Stantec

Memo

To:	[redacted] QLDC Queenstown	From:	[redacted] Unit D1-03, 19 Grant Road Frankton Queenstown 9300 NEW ZEALAND Mail to: PO Box 13052, Christchurch 8140
Project/File:	310206053	Date:	17 December 2025

Reference: Skippers Bridge Cables

Executive Summary

Due to extensive brittle failure of the wires in the Skippers bridge cables we are unable to confirm the load capacity of the cables. Consequently, we recommend that the bridge is closed to pedestrians and vehicles until repair, or replacement, can be implemented.

Excavation of the cables on the Skippers suspension bridge has exposed severe brittle failure of the wires of the cables on the True Left (TL) side of the bridge. The damage is worst where the cables are both radiused over a ‘roll over’ plate and are buried in the ground. No damage to the cables has been detected above ground. Approximately 20% of cable cross section area may be lost in some locations. All cables on the *TL upstream* side are severely affected. All cables on the *TL downstream* side have notable damage. Minor broken wires were detected on the True Right (TR) cables, but only limited excavation was undertaken on the TR to expose the cables.

The cable damage is believed to be caused by Stress Corrosion Cracking. Additional stress caused by the cable bend radius over the plate on the TL is believed to be a contributing factor to the damage.

A photograph of the damage to some of the cables on TL is shown below;

Figure 1. Broken Wires on the TL upstream cables

We are unable to reliably calculate the remaining strength of the damaged cables as fine, but undetectable, cracks may be present throughout the buried section of the cables. Load testing runs the risk of causing a catastrophic cable failure. As the individual wires of the cables crack the load on the remaining wires will increase and the rate of crack propagation and resulting capacity loss may be increasing. For this reason, we are unable to confirm if the bridge is safe under any loading regime. Rapid brittle failure of the cables under minor load is possible.

Reference: Skippers Bridge Cables

We have considered that there are three options available to maintain access to the Skippers Homestead and School Site. These options are:

- Use the above ground part of the existing cables and fix these existing cables into new or extended anchor blocks on both sides of the bridge. This would be a complex task and access for pant and consumables to the TR side would have to be by helicopter
- Replace the cables with new cables. This is more complex than using the existing cables as the new cables would need to be installed above, and parallel to, the existing cables. This is because the existing cables are bundled and cannot be individually separated and replaced.
- Abandon the existing bridge structure and construct a new, shorter, and lower, bridge in the original 1890 location approximately 300m downstream of the existing bridge

There remain issues relating to other parts of the bridge structure. Any decision relating to repair of the cables will need to consider the durability, ongoing maintenance and robustness of the other elements of the existing structure. These considerations include the factors below.

- The towers are 120 years old and are unlikely to have sufficient capacity to resist a current design level earthquake
- The existing site is unlikely to be suitable for a bridge designed to current standards. The towers are founded on the top of a 90m high cliff on both sides. No extensive geotechnical analysis of the stability of the cliff has been undertaken, but we note a significant adverse dip of the schistosity on the TL side and the risk of block toppling on both sides during an earthquake. Peer review of the design of a new bridge in this location is likely to raise concerns about the suitability of the site as a whole.
- The existing timber trusses on either side of the deck are degraded and showing signs of decay
- The deck planks have a number of areas of decay
- Cracking and splitting of the transoms has been an ongoing issue
- The longitudinal beams under the deck and on top of the transoms cannot be readily inspected and decay of these timbers remains a risk.
- There is a significant active slip immediately adjacent to the TL cable anchorage

Reference: Skippers Bridge Cables

Background

The Skippers suspension bridge was officially opened in 1901. Construction had been delayed by having to tunnel deeper than expected for the cable anchorages. The bridge is 91.4 metres (m) above the river, and it is the highest suspension bridge in New Zealand. The bridge is a single lane traffic bridge and is 2.2m-wide and has a span of 96.3m. The deck and stiffening truss are constructed in timber, and the towers are reported to be reinforced concrete rather than the typical stacked stone for similar bridges of this age.

The Skippers Canyon Suspension Bridge was added to the IPENZ Engineering Heritage Register on 28 May 2013.

This place is part of a Heritage New Zealand Category 1 historic place (List no.7684).

There has been concern regarding the suspension cables for the Skippers bridge for some time. The cables on the True Left (TL) side pass over a steel 'roll over' plate and then drop vertically into a shaft where they are anchored around a dead man. The cables on the True Right (TR) are anchored to a deadman of unknown detail. This layout is shown in the original construction drawings below.

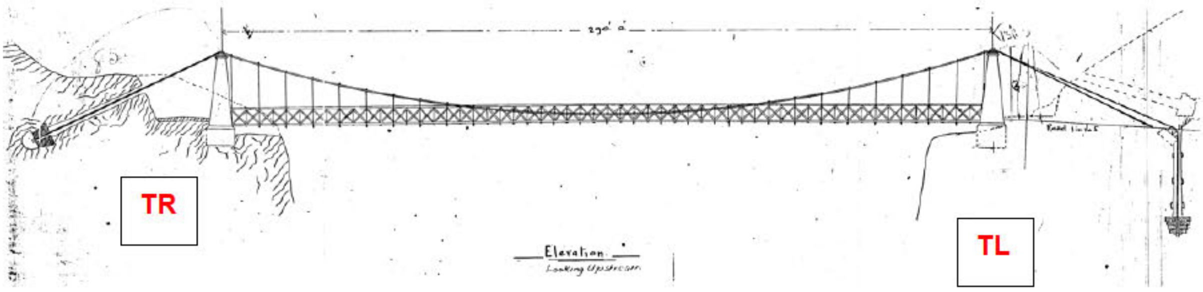

Figure 2. Original Construction Drawings showing cable anchorages

Site Observations and Previous investigations

Please find attached to this memo the following previous studies relating to the bridge.

- Skippers Suspension Bridge – Proposed Strategic Bridge Management 20 May 2025
- Skippers site visit record 17 October 2025

On the TL side the schistosity dips toward the Shotover River at a significantly adverse angle, (approximately 40°) and the soil overlying the rock is slipping on this plane. The northern margin of this slip is immediately adjacent to the TL cable anchorages. This is shown in the figures below

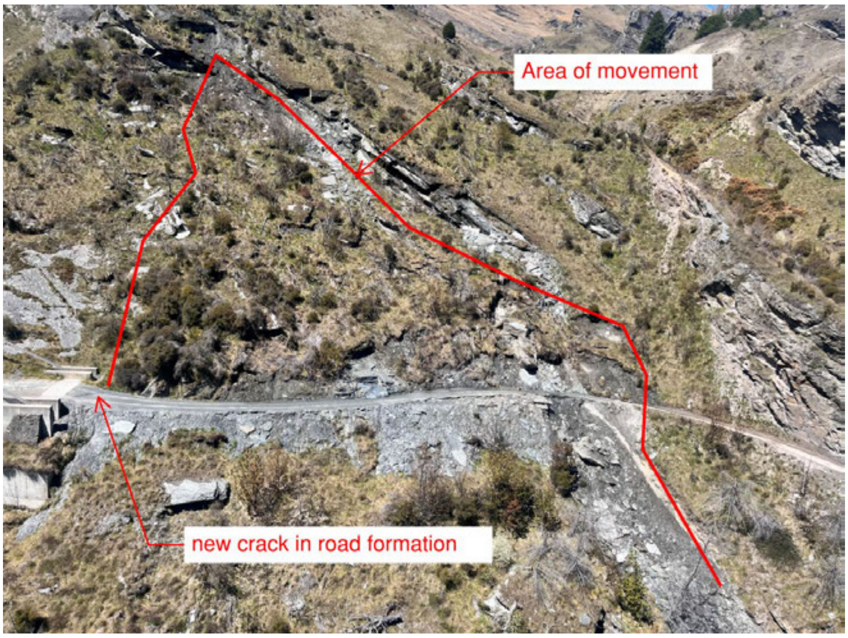

Figure 3. Area of instability adjacent to TL cable anchorages

Figure 4. Crack in road surface immediately adjacent to cable anchorages on the TL taken in November 2025.

Reference: **Skippers Bridge Cables**

Figure 5. Unstable area showing its proximity to the TL anchorages

In 2003 the Stoney Roller bearings on the towers at the TL were observed to be displaced by approximately 120mm. The cause of the movement of the bearings was thought to be relaxation of the TL cable anchorage. As a result, hold down blocks, placed over the cable 'roll over' blocks and rock bolted to the rock below were constructed to hold down the anchorages. This work was carried out in 2004. Since this time no further movement of the bearings has been observed. The displacement of the bearings is shown in the figure below.

Figure 6. Displacement of the Stoney Roller bearings toward the span on the TL

The blocks intended to hold down the cable anchorage on the TL are shown in the photograph in Figure 4 and a section of the drawings is shown below.

Reference: Skippers Bridge Cables

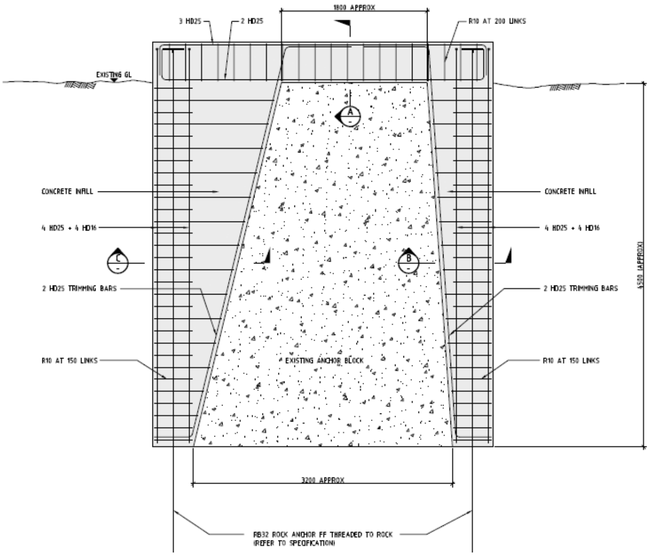

Figure 7. Rock bolted hold down block on the TL cable anchorage.

The displacement of the Stoney Rollers on the TL resulted in movement of the point of application of the vertical cable load on the top of each tower. Cracking of the capping blocks was detected, and this is believed to be a result of the eccentricity of the application of this load. To remedy this, the grouted steel jacket visible in figure 6 above was constructed to confine the masonry in the top of the TL upstream tower.

In 2025 initial excavation was undertaken by Downer, at our request, with the intention of exposing the cables to confirm the level of corrosion. This investigation revealed a significant number of broken wires on the TL cables where these had been below ground level. A copy of our site visit record for 17 October is attached recording the findings.

Further excavation was requested to expose the cables further to identify if the damage extended below the roll over plate and to identify if there was a sufficient length of straight, undamaged, cable below the roll over sufficient to connect to the cables above and below the damaged area. This additional excavation was inspected on 15 December 2025.

The 15 December 2025 inspection identified the following.

- The upstream (US) TL cables are embedded into a concrete slab approximately 700mm below the earlier excavation level.
- The US TL cables have broken wires throughout the previously buried area
- Approximately 1.5m of further excavation was undertaken on the TL DS cables. These cables also have broken wires, although fewer than the TL US anchorage

Photographs of these areas are shown in the figures below.

Reference: Skippers Bridge Cables

Figure 8. Excavation and cable damage on the TL US anchorage

Figure 9. Cable damage on DS TL cables

The highest concentration of broken wires occurs where the cables pass over the roll over plate, but there are still a number of broken wires in the vertical section of the cables which has been buried below the roll over plate.

We consider that the most likely cause of the damage to the cables is Stress Corrosion Cracking. Stress has been increased where the cables are wrapped over the roll over plate.

Reference: Skippers Bridge Cables

Academic literature reviewed as part of our research into this issue has the following to say about Stress Corrosion Cracking.

" SCC is classified as a catastrophic form of corrosion, as the detection of such fine cracks can be very difficult and the damage not easily predicted. Experimental SCC data is notorious for a wide range of scatter. A disastrous failure may occur unexpectedly, with minimal overall material loss"

And;

"Stress Corrosion Cracking (SCC) is a failure mode characterized by the progressive, localized cracking of steel materials subjected simultaneously to tensile stress and a corrosive environment. It manifests as brittle, intergranular or transgranular cracks that develop over time, often without significant prior warning. SCC is a critical concern in steel quality control because it can lead to sudden, catastrophic failure of structural components, especially in environments where corrosive agents such as chlorides, sulfates, or other aggressive chemicals are present."

