, that have known potential structural defects, or require specialist inspection, where the frequency or the scope of the general or principal inspections are not appropriate.

Examples:

- steel structures susceptible to fatigue
- timber bridges with decay
- bridges with foundation scour
- concrete structures with corroded reinforcement.

The Bridge Inspection Engineer shall prepare a specific inspection brief outlining the inspection requirements including inspection frequency and required personnel.

6. Reporting

6.1 Bridge inspection

Each inspection shall be reported on the bridge inspection report (refer to appendix C for the proforma), accompanied by a written engineering report as necessary to describe specific defects. Maintenance work, further detailed investigation or changes to the inspection regime shall be recommended as appropriate.

Where a posted bridge, or bridge which operates at a stress level or load factor other than the standard values specified in the *Bridge Manual*[6], shows deterioration, the report shall make recommendations on action needed, taking account of previous reports and current condition.

Each report and recommendations shall be sent to the Principal.

If the results of any inspection show that emergency action is required to temporarily strengthen or to close a bridge or perform any other work, the Bridge Inspection Engineer shall immediately advise the Principal, who shall implement appropriate action as necessary.

6.2 Other significant highway structures inspection

Each inspection shall be reported on an inspection report adapted to the specific structure configuration as appropriate (refer to appendix C for examples for retaining walls and large cantilever and gantry signs/signals), accompanied by a written engineering report as necessary to describe specific defects. Maintenance work, further detailed investigation or changes to the inspection regime shall be recommended as appropriate.

Each report and recommendations shall be sent to the Principal.

If the results of any inspection show that emergency action is required, the Bridge Inspection Engineer shall immediately advise the Principal, who shall implement appropriate action as necessary.

6.3 Structures database

Changes required to the NZ Transport Agency's structures database, including the addition of structures, shall be reported to the Principal on the necessary input forms. The Principal shall be responsible for approving the addition of structures to the database. Inspections shall be used to verify the data fields in the structures database and also complete any missing data fields.

7. Records

The Bridge Inspection Engineer shall maintain the files of inspection records and maintenance, so that a continuous history of each structure is available.

The Bridge Inspection Engineer shall also maintain a schedule of structure inspections covering in particular principal inspection requirements and special inspection requirements, including specific access requirements, features requiring specific inspection and frequency of inspection.

8. Verification of maintenance

A system shall be instituted to verify that approved maintenance work has been carried out as programmed. The cost, description, quantity and timing of the completed work, other than routine maintenance, shall be recorded on the structure files.

9. Traffic control

At all times during the work or activities associated with or arising from the exercise of this specification, the Bridge Inspection Engineer shall take responsibility to ensure all traffic control is carried out in accordance with the *Code of practice for temporary traffic management (CoPTTM)*[8].

10. References

(1) NZ Transport Agency (2015) NZTA S8 *Tunnels management and inspection policy.* Wellington.

(2) Highways Agency (2007) *Inspection manual for highway structures.* TSO, London, United Kingdom.

(3) Highways Agency (2012) IAN 171 *Risk based principal inspection intervals*. Last accessed 20 February 2015. <www.standardsforhighways.co.uk/ha/standards/ians/pdfs/ian171.pdf>.

(4) NZ Transport Agency (2010) SM032 *State highway maintenance contract proforma manual.* Wellington.

(5) NZ Transport Agency (2011) SM030 *State highway professional services contract proforma manual*. Wellington.

(6) NZ Transport Agency (2013) SP/M/022 *Bridge manual*. Wellington.

(7) NZ Transport Agency (2009) SM061 *Bailey bridge manual*. Wellington.

(8) NZ Transport Agency (2014) SP/M/010 *Code of practice for temporary traffic management* (CoPTTM), Wellington.