Because of the presence of this cracking, we believe that the buried cables cannot be relied on to have reliable strength. There may be undetected cracks throughout the wires. As the wires crack, the remaining wires will carry greater load, and the rate of cracking in the remaining wires may be increasing as a result. The cables may be prone to sudden catastrophic failure without warning. Any remedial works cannot rely on strength in the cables below the ground.

Only shallow excavations were undertaken on the TR of the bridge. These excavations revealed limited cracking of the individual wires, but we cannot rule out the possibility that greater damage exists in a location on the TR that was not inspected.

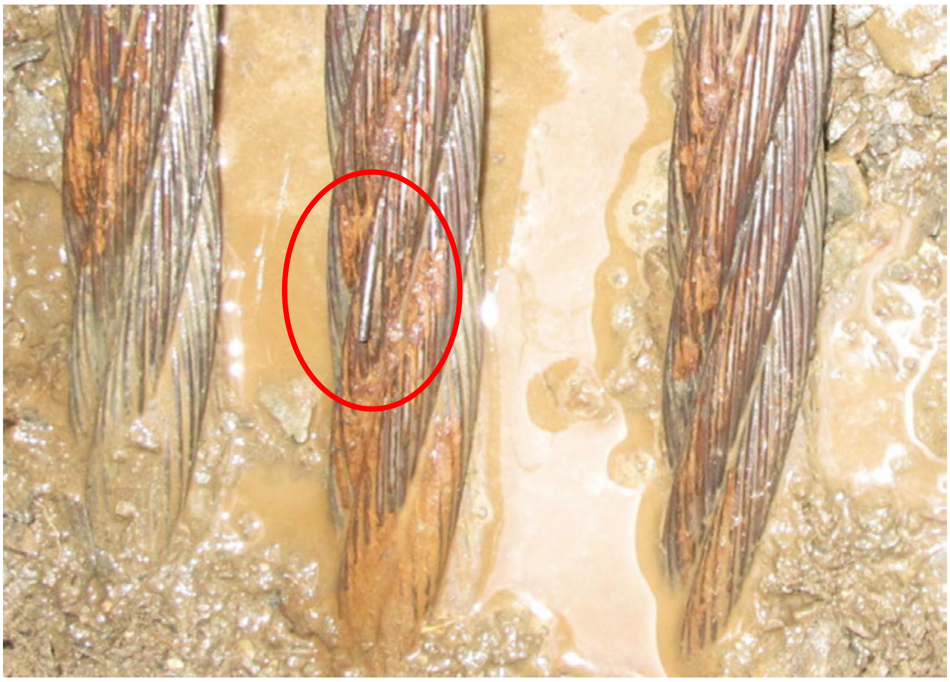

Figure 10. Cable on TR with rust and a single broken wire evident

Options for action

We cannot guarantee the load capacity of the cables and, as a result, we cannot be confident about the load capacity of the bridge. Load testing will not necessarily prove the capacity of the bridge, because of the risk of unpredictable brittle failure of the cables. Plus, there is a risk of load testing causing a catastrophic collapse.

For these reasons we cannot recommend that the bridge is reopened to either pedestrian or vehicle access until the cables are repaired or replaced. Repair of this situation is difficult and will be neither cheap nor quick to implement.

Sequential individual cable replacement is not possible as the cables are bundled together over the bearings on the towers and across the span. Consequently, only the upper two cables can be readily replaced as the other cables are directly below the upper two and are inaccessible. The cables along the span between the towers are also bundled together. This is shown in the figure below.

Figure 11. Bundling of the cables over the tower and span

Three options have been outlined below for consideration by Council.

1. <u>Use the existing cables, where these are above the ground, and anchor these into new anchor blocks</u>.

No decay of the cables has been detected above ground. The existing cables could be connected to the new anchor blocks by placing wire rope grips around the cable and casting these into new reinforced concrete anchor blocks. This would result in the cables being hidden in concrete and not being able to be either inspected or replaced. As such this type of repair is not current best practice. However, the life of the existing cables, cast into dense concrete, is likely to exceed the remaining life in the other elements of the structure. The strength of the connection that can be developed with cable clamps and concreting in of the cables remains to be identified. But it is likely that sufficient strength will be able to be developed with the combination of concrete encasement and cable clamps.

Plant and materials for the construction of the new cable anchor on the TR abutment would have to be flown to site by helicopter. This would include excavators, drill rigs, compressors, reinforcing and concrete. All concrete will need to be delivered to Skippers Saddle and then flown to site by helicopter as it is not possible to get concrete trucks to site. It may be possible to construct a catenary safety line to allow personnel access across the bridge. It may also be possible to construct at temporary flying fox to transport some construction materials across the river.

The nominal layout of this option is shown below.

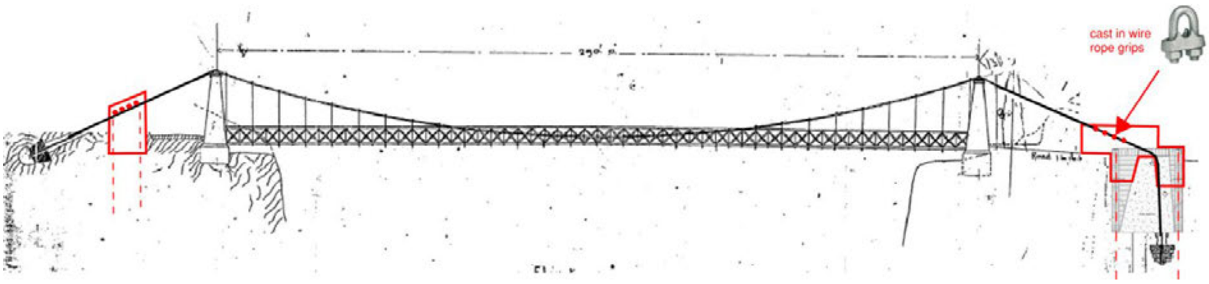

Figure 12. Concept for repair using existing cables with new anchor blocks shown in red

2.<u>Replace the cables and fix these to new anchor blocks</u>.

This is more complex than option 1. The new cables would need to be higher, and parallel to, the existing cables and would require new hangers to be constructed around the existing cables. The existing cables cannot be replaced individually as they are bundled over the stoney roller bearings (see figs 5 and 11). Consequently, the new cables would need to be above the existing cables on new saddles above the existing stoney roller bearings. This would necessitate some form of steel jacket around the existing towers with a 'bridge' over top of the existing stoney roller bearings.

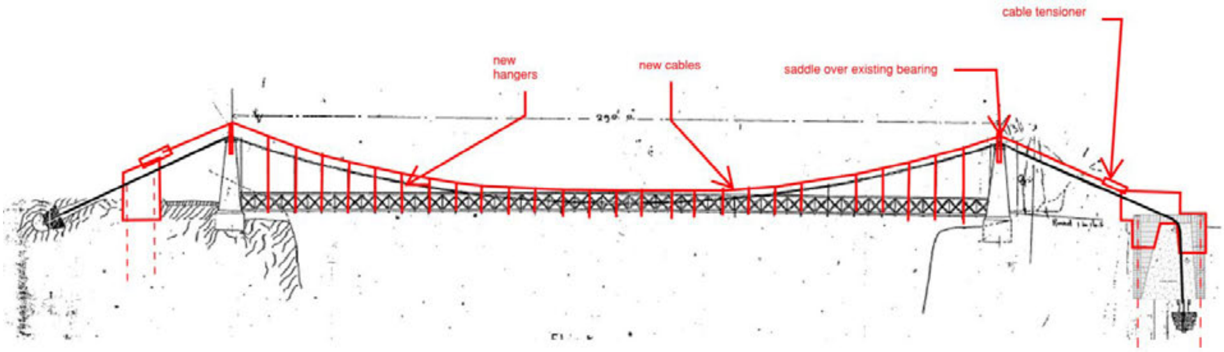

Figure 13. Concept for repair using new cables

For either option, the value of the repairs is likely to exceed a million dollars. The durability of the existing bridge fabric varies depending on the individual element, but as recorded in the existing 'Skippers Strategy Memo' the existing trusses are partially decayed, the deck timber is decayed, a number of transoms will require replacement, and the existing towers are 125-year-old concrete and are unlikely to withstand a design level earthquake. There is significant land instability on the approach to the TL side of the bridge.

3. <u>Construct a new pedestrian bridge in the 'original' 1890 alignment downstream of the existing</u>.

The final alternative considered is to construct a new pedestrian suspension bridge at the beach 300m downstream of the existing bridge. This would be in the location of the 'original' pre 1900 bridge. This location is indicated below:

Figure 14. Location of 'original' Skippers Bridge

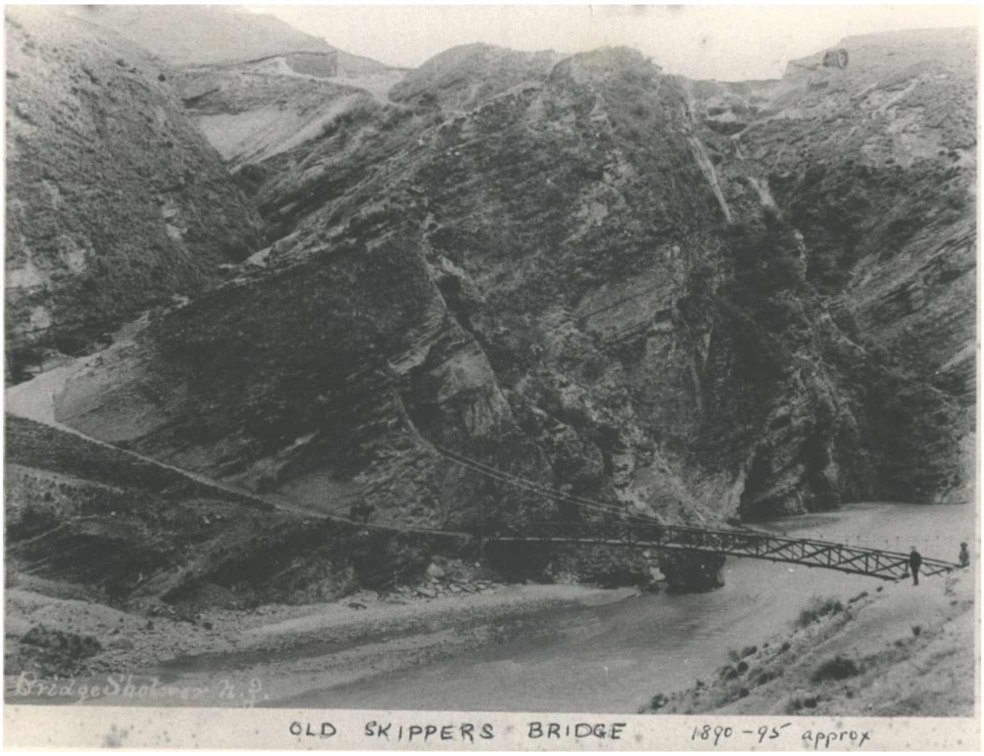

Figure 15. 'Original' Skippers bridge from the Hocken Library

A pedestrian bridge with a car parking area will allow pedestrian access to the school. A 4WD access track and low water level ford across the Shotover, may provide sufficient access for robust vehicles (bull dozers, tractors or similar) during low flow conditions to maintain the school building and access to the existing buildings.

Reference: Skippers Bridge Cables

We appreciate that this is an unfortunate situation, but we consider that pre-emptive closing of the bridge is appropriate to mitigate the risk of a catastrophic failure.

We trust that this is sufficient information for you to consider immediate actions and we await any questions you may have regarding the structure.

Yours sincerely

Stantec New Zealand

[redacted]

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Senior Principal Structures Engineer
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Mobile: [redacted]

Attachment:

- 17 October site report
- 20 May Strategy Memo

c.

Site Visit Record

Contractor:	Downer	**Client:**	The Queenstown Lakes District Council
Site :	Skippers Bridge	**Date**	17 October 2025
Subject:	**Inspection of reported cable damage**		

Executive Summary

Investigations have revealed a significant number of broken wires on the cables on the True Left (TL) Upstream (US) side of the Skippers Bridge. In the location where the damage was observed, the cables are buried and bent over a steel roll-over plate. After the plate the cables drop vertically to a ‘dead man’ anchorage which is concreted into a vertical shaft.

The damage to the cables appears to be significant. There are seven cables on each side of the bridge, on the TL US side;

- The centre four cables are estimated to have between 50 and 60% section loss
- The four outer cables are estimated to have approximately 30% section loss

The damage to the cables is over a length of approximately 700 mm, and thus the total section loss is difficult to estimate.

The TL upstream side of the bridge is the only location where the cables are both buried and change direction over a radius plate. On the TL downstream side, the radius plate is above ground and only a limited number of broken wires were detected. On the TR side the cables are anchored in an inclined tunnel and there are no radius plates, and no significant cable damage was detected.

We recommend that the bridge is closed to traffic immediately and further investigation of the TL US cables are made. We recommend excavation down to expose the vertical section of the cables below the roll over plate. Downer have been requested to close the bridge immediately, and to mobilise a small digger to expose the cables on the TL by removing the soil.

The cable damage appears to be brittle, and the wires do not appear to have yielded as no necking is evident. The wire breakages may be caused by either

- overloading of the structure, or
- Stress corrosion cracking
- An as yet unidentified cause

Stress corrosion cracking occurs when a metal is simultaneously exposed to tensile stress and a corrosive environment. This is consistent with the TL US cables where they are both below the ground and radiused over the steel plate. Consequently, stress corrosion cracking is currently considered to be the most likely cause of the broken wires observed.

We anticipate it may be possible to repair the damage by capturing the cables above and below the damaged area with a epoxy grouted steel jacket around each cable and connecting these over the broken area with a reinforced concrete block. This block would extend over the damaged area at the radius location. Further investigations required to confirm the practicality of this repair method.

Background

There has been concern for some time regarding the condition and remaining life of the Skippers Bridge. The bridge is now 124 years old and elements of the structure may be reaching the end of their life. It was recommended that, where the suspension cables are buried, they were exposed, and an inspection of the condition of the cables could be made. Downer made an initial excavation of the two cables on the True Left side. This excavation revealed damage to the upstream cable where it was buried and passed over a radiused steel plate. Stantec Engineers Lachy Goldsworthy and Derek Chinn visited site the next day on 17 October 2025 and excavated the cables on the TR and extended the excavation on the TL to make a more detailed inspection.

On the TR (True Right) the cables are believed to be anchored in inclined tunnels which are sloped to match the cable angle. On the TL the cables are draped over a steel plate roll over and then drop vertically down to the cable anchorage in a shaft.

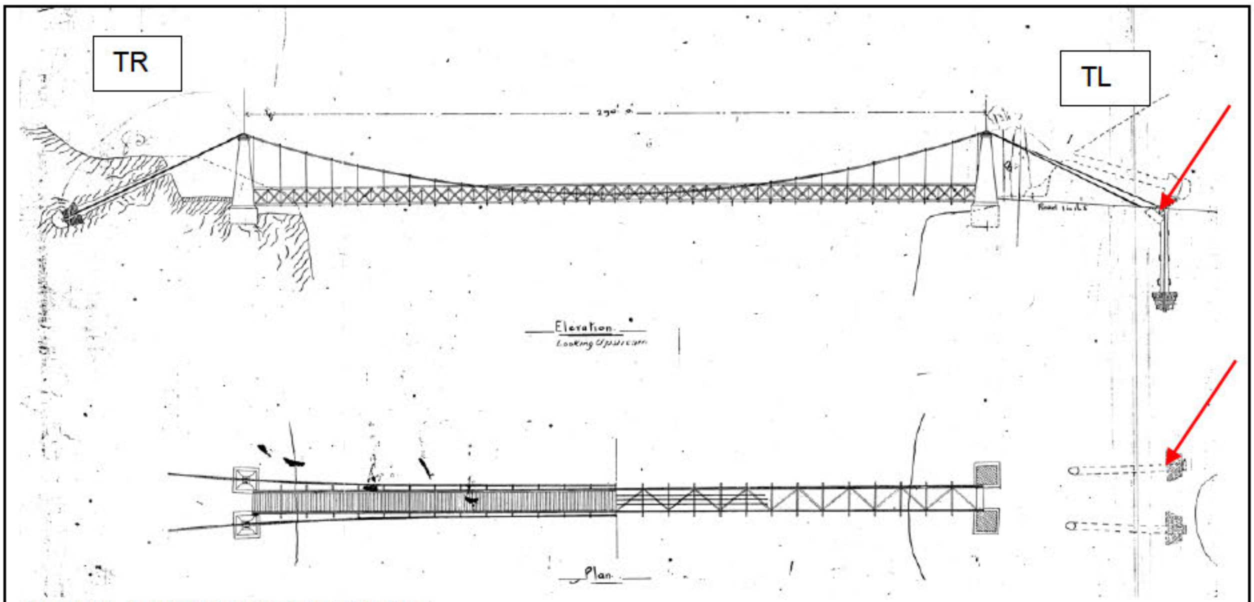

Figure 1. Location of damaged cables

The cable anchorage consists of a deadman cast into a vertical shaft.

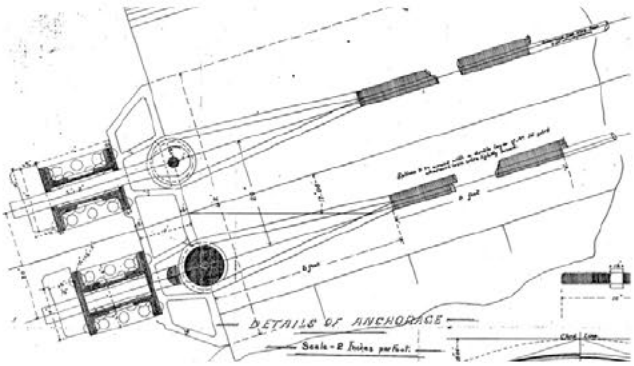

Figure 2 Deadman cable anchorage detail

Shallow pits were excavated on the two TR cables where these disappeared into the ground. There is no cable roll over on the TR. On both the US (upstream) and DS, TR cables no significant corrosion or cable damage was detected.

Figure 3. Excavation and cable cleaning on the True Right, Upstream and Downstream sides

Figure 5. True Right, US cable- insignificant corrosion and no broken wires located

Figure 4. TR, downstream cables. No significant corrosion and no broken wires detected

Figure 6 limited number of damaged wires on True Left downstream

On the TL side the US roll over plate and cables are buried. On the TL DS side, the roll over plate is above the ground and the cables drop straight into the ground.

The existing excavation on the TL US and DS locations was extended. There is extensive damage to all seven cables over the steel roll over plate on the TL US side where the cables were previously buried.

There are a small number of broken wires on the cables on the TR DS side where the roll over plate is exposed to the air. Where these cables enter the ground, and are straight after leaving the roll over plate, neither significant corrosion nor broken cables were detected.

Figure 7 Cable Damage at rollover. Behind the cables is a radiused steel plate. The water visible was used to wash the cables

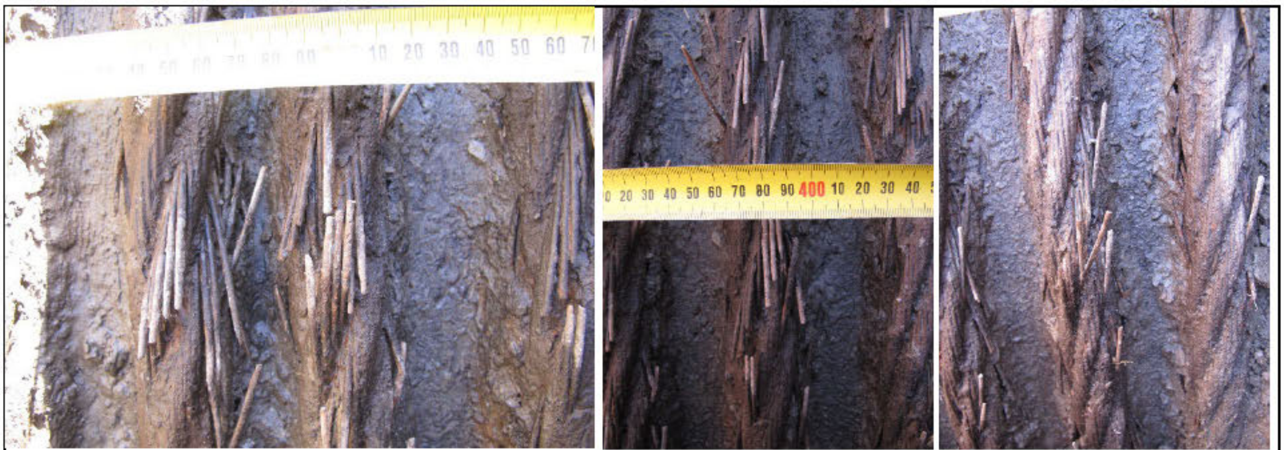

Figure 8. Cable damage on the True Left Upstream side

Extent and nature of damage

Significant damage was detected only on the True Left Upstream Anchorage. This is the only area where the cables are both buried and pass over a radius plate.

Over a length of approximately 700mm where the cables pass over the plate there are a significant number of broken wires. The breaks of the wires are brittle and not ductile as there was no evidence of yield or necking of the wires.

Figure 9. Example diagram and photo of brittle failure of the wires on the TL US location

The damage to the cables appears to be significant. There are seven cables on each side of the bridge, on the TL US side;

- The centre four cables are estimated to have between 50 and 60% section loss
- The four outer cables are estimated to have approximately 30% section loss

Figure 10. Damage to the two downstream most cables and the central three cables

This is a significant risk as the extent of the damaged cables cannot be accurately assessed and there may be a major reduction in the capacity of the cables at this location.

Potential Causes of Damage

The potential causes of the brittle failure of the wires observed are:

- overloading of the structure, or
- Stress corrosion cracking
- An unidentified cause

We believe that if the cause of the broken wires were overloading, then the damage would not be limited to this one location. If overloading were the cause we anticipate that there would be damage on the TL downstream roll over plate and potentially at the bearings on the top of the towers. This does not appear to be the case.

Consequently, we believe that the most likely cause of the damage is stress corrosion cracking. But it is possible that some other, currently undefined, mechanism may have caused the damage.

Stress Corrosion Cracking (SCC) of steel occurs when a metal is simultaneously exposed to a corrosive environment and tensile stress, the stress in the cable may have been increased by the radius over the roll-over plate. It's particularly insidious because it can lead to sudden and catastrophic failure of components without significant prior deformation or warning.
Key Characteristics of SCC:

- Tensile Stress: Can be residual (from manufacturing processes like welding or forming) or applied during service.
- Corrosive Environment: Specific chemicals or conditions (e.g., chlorides, caustic solutions, or even humid air) can trigger SCC.
- Susceptible Material: Not all steels are equally vulnerable. High-strength steels, stainless steels, and certain alloyed steels are more prone.

Further Actions

We recommend immediate closure of the bridge until further investigation is complete.

We recommend that the cables on the True Left side, both upstream and downstream are exposed as deep as practical. This is intended to confirm the following:

- The extent of damage and confirmation that the damage is limited to the area over the roll-over plate on the Upstream side of the TL
- The nature of the cables below the plate and confirmation of the length of cable available to attempt to capture the cable and transfer the loads to an alternative load path, potentially a block of reinforced concrete.

If the excavation reveals that the damage is limited to the roll over plate on the upstream side only, and there is a sufficiently long length of straight cable below the roll-over plate to allow a epoxy grouted sleeve to capture the cable, then we may be able to design a repair.