Appendix A

Structure inspection requirements

Table 1: Bridge inspection requirements

Category of inspection	Minimum frequency for inspection	Personnel involved (minimum requirements)	Reporting
Routine surveillance inspection	Sufficient (as determined by the Bridge Inspection Engineer) to ensure timely identification of safety defects but not less than 1 year	See 4.1	As required
General inspection	2 years	Bridge Inspector	Bridge inspection report
Principal inspection	6 years	Bridge Inspector	Bridge inspection report and engineering report as necessary
Special inspections:			
Posted bridges	As determined by the Bridge Inspection Engineer.	Bridge Inspector	Bridge inspection report and engineering report as necessary
Bailey bridges	1 year	Bridge Inspector	Bridge inspection Report and NZTA 802
Large or complex bridges	As agreed with the Principal	As determined by Bridge Inspection Engineer	As required
Earthquake event inspection	Immediately following a significant earthquake	Bridge Inspector	As required
Flood event inspection	Immediately following a flood event	Bridge Inspector	As required
Overload damage inspection	Immediately following the event	Bridge Inspector	As required
Vulnerable structures	As determined by Bridge Inspection Engineer and agreed with the Principal	As determined by Bridge Inspection Engineer	As required

Table 2: Other significant highway structure inspection requirements

Category of inspection	Minimum frequency for inspection	Personnel involved (minimum requirements)	Reporting
Routine surveillance inspection	1 year or less frequent (as determined by the Bridge Inspection Engineer)	See 4.1	As required
General inspection:			
Footbridges, cycle bridges, redundant bridges (accessible), large cantilever and gantry signs/signals, bridges over or adjacent to state highways, large lighting masts, CCTV masts	2 years	Bridge Inspector	Relevant proforma
Retaining walls, noise walls, large drainage structures, slope protection works, critical river protection works, major coastal protection works, critical small culverts, large stabilised slopes/batters	4 years when determined appropriate through risk analysis and agreed between the Bridge Inspection Engineer and the Principal (see 5.), otherwise 2 years	Bridge Inspector	Relevant proforma
Principal inspection:			
Footbridges, cycle bridges, redundant bridges (accessible), large cantilever and gantry signs/signals, bridges over or adjacent to state highways, large lighting masts, CCTV masts	6 years	Bridge Inspector	Relevant proforma and engineering report as necessary
Retaining walls, noise walls, large drainage structures, slope protection works, critical river protection works, major coastal protection works, critical small culverts, large stabilised slopes/batters	8 years when determined appropriate through risk analysis and agreed between the Bridge Inspection Engineer and the Principal (see 5.), otherwise 6 years	Bridge Inspector	Relevant proforma and engineering report as necessary
Special inspection	As agreed by Bridge Inspection Engineer and Principal	As determined by Bridge Inspection Engineer	Relevant proforma and engineering report as necessary

Appendix B

Inspection of in-service Bailey bridges

B1 General

A thorough inspection shall be carried out by a Bridge Inspector at least once per year.

B2 Inspection

Inspection of Bailey bridges shall cover the following points:

(a) Check for tightness of all raker, bracing frame, tie plate and riband bolts.

(b) Check tightness of transom clamps.

(c) Check sway braces are taut.

(d) Check that all panel pins have safety wires installed.

(e) Examine bearing foundations with particular emphasis on erosion, foundation shear failure and uneven settlement which, if present, must be corrected immediately.

(f) Check all packing is tight and if timber is used to retain approach fill, make sure timber is sound and approach fill is not spilling through.

(g) Check the condition of the decking.

(h) Ensure that all pins are greased to prevent water entering the joints. Ensure that all exposed threads of bolts, clamps and swaybraces are greased.

(i) Inspect protective coatings. Where significant damage to the coatings has occurred, the damaged areas shall, as soon as practicable, be first washed to remove any contamination from air-borne salts and then thoroughly cleaned by wire brushing, and reprimed with an approved epoxy zinc-rich paint. (A burnished surface should be avoided as it gives a very poor surface for bonding of the new coating.)

(j) Check visually for signs of cracking in both welds and parent metal, particular attention must be paid to the swaybrace slot and male lug areas illustrated in Figure B1. Where cracking is suspected, magnetic particle or dye penetrant tests shall be carried out.

B3 Crack monitoring and recording

(a) When cracks are located their ends shall be centre-punched to allow monitoring of crack growth during subsequent inspections.

(b) Where cracks have been located, repeat inspections shall be carried out and Bailey bridge crack testing reports NZTA 802 (figure B2) completed. All identified cracks shall be recorded on the NZTA 802 report by showing their location and length and whether they occur in welds (W) or parent metal (PM).

(c) If significant crack growth is observed the defective component shall be replaced, subject to Bridge Inspection Engineer approval.