Stantec **Memo**

To:	[redacted]	From:	[redacted]
	QLDC		Frankton
Project/File:	310206053	Date:	20 May 2025

Reference: Skippers Suspension Bridge – Proposed Strategic Bridge Management

Purpose of this Document

The purpose of this document is to initiate consideration of the medium to long term options for the Skippers Bridge. The bridge is 124 years old and a number of the significant items of the original structure are near the end of their useful life. This document is to achieve the following:

- recommend immediate invasive investigations to identify if there is detectable significant corrosion of the suspension cables and the results of this investigation will dictate further maintenance considerations.
- List recommended immediate corrosion protection measures for the suspension cables, if the invasive investigations so not reveal significant corrosion of the cables
- Identify maintenance items to date and the annual maintenance cost to date
- Identify future significant maintenance items in order that these may be scoped in greater detail, cost estimates prepared for these items and a financial allowance provided for the work.
- recommend immediate invasive investigations to identify if there is detectable significant corrosion of the suspension cables
- Provide a qualitative observation of the seismic and geotechnical risks to the structure which would not be addressed by maintenance alone, in order that council may consider the level of risk and future investment

Executive Summary

The findings of this report are summarised as follows:

Recent average annual maintenance expenditure on the bridge has been approximately $62,000 per year. We anticipate that considerably more maintenance effort will be required immediately and within the next 20 years a variety of significant upgrades are likely to be required to maintain the bridge in a trafficable state.

There are some immediate items to be addressed in the bridge the most significant of which includes investigation and protection of the cables.

Within the next 20 years significant maintenance items are likely to be required to keep the bridge open for vehicle access. These items include deck replacement, steel sleeve around the True Left

downstream column, transom upgrades and the largest item of this work is repairing or replacing the existing trusses. The truss upgrades is a complex element of work, and the cost will be in the order of hundreds of thousands of dollars, and we recommend specific cost estimation to allow for this and other longer term maintenance items to be budgeted for.

If the upcoming significant maintenance items are not undertaken it is likely that the bridge will need to be closed to vehicle traffic. This will have a significant impact on both commercial and recreational users of the bridge. If the bridge is closed there are limited parking spaces for vehicles near the True Left approach to the bridge. This is due to the narrow existing formation and the difficulty of widening the formation for parking due to the unstable nature of the shoulder and the adverse foliation of the upslope rock.

The bridge provides recreational and commercial access to the Mt Aurum Recreation reserve where are wide variety of recreational activities are undertaken.

Recommended immediate maintenance actions are listed below.

- The cables on the True Right (TR) disappear into soil. Remove soil from around the TR cables to where these enter the concrete anchorage. Then either concrete encase the cables or construct a retaining structure, so the cables are not in contact with soil.
- The cables on the True Left (TL) have initial surface corrosion and some broken strands. Remove detritus from around the TL cables and concrete encase the cables up the level of the existing concrete blocks to provide corrosion protection.
- Investigate corrosion to the cables within the existing concrete anchorage blocks on both sides by excavating approximately 100 -150 mm to check for corrosion. If corrosion is present within this existing concrete, this indicates there may be hidden corrosion within the anchor block. Corrosion within the anchor block may be impractical to repair and the effect on the cable capacity will be difficult to quantify. If no corrosion is detected it is reasonable to assume the cables in the anchorage blocks are not significantly corroded. Areas investigated to be repaired with Conbextra GP grout, and we anticipate covering the cables with further concrete.
- Permanently remove the flashings from the top chord of the trusses and inspect the exposed timber to assess the extent of decay. Treat areas of decay with timber preservative.
- Repair recently installed transoms which have midline cracking (likely to be due to drying shrinkage). Repair this cracking with stainless steel nail on plates.
- Replace cracked and split running planks on the TR.
- Inspect a sample of hangers were these pass-through the transoms to identify if corrosion is occurring in the hole in the transom.

Significant future major maintenance items identified are listed below. The structure is technically an Archaeological Site for which an Archaeological Authority is required to modify the structure.

- Replace the remaining hardwood deck planks over a 10-year period. Recent deck plank replacements have been with treated pine, but considering the historical importance of this bridge, replacement of timbers with adequate strength hardwood (F27) may be used to restore (or improve) the bridge's load carrying capacity. Sustainably sourced mixed Australian hardwood is available and has been imported into NZ for Nelson Ports work in the past. It is possible to bulk order to include future member replacements and minimise delivery costs. An indicative cost estimate could be sought from the NZ timber supplier to establish the cost viability of this approach.

- The depth of the plank replacement should be checked in order to confirm the timber suitability for the point loads of vehicles allowed to use the structure.
- Upgrade the trusses using either in-situ timber or prefabricated timber or steel modules. This is anticipated to be required within 20- 30 years provided timber is protected with preservative in the immediate term. This is a significant task and will be expensive to achieve. This work also has a significant heritage implication and early consultation with Heritage New Zealand is appropriate.
- Install a grouted steel jacket around TL downstream tower basalt stoney roller bearing block which is degrading. This is anticipated to be required within 10 years.
- We anticipate that most transoms will require replacement within approximately 25 years, we note the longitudinal cracking of recent replacement transoms. It is worthy to consider using steel UC's (universal channel sections) to replace the transoms rather than timber, but we recognise that this will change the overall aesthetic of the structure and change the nature of the fabric of parts of the structure.
- We estimate that the cables (where they are clear of the ground) and the hangers are adequate for a further approximately 40 to 50 years. However, this figure is difficult to estimate with accuracy.

We consider that it is unlikely that the heavy and likely lightly reinforced towers, and tower foundation rock will survive in a design level earthquake. We also think that it is unlikely that building consent would be granted for a replacement structure because of the potential instability of the foundations and the requirements of the modern New Zealand Building Code. Significant rock bolting and foundation rock stabilisation work is likely to be required for any new structure to comply with the Building Act. We anticipate that long rock bolts will be necessary to secure the tower rock, and that this work may prove impractical at the site. An alternative bridge location is at the earlier bridge position downstream and near the river. In this location a bridge would have a span of approximately 100m and road access to the Skippers Township site would be challenging due to the steepness of the terrace.

If the bridge is closed to vehicle traffic because replacement of the trusses (or other elements) is either unaffordable, impractical, or too risky, then there are few locations for vehicle parking along the access road to the bridge on the TL. The road shoulder on the TL approach to the bridge settled significantly in multiple locations during the October 2024 floods. On the uphill side of the access road cuts into the rocks will require significant stabilisation as there is a severe adverse dip of the foliation of the rock toward the river. We anticipate that stressed anchors will be required to secure the rock slabs on the up-hill side of the road.

Bridge Description

- The Skippers Suspension bridge was constructed between 1898 and 1901.

- The bridge deck is 2.2m wide. The bridge spans 96.3m and is 91.4m above the river below, and is the highest suspension bridge in New Zealand

- It is a category 1 historic place and in 2013 it was added to the IPENZ Engineering Heritage Register. Because the construction of the bridge commenced before 1900 (in 1898) the structure is an 'Archaeological Site' under the Heritage New Zealand Pouhere Taonga Act 2014. An Archaeological site defined in the act as follows:

In this Act, unless the context otherwise requires,—

archaeological site means, subject to section 42(3),—

(a) any place in New Zealand, including any building or structure (or part of a building or structure), that—

  (i) was associated with human activity that occurred before 1900 or is the site of the wreck of any vessel where the wreck occurred before 1900; and

  (ii) provides or may provide, through investigation by archaeological methods, evidence relating to the history of New Zealand; and

(b) includes a site for which a declaration is made under section 43(1)

- The bridge towers are reported to be constructed from reinforced concrete, but no details are known about the reinforcing in the towers.

- The cables are galvanised steel and are fixed to buried anchorages. The existing cables cannot be either replaced or adjusted as the cables are bundled together and secured directly to the anchorage beneath the ground. Little is known about the anchorages, although the TL anchorages are in a vertical shaft while the TR anchorages appear to have been constructed in an inclined tunnel.

- The deck planks, longitudinal beams and transoms were originally from some form of hardwood – the exact timber type is not known

- The deck has stiffening trusses on each side which sit on top of the transoms. The trusses have an unusual arrangement, and the chords are clamped from top chord to bottom chord with tie bolts. The cross-bracing struts between the chords are clamped in position without positive tension connections.

- The bridge cables pass over 'Stoney Roller' bearings on the top of the towers. Such bearings are no longer commonly used in suspension bridges, and they are of historical interest.

Reference: **Skippers Suspension Bridge - Proposed Strategic Bridge Management**

Figure 1. Bridge plaque

Naming Convention

The elements of the bridge are named in this document as per the figures below.

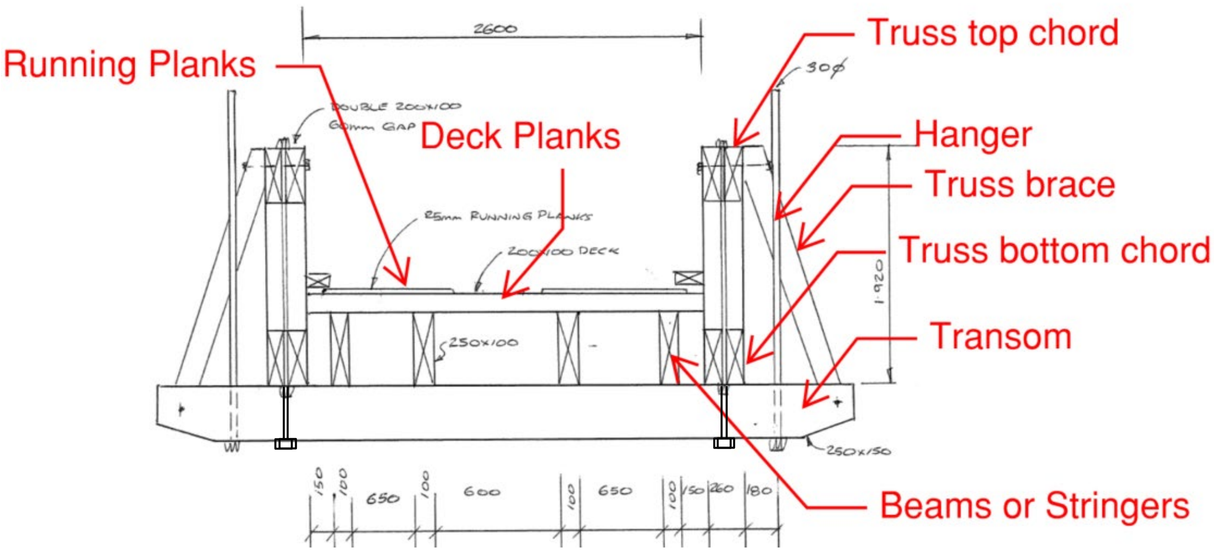

Figure 2. Cross section and element names

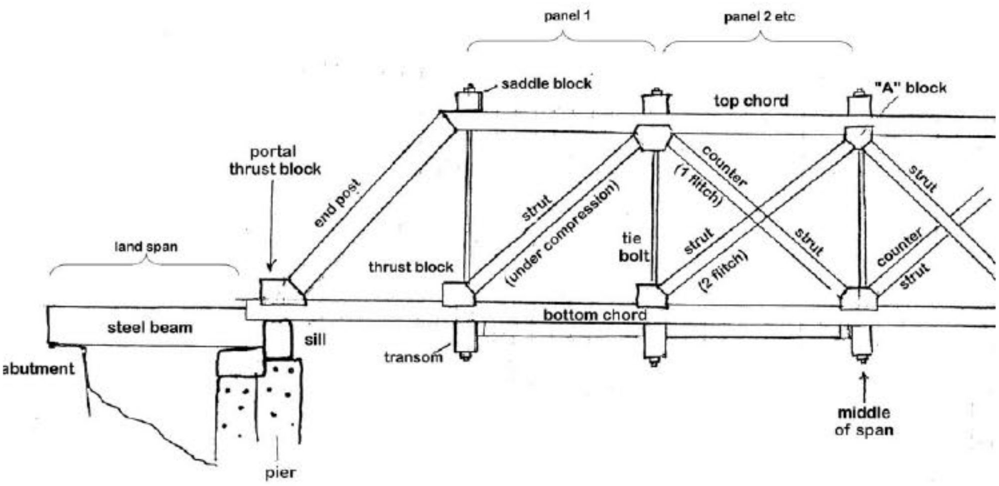

Figure 3. Truss component names

Previous Significant Maintenance Items

In 1995 it was noted that the stoney roller bearings on the true left (TL) towers of the Shotover Bridge were displaced by approximately 100mm towards the centre of the bridge. The specific cause of the displacement of the bearings was not identified, but the displacement is indicative of relaxation of the cable anchorages on the TL side. In 2004 the TL cable anchorages of the bridge were stabilised with concrete blocks constructed over the existing cable anchorages to add additional resistance to relaxation of the cables. These blocks are shown in the figure below.

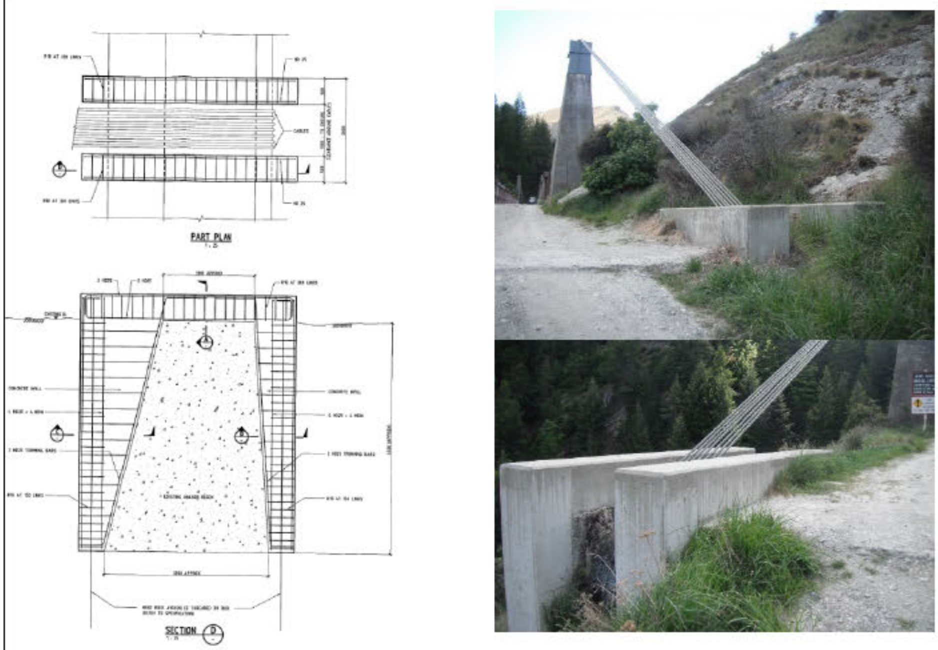

Figure 4. Gravity 'hold down' blocks constructed over the existing cable anchorages in 2004.

Figure 5. Displaced Stoney Roller bearings on both towers on the TL side 2013. The movement indicates possible relaxation of the TL cable anchorages and introduces eccentric loading onto the top of the tower.

In 2013 significant deterioration of the TL upstream tower capping block, and the concrete tower immediately below the capping block, was detected. The upper part of the tower, including the capping block, was repaired with grouted steel jacket as shown below.

Figure 6. TL upstream tower capping block deterioration and cracking in the tower in 2013 prior to repair of the tower

Reference: Skippers Suspension Bridge - Proposed Strategic Bridge Management

Figure 7 the steel jacket grouted around the capping block and top of the TL upstream tower where cracking of the top of the tower was occurring

Land Tenure

The land on the TL of the bridge is road reserve. The TR area is recreation reserve. The block on the TL covers considerably more area than the road formation, and if a parking area were developed on the TL of the bridge this may be achieved without land take issues. This area is shown below.

Reference: **Skippers Suspension Bridge - Proposed Strategic Bridge Management**

Figure 8. Land Tenure Around the Bridge

Commercial and Recreational Use of the Skippers Bridge

The bridge provides access to numerous sites including the following:

- Recreational hunting to the Mt Aurum Recreation Reserve
- 4WD access
- Walking access to recreational and historical sites including the Skippers Township, Skippers cemetery, Bullendale, Dynamo and Crystal Battery the Mt Aurum Recreation Reserve
- Adventure skiing activities
- Camping and sightseeing at Skippers Township
- Privately owned huts located near the bridge and on Pleasant Creek Terrace
- Recreational access

Commercial users of the bridge identified include the following:

- Blacks
- Queenstown Heritage Tours
- Nomad Safaris
- 4WD Expeditions
- Private Discovery Tours
- Pure Glenorchy

Without the bridge all vehicle access would be cut off and foot access would be very challenging and possible only to a few people. Pertinent features and recreational huts are shown in the figure below.

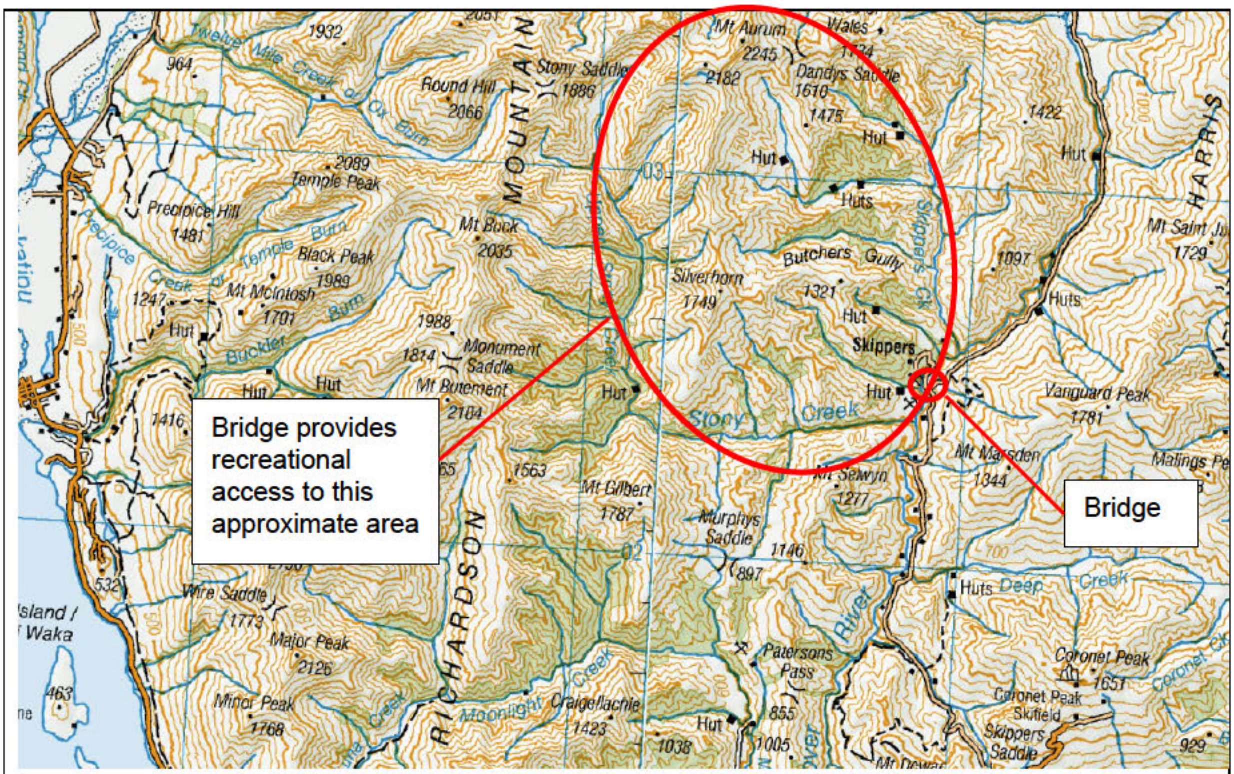

Figure 9. Huts and features of the Mt Aurum Recreation Reserve

Previous Load Testing

The bridge has been load tested on three occasions. The purpose of this load testing has been primarily to confirm the capacity of the cable anchorages as the test loads were placed mid-span. The load testing also provided a check of the transoms, deck and hangers in the mid-span area of the test, but did not test all transoms, deck and hangers at the ends of the span. The load tests were carried out as follows:

- 12 November 2021 – bridge tested to 10 tonnes with water pumped to containers placed midspan. The cables were visually monitored for slippage and no cable movement was detected.
- 26 February 2014 – bridge tested to 10 tonnes with water pumped to containers placed midspan. The cables were visually monitored for slippage and no cable movement was detected.
- 25 May 1995 – bridge tested to 18 tonnes with water tanks midspan and the cables monitored with strain gauges. Only insignificant movement of the cables was observed.

Reference: Skippers Suspension Bridge - Proposed Strategic Bridge Management

Figure 10. 2021 load testing arrangement

Prior to 2014 the bridge limits were 2,500 kg but following the testing in 2014 the load limit was increased to 3,000 kg. This increase in load limit better reflects the vehicles using the bridge and has a factor of safety against the tested load of approximately three. The load limit signage in the bridge is shown below.

Figure 11. Load limits prior to 2014

Figure 12. Load limit after 2014

Previous Maintenance Expenditure

Downer advises that they have charged $377,259.01 + GST(?) between 2019 and 2025 (six years) for maintenance activities on the bridge. This is an average of $62,876 + GST per year.

To date this maintenance has included the following elements.

- Replacement of approximately half the deck timbers
- Replacement or supplementing approximately five transoms
- Fixing a variety of the truss cross braces with steel brackets to hold the cross braces in place

The steel jacket around the TL upstream column was implemented in 2013 and is not included in this figure.

This recent maintenance has been relatively minor. We anticipate that considerably more expenditure will be required to implement the immediate repairs recommended in this document, and the longer-term repairs anticipated to be required in the next 20 years, to keep the bridge trafficable.

WSP Structural Model Results

In March 2024 WSP carried out a review of the previous load testing and undertook a computational analysis of the structure using existing drawings, site measure and drone photography. The results of WSP's analysis are summarised as follows:

- The transoms failed in shear with a 5-tonne excavator load
- The truss top chord failed in compression with a 5-tonne excavator load
- The truss single diagonal ***pine*** members failed in tension with a 3.5 tonne vehicle, a 3.5 tonne vehicle and trailer, a 3.5 tonne excavator and a 5-tonne excavator.
- The truss diagonal double hardwood struts fail in compression under at 5 tonne excavator loads
- The truss double diagonal pine members fail in compression under a 3.5 tonne vehicle, a 3.5 tonne vehicle plus a trailer, a 3.5 tonne excavator and a 5-tonne excavator.
- The stringers (the below deck beams) fail in shear under both 3.5 tonne and 5 tonne excavators in shear.

The WSP analysis makes the following conclusions:

- Diagonal truss members made from pine may be understrength. The report identifies both tension and compression failure in these members.
- The report identifies that the test load procedure tested only the transoms near the middle of the bridge span and did not test the capacity of the transoms at the end of the span.

Reference: **Skippers Suspension Bridge - Proposed Strategic Bridge Management**

Figure 13. Truss cross bracing connection with location plate and pine blocking arrowed. This connection is capable of resisting compression forces in the struts only.

Stantec make the following observations regarding the WSP model.

- We do not believe that the truss cross members are pine. These appear to be some form of hardwood, but the specific type is not apparent.
- The truss cross members are held in place by clamping only from the tie bolt, and they are not positively fixed, and thus cannot be in tension. Thus, if the WSP model predicts tension failure in these members the model may be providing results which overestimate the capacity of the truss cross members in tension.
- The trusses control deflection by distributing vertical load over multiple hangers. This is a consequence of the stiffness of the trusses.
- Stantec note the trusses are of variable stiffness along their length. Thus, quantifying the stiffness and resulting load distribution is imprecise. The truss stiffness will be affected along their length by movement in the timber connections and by variability of the timber properties, primarily because of localised decay.
- If the trusses deflect significantly the bending moment in the transoms increases because a higher load is carried by the hanger adjacent to the load.
- Stantec note that there is detectable decay in the truss top chords. Consequently, the trusses may not have the degree of stiffness predicted by the WSP model. The extent to which the existing trusses reliably distribute the loads between hangers is difficult to assess and is likely to be variable along the bridge and likely to decrease over time. Consequently, the WSP model potentially represents an idealised model, and the model results may be an upper bound (non-conservative) strength for the structure.
- A lower bound assessment of the structure may be best made by assuming that the trusses do not distribute load and applying the full vehicle load to the stringers below and onto the adjacent transoms without redistribution from the trusses.

2025 Inspection Results

An inspection of the structure was undertaken by [redacted] on 19 March 2025 to assist in the development of a strategy for the management of the bridge and to estimate likely maintenance requirements over time.

Cables and Cable Anchorages

In the clear span between towers, the cables appear in good condition and no signs of significant corrosion have been detected.

True Right (TR) Cable Anchorages

The cable anchorages on the TR are not visible. The cables disappear into the site soil. The drawings indicate an angled dead man anchor in a tunnel, but the drawings available do not include either details or dimensions of the anchorage. Relevant sections of the drawings available are shown below.

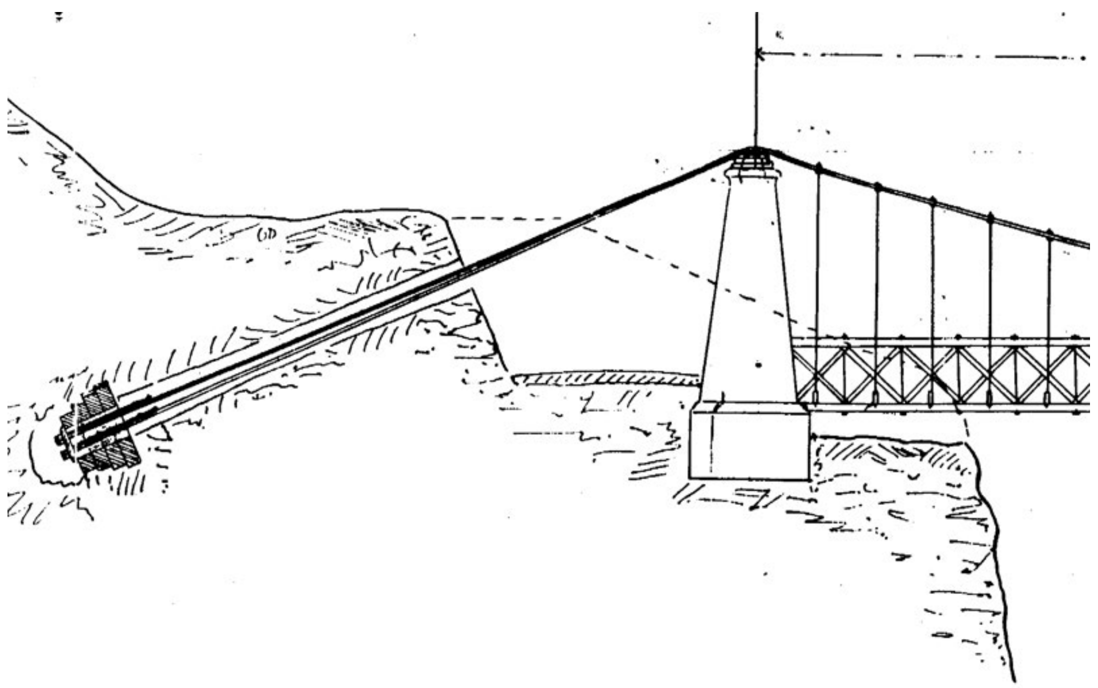

Figure 14. Unspecific drawing showing TR cable anchorage

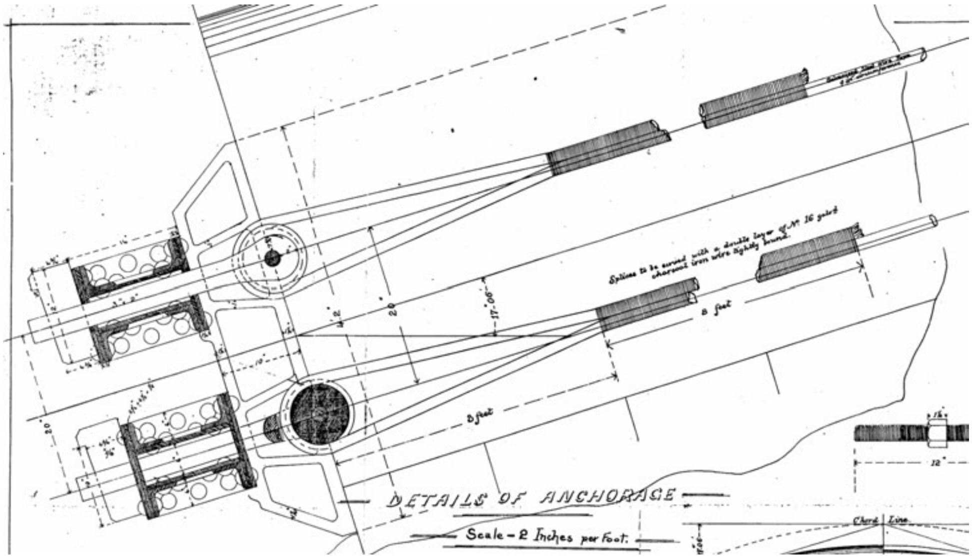

Figure 15. Deadman anchorage. Text reads “splices to be scried with a double layer of no. 16 galv’d charcoal iron wire tightly bound”

Figure 16. Cables on TR entering the ground with only galvanising of the cables for corrosion protection. No significant corrosion was observed in this location

Reference: Skippers Suspension Bridge - Proposed Strategic Bridge Management

True Left (TL) Cable Anchorages

On the TL the cables are anchored in vertical shafts, and the drawings indicate a similar deadman anchorage detail as the TR. Again, there are no dimensions or specific details in the drawings available. As previously noted, it was believed that the cable anchorages on the TL were relaxing and allowing the cable to slacken and consequently move the bearings on both TL towers. Concrete blocks were constructed over the anchorages in 2004 to prevent further relaxation of the anchorages. Corrosion of cables near the ground is visible in both the upstream and downstream TL anchorages. This is shown below.

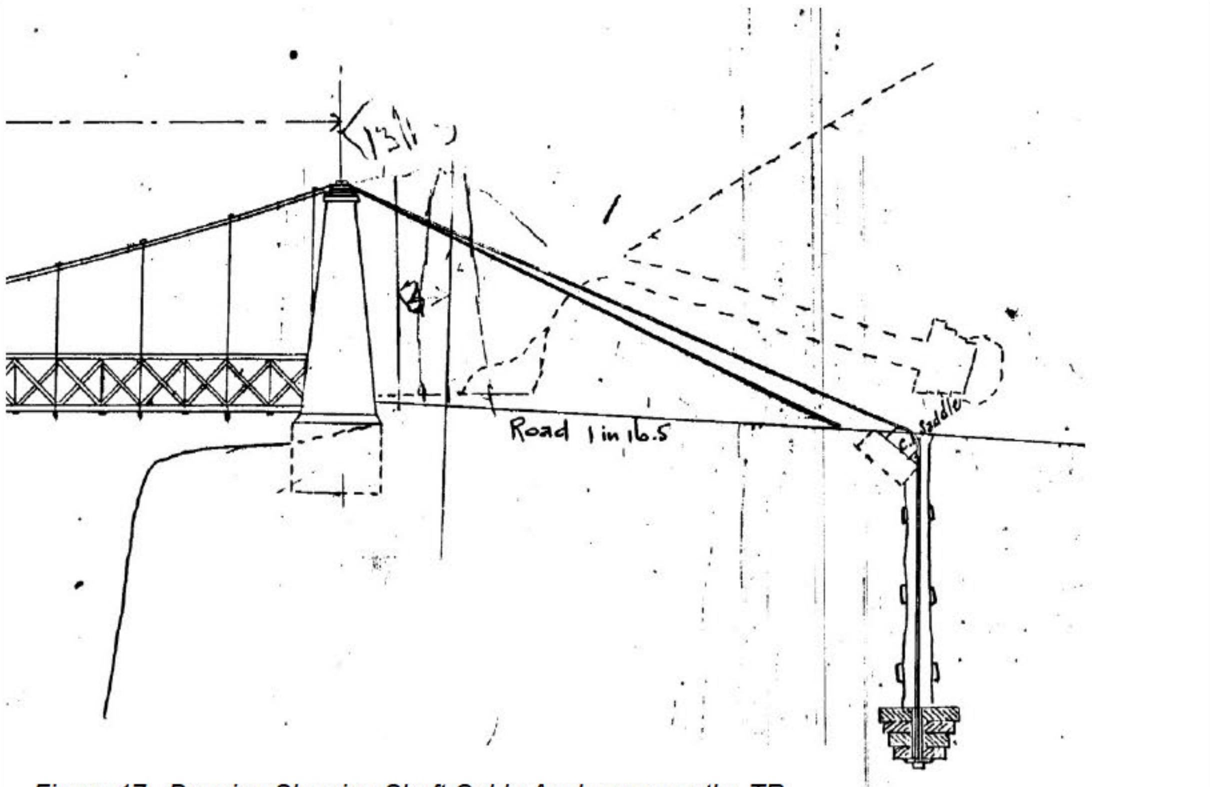

Figure 17. Drawing Showing Shaft Cable Anchorage on the TR

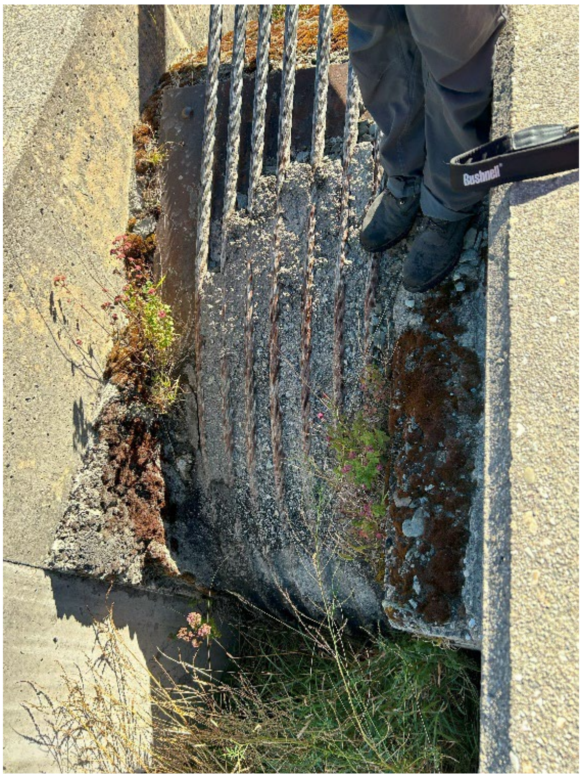

Figure 18. Saddle at TL downstream anchorages where the cables change direction into the anchorage shaft. Note rust on cables

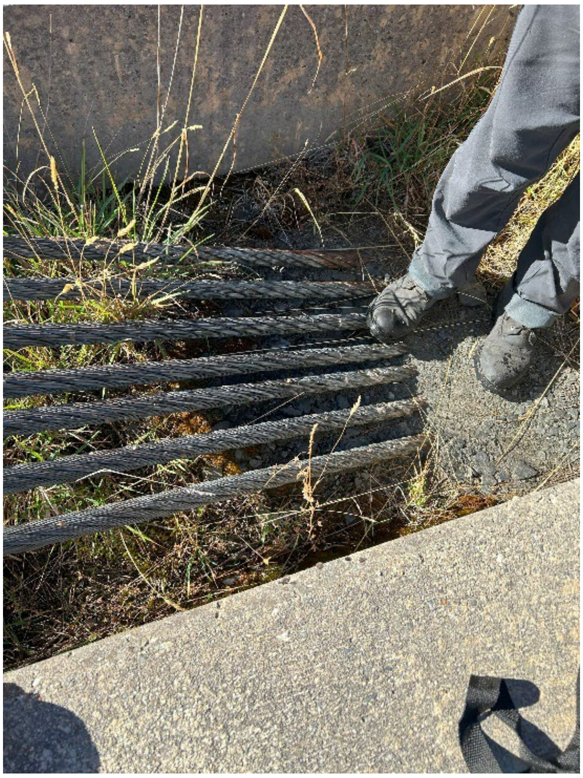

Figure 19. Cables entering anchorage concrete on the TL upstream anchorage. Also localised corrosion here

Clear of the area adjacent to the anchorages, the cables are in good condition. Adjacent to where the cables on the TL enter the anchorage concrete the cables have surface rust and some broken strands.

The corrosion and broken strands on the TL side are shown below.

Figure 21. TL upstream surface corrosion of cables

Figure 22. TL downstream surface corrosion of cables

Figure 20. TL Downstream broken strands

The following action is recommended at the cable anchorage locations.

True Right

- Excavate and remove vegetation/soil/detritus from around the TR cables to where the cables are anchored in concrete
- Subsequent actions on the TR are dependent on whether corrosion is exposed by excavation of the soil. Depending on condition, potential courses of action include either a protective coating treatment of the cables; full concrete encasement of the cables to ground level; construction of a small retaining structure around the cables to protect them from ground exposure and resulting corrosion or any combination thereof

True Left

- Remove vegetation/soil/detritus from around the TL cables
- Following cleaning of the area, fully concrete encase the cables on the TL to the level of the top of the existing anchor blocks to provide corrosion protection to the sections of cables where initial corrosion is occurring

Investigation for corrosion within anchorage blocks both TL and TR

- Cut away 100mm of existing concrete from around cables at both TL and TR to check for hidden corrosion in the concrete. If corrosion of the cables is visible within the concrete encasement, this indicates that there may be corrosion of the cables within the anchorage, this is potentially a serious situation, and further investigation will be required. If there is minor or no detectable corrosion of the cables within the first 100mm of anchorage concrete, it is reasonable to assume that the remaining length of cables within the anchorage are in acceptable condition.

Towers, Stoney Roller Bearings and Tower Foundations

The towers currently appear to be in acceptable condition. There is some degradation of the basalt capping stone on the TL downstream tower and it is anticipated that a new steel jacket will be required around this within the next 10 years. This is shown in the photograph below.

Figure 23. Decay of the TL downstream tower basalt cap and displacement of the bearing

The ‘stoney roller’ bearings on the top of the towers on the TL side are displaced as previously noted, and as shown in the figures above and below. No further movement of the bearings has been detected since the cable anchorages were supplemented with additional concrete. But this may also be due to the bearings being seized, and any relaxation movement of the cables may potentially be taken by either flexure or rocking of the towers. It is a challenging task to lift the cables clear of the bearings and replace the bearings centrally. Consequently, we do not recommend centralising the bearings.

The cracks on the TL upstream tower were repaired with a steel jacket and no further movement has been detected following this repair.

The towers are constructed from concrete and are believed to be reinforced. The reinforcing details are unknown. Scanning of the towers using a reinforcing scanner may identify the location and possibly the diameter of reinforcing within the tower, but it would not confirm connection details (or otherwise) between the tower and the underlying rock.

Figure 24. TL towers and displaced bearings. Decay of downstream TL basalt capping block visible. Steel jacket installed in 2013.

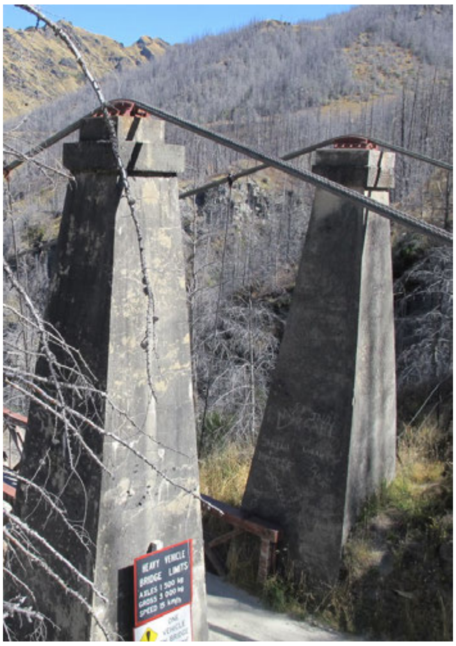

Figure 25. TR towers – these TR do not have stone capping blocks although historical photographs suggest that all four towers originally had basalt capping blocks.

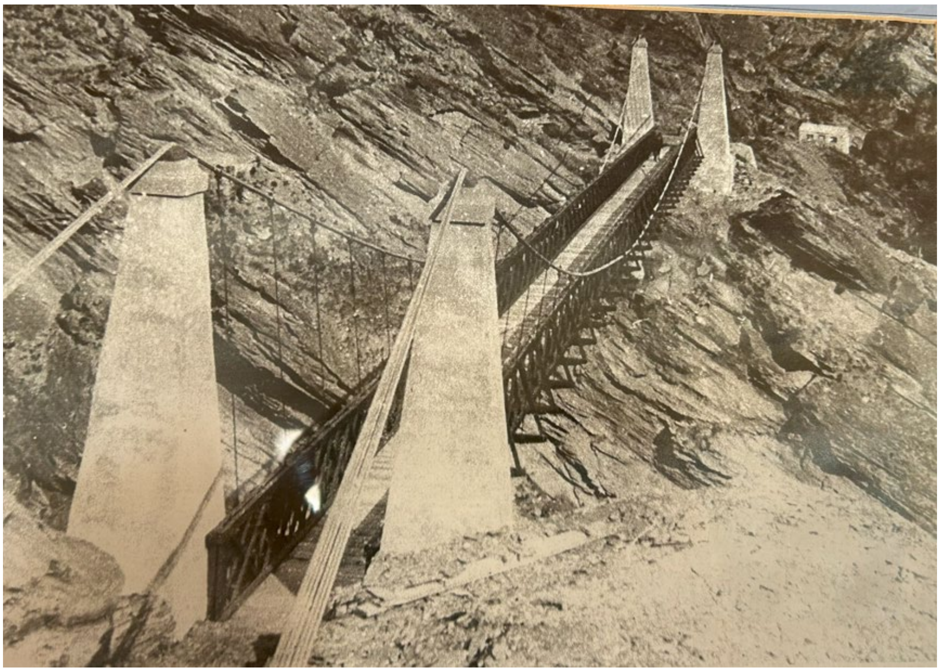

Figure 26. Historic photograph of the TR end of the bridge which appears to show the original shaped basalt tower capping blocks

The tower foundations on both abutments are close to the cliff edge. There appears to be a risk of block failure beneath the towers on both sides of the bridge, particularly in an earthquake. It is considered unlikely that these foundation conditions would meet current standards. Consequently, if the bridge is completely replaced, stabilising work is likely to be required at the tower locations and this work will be a significant expense. Stantec consider it is unlikely that a bridge design in this location, without significant stabilisation work, would pass peer review and consequently a building consent application for a complete replacement is unlikely to be approved. The tower foundation conditions are shown in the figures below.

Figure 27. TR abutment and potentially unstable blocks on the bluff (looking upstream)

Figure 30. TL abutment and bluff with adverse schistosity (looking upstream)

Figure 28. TR abutment rock photographed from upstream

Figure 29. TL abutment rock looking downstream

Hangers

The hangers are generally in good condition and no significant deterioration or loss of section in the hangers has been detected. The hangers are shown below.

Figure 31. Top section of hanger

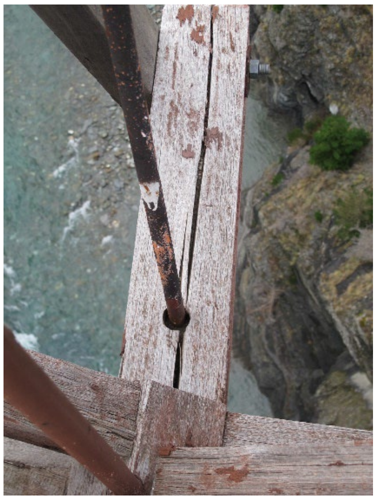

Figure 32. hanger/transom connection (split transom replaced after this photograph was taken)

Transoms

The transoms are in variable condition and are difficult to inspect as they are inaccessible beneath the deck without rope access. The defects detected in the transoms so far include longitudinal and transverse cracking. Recently a few transoms have been replaced or supplemented with steel channels. The recent timber transom replacements have longitudinal cracking which is potentially a result of being poorly seasoned prior to installation and drying post installation. Typical transom defects and repairs are shown below.

Figure 33. typical damaged transoms (these have been replaced since this photo)

Figure 34. Transoms supplemented with steel channels

Reference: Skippers Suspension Bridge - Proposed Strategic Bridge Management

Figure 35. Three timber transoms, replaced within the last four years, identified by the new steel angles to the stringer beams above, which have longitudinal cracking, probably due to drying shrinkage since placement

Reference: **Skippers Suspension Bridge - Proposed Strategic Bridge Management**

Figure 36. bolting channel section to strengthen a transom in 2019

Trusses

The trusses are in degraded condition. There are numerous areas of decay in the top chord timber and the splices in both upper and lower chords are likely to have a degree of play. Thus, a model assuming uniform stiffness in the trusses, and resulting load sharing along the trusses, may produce a non-conservative result. Representative areas of decay in the upper truss chord are shown in the figure below.

Figure 37. decay in the top chord of the trusses and steel plates to locate the truss cross bracing

The upper truss chord has an over flashing, which we assume has been installed for weather protection of the timber. This is an inconsistent approach as no other timber elements are protected from the weather. We consider that it is unlikely the flashing is effective in protecting the truss timber from water ingress as there are joints in the flashing which will let water in. The flashing may even hold water in the top chord and cause accelerated decay. In addition, the flashing prevents inspection of the truss chords for decay and prevents rot treatment of the top chord. In some areas the flashing has been compressed by the truss tie rods, and this may be indicative of rot of the timber beneath, but this is not visible due to the flashing.

Reference: Skippers Suspension Bridge - Proposed Strategic Bridge Management

Figure 38. local buckling in truss flashing which may indicate decay of the timber below

The following action is recommended to prolong the life of the truss top chords:

- Permanently remove the flashing from the top of the truss chords
- Assess the extent of timber decay and estimate residual effective timber cross-section
- Establish what effect residual effective timber cross-sections have on the current bridge posting.
- Treat the exposed surfaces of the truss chords with some form of copper napthenate in accordance with the recommendations of the document 'Stop The Rot' which is attached.
- Depending on the above findings, where necessary, introduce a planned replacement programme of chord members in critical condition

Deck Planks

Approximately 50% of the hardwood deck planks have been replaced with pine recently and the pine planks are in satisfactory condition. The remaining Hardwood deck planks are generally in poor condition, and we anticipate that replacement of the remaining hardwood deck planks will be required within the next ten years. The selection of whether the deck planks are replaced with imported renewable Australian hardwood or pine remains to be made. Pine planks are softer and less strong than hardwood. The deck planks are shown in the figure below.

Figure 39. bridge deck consisting of both pine and hardwood planks

Deck Running Planks

The running planks on the TR side of the bridge are split and degraded and require replacement. The running planks over the remainder of the structure are in satisfactory condition. The running planks are hardwood. This is shown in the figure below.

Figure 40. Degraded and split running planks on the TR end of the bridge

Deck Stringer Beams

The Stringer Beams below the deck beams which span between the transoms are difficult to observe. Where visible, the stringer beams are in good condition and no issues with the stringer beams has been identified when either deck planks or transoms have been replaced. Consequently, there is no evidence to suggest significant deterioration of the stringer beams. It is appropriate to undertake a specific check of the stringer beams when deck planks are replaced to confirm that their condition is satisfactory.

Strategic Options

The bridge is of a form where it is practical to replace most elements other than the suspension cables or towers. Piecemeal replacement of the transoms, deck, stringers, trusses and running planks can be spread out over many years, if required, to distribute the maintenance cost burden. The key element that will ultimately define the remaining useful life of the bridge is the condition of the suspension cables as these are continuous from anchor to anchor and are therefore much more difficult to replace.

We recognise that the bridge is unique and historically important. It may be worth exploring grants or other funding mechanisms available from government entities to assist QLDC with the refurbishment of the bridge.

We consider that there are four possible approaches to the maintenance and operation of the bridge. We also note that the strategy for the bridge is interrelated with any strategy for the management of the Skippers Road. The four approaches for the bridge are summarised as follows:

Option 1(Current approach): **Ongoing reactive maintenance with upcoming significant element replacements**	This is the current approach to maintenance of the bridge but in the next few decades some significant items of maintenance are anticipated. These include replacement of the remaining hardwood deck planks over the next decade, transom replacement and substantial replacement of the trusses in approximately 30 years' time. These elements are summarised in the table below in this report
Option 2: **Planned maintenance for minor and significant elements**	Thorough structural and condition assessment, followed by prioritisation and planned replacement of defective elements including such elements as the trusses and transoms
Option 3: **Ongoing piecemeal maintenance <u>until a significant element requires replacement</u> and then closure to vehicles. Anticipated to be within 20 years**	There are a variety of upcoming significant maintenance items. These include replacement of the remaining deck and upgrading of the trusses. In addition, significant transom replacement may be required. The requirement for a significant maintenance item may trigger closure of the bridge to vehicle traffic. However, we note that if the bridge is closed to vehicles there are very limited options for parking on the TL side.
Option 4:	We believe that is impractical to replace the bridge in the existing location as the existing rock foundations are unlikely to meet current standards for stability. As a

Replacement of the Bridge	result, the design for a replacement structure is not likely to pass a peer review without significant rock stabilisation works or departures from standard. Such works are likely to be cost prohibitive. . A new bridge may be able to be constructed at the location of the previous bridge (Old Skippers Bridge), however, this would require a bridge of approximately 100m span and extensive works would be required to form the road on the true-right side. It is considered this option is also likely to prove cost prohibitive.

If Council were to consider closing of the bridge to vehicle traffic this would have a significant effect on various users of the area (landowners, campers, tourists, local businesses etc.) and a consultation and/or long warning period would be required. In addition, there are limited opportunities for parking on the TL side and few vehicles can practically park adjacent to the bridge on the TL side. The existing road formation is unstable, and significant repairs were required following the heavy rain in October 2024. In addition to the instability of the road shoulder there is an adverse dip of the schist planes on the uphill side of the road which make excavation to widen the formation for parking into this area a risk. We note that there are already extensive areas of instability due to this adverse schistosity. This is shown in the figure below.

Figure 41. Adverse orientation of the schist planes on the TL side and the nominal first bridge location

It may be possible to construct a replacement bridge in the original bridge location which was located at the beach in the figure above. This would have span of approximately 100m and would require a steep road to be cut on the TR side.

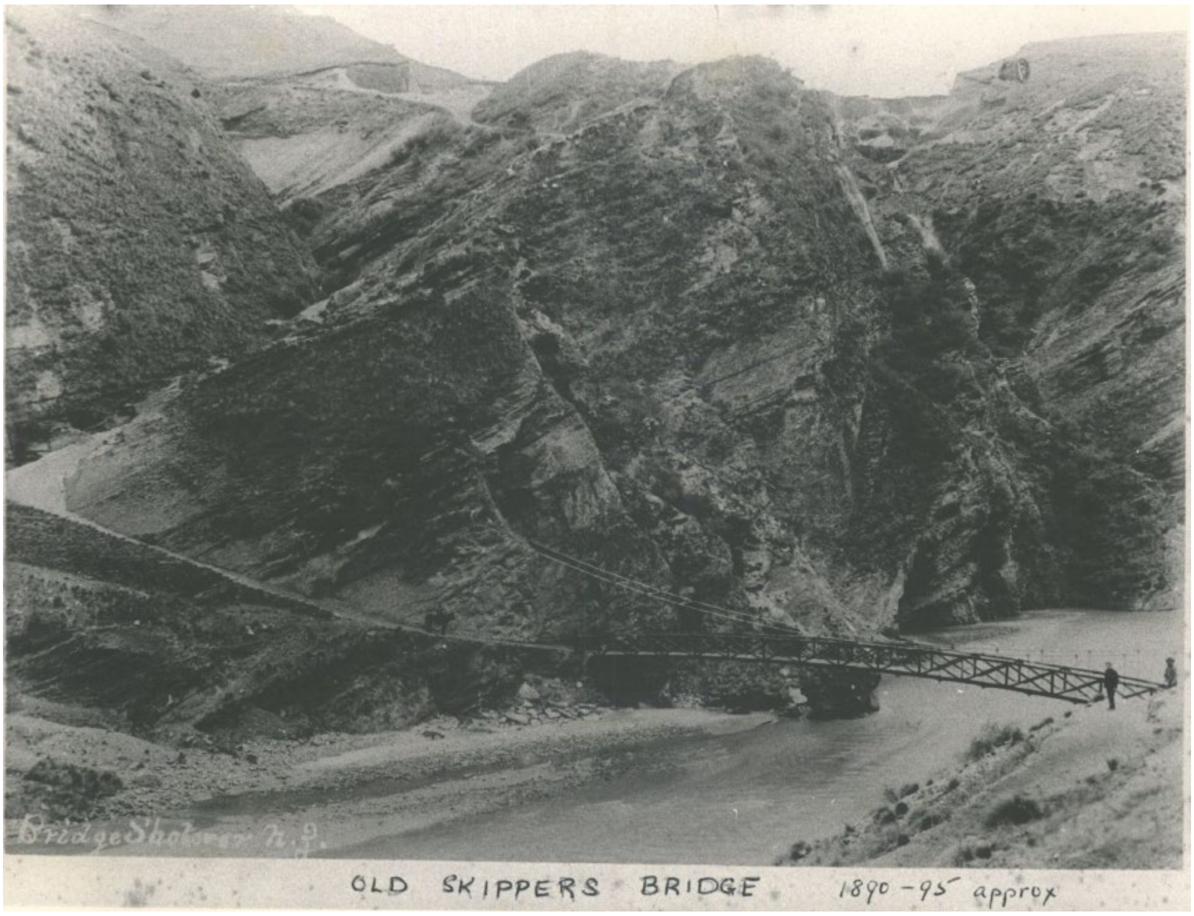

Figure 42. First Skippers Bridge, Photo from the Hocken Library

The maintenance and remaining life of each of the elements is discussed in the table below. We note that neither the towers nor the tower foundation rock is likely to meet current seismic stability standards and thus a design level earthquake may cause collapse of the towers and/or failure of the foundation blocks. An assessment of the rocking stability of the towers is recommended to confirm if a design level earthquake would cause the towers to topple. A reinforcing finder may be used to confirm the reinforcing layout in the column to confirm it has sufficient strength to rock without rupturing.

Recommended immediate and longer term actions for the various elements of the bridge are listed in the table below.

Bridge Element	Recommended Immediate Actions	Long Term Maintenance Actions	Remaining Anticipated Life Assuming Implementation of Maintenance Items
Cable Anchorages	• Excavate soil/vegetation from TR to expose cables and implement retaining structure or concrete encasement of cables to protect cables from corrosion • Clear out TL anchorages of vegetation and soil • Concrete over TL cables for corrosion protection to the level of the existing blocks • Investigate in first 100mm of existing concrete for corrosion at both TL and TR	If no significant corrosion is detected within the top 100mm of anchorage concrete, no further action is required. If corrosion of the cables within the concrete is detected there may be further undetected corrosion and further investigation is required	If no corrosion is detected during the investigations in the anchorage concrete, a remaining life of approximately 50 years is possible for the cable anchorages provided corrosion protection is provided to the existing exposed corroded areas of the cables
Cables above ground	Nil	Nil	We anticipate at least 50 years useful life remains in the cables where they are clear of the anchorages. We note the existing broken wires on the TL and the capacity of the structure will need to be assessed to allow for this reduction in capacity

Bridge Element	Recommended Immediate Actions	Long Term Maintenance Actions	Remaining Anticipated Life Assuming Implementation of Maintenance Items
Hangers	Check hanger shafts for corrosion where they are hidden in the transoms as the transoms are replaced	Nil identified	Potentially 50 years
Transoms	Repairs to recently installed but longitudinally split transoms.	Ongoing piecemeal replacement of transoms. Either steel channels or timber may be used for transom replacement and a decision on the cost, durability and aesthetic acceptability of the transom material will have to be made. We anticipate near complete replacement of timber transoms over the next approximately 25 years.	Transoms may be replaced with either hardwood or steel sections and further work is required to make this selection.

Reference: **Skippers Suspension Bridge - Proposed Strategic Bridge Management**

Bridge Element	Recommended Immediate Actions	Long Term Maintenance Actions	Remaining Anticipated Life Assuming Implementation of Maintenance Items
Trusses	• Remove flashings • Inspect to identify extent of rot within timber and extent of replacement or repair required • Treat top chord timber with a preservative agent (e.g. CN emulsion) generally in accordance with the publication 'Stop the Rot'	Piece meal rot treatment and potentially in situ timber member replacement over the next 20-30 years.	We anticipate that there is approximately 20 years effective life remaining in the trusses, but this is not an accurate figure as the extent of decay cannot be assessed with the flashings in place. Recommend removal of the existing flashing and an assessment of the quantity of timber replacement is necessary before implementing timber treatments.
Deck Stringer Beams	Nil	These are difficult to inspect, and inspection and assessment recommended when deck planks are replaced.	No significant issues with the stringer beams have been identified to date. Visual assessment of the stringers which can be seen has not detected any issues nor are issues with the stringers reported during the previous deck plank and transom replacements

Reference: **Skippers Suspension Bridge - Proposed Strategic Bridge Management**

Bridge Element	Recommended Immediate Actions	Long Term Maintenance Actions	Remaining Anticipated Life Assuming Implementation of Maintenance Items
Deck Planks	Nil	Replacement of all remaining hardwood deck timbers with either hardwood or pine timber within the next 10 years	If the original deck planks are replaced with suitable timber, we anticipate 50 years life
Running Planks	Replace planks at TR end	Piecemeal replacement of planks with hardwood (pine is not a durable choice)	We anticipate that the durable life of running planks is approximately 20 years
Towers	Nil	Grouted steel jacket around basalt block on TL downstream within next 10 years. We anticipate something like the jacket on the upstream tower	Recommend scanning towers to confirm the reinforcing details to confirm that the towers have sufficient strength to remain intact during an earthquake and a quantitative assessment of the PGA which would cause toppling of the towers. Seismic toppling of the towers is a potential significant risk.

Reference: **Skippers Suspension Bridge - Proposed Strategic Bridge Management**

Bridge Element	Recommended Immediate Actions	Long Term Maintenance Actions	Remaining Anticipated Life Assuming Implementation of Maintenance Items
Cable Stoney Roller Bearings	We do not believe that it is practical to relocate the displaced bearings	The bearings may be bound up/seized and we suggest installing a flashing around the bearings and packing the area with grease	At least 50 years remaining life is anticipated. There are current registration marks on the saddles which are used to monitor for movement, but these marks are deteriorating. Placing some form of permanent registration marks is recommended so that these can be observed with binoculars

Notes on Costing

We recognise that difficult access to the site plus distance to the site will have a major impact on the price of repair works. As previously noted, the average expenditure on annual maintenance is approximately $62,000 + GST and covers only relatively minor maintenance items. More significant maintenance items such as the works proposed on the cables, the steel jacket around the TL downstream tower(installed in 2013) and the truss upgrade will cost considerably more than this figure. These are difficult elements to price accurately without input from the maintenance contractor. We anticipate that the cost of truss replacement or upgrade will be multiple hundreds of thousands of dollars. The upgrades of the Port Craig Viaducts undertaken approximately 5 years ago cost $600,000 and involved a similarly inaccessible site. The cost of the works will depend on the extent of the work required and the nature of implementation such as whether the trusses are repaired in situ or are repaired with prefabricated sections. Consequently, a more accurate assessment of the cost of implementation of the individual repairs will require further work, but it is reasonable to expect that the value of the works will be hundreds of thousand dollars and potentially approximately a million dollars.

Notes on Remaining Useful Life of Structural Elements

The remaining useful life (RUL) of the various structural elements is difficult to predict with accuracy and is very subjective. The RULs presented in this report have therefore been rounded to the nearest 10 years and are based on professional judgement and site observation of visible elements and their condition at the time of inspection.

Reference: Skippers Suspension Bridge - Proposed Strategic Bridge Management

We trust that this assessment meets your requirements and promotes discussion of the strategy for the future of the bridge. Please do not hesitate to contact the undersigned should you have any questions regarding this issue.

Regards,

Stantec New Zealand

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Attachment: Attachment