APPENDIX M

Gostwyck Bridge Report

DARACON Group

Focus Bridge Engineering

Daracon Group

Gostwyck Bridge BN1461

Summary Strategic Report

Revision 1

November 2020

Executive summary

Gostwyck Bridge

Gostwyck Bridge over the Paterson River has a single main steel Pratt truss span supported by concrete piers and flanked by six timber girders approach spans. The bridge is generally in good condition.

The bridge is not on a B-Double route but is open to general access vehicles. When the environmental impact statement (EIS) for the Martins Creek Quarry Extension Project was submitted in 2016 it carried around 900,000 tonnes or 30,000 heavy vehicles (up to 50.5 tonne trucks) annually.

This report assesses the potential impacts of the proposed truck movements on the structure and operation of the Gostwyck Bridge and assesses the options for the ongoing maintenance of the bridge.

Heritage

Gostwyck Bridge is listed on the Transport for NSW (TfNSW) Section 170 heritage and conservation register and notification is required to Heritage NSW of any intention to modify the structure. The bridge has been assessed as a high heritage significance at a local level.

Daracon proposal

Martins Creek Quarry (the Quarry) was established in 1914 by the NSW Government Railways for the purpose of supplying track ballast and other quarry materials to the NSW rail network and other construction projects. Daracon has been operating the Quarry since December 2012 under a long term lease arrangement. The Quarry services the local market and the Gostwyck Bridge is the main access for Quarry vehicles from Dungog Road to Gresford Road, across the Paterson River.

Quarry traffic provides the predominant heavy vehicle usage on the bridge. In 2016, Daracon lodged an EIS, seeking approval for transportation of up to 1.45 million tonnes of quarry product by road. TfNSW requested that Daracon explore the potential impacts from increasing the Quarry's output on the bridge including identifying possible maintenance strategies and potentially duplicating the bridge.

Since the submission of the EIS, the proposed Project has now been revised to include output of 1.1 million tonnes per annum, with a maximum of 500,000 tonnes per annum transported by road.

Load testing and fatigue life assessment

Investigations by FBE, including load testing and structural assessment, have found the steel truss span operating as a one lane bridge is capable of supporting vehicle loads up to 68 tonne B-Doubles.

The bridge has also been found to have a remaining fatigue life well in excess of 90 years under current and proposed usage (50.5 tonne trucks) and in excess of 100 years for BD68 vehicles.

Maintenance strategy

The strategic cost estimate to maintain the bridge until 2045 or for the next 25 years is $9,079,600 (CPI adjusted but excluding GST).

Table of contents

Table index

Figure index

Appendices

1. Introduction

1.1 Background

Martins Creek Quarry (the Quarry) was established in 1914 by the NSW Government Railways for supplying track ballast and other quarry materials to the NSW rail network. Daracon Group (Daracon) has been operating the Quarry since December 2012 under a long term lease arrangement. Material from the Quarry is conveyed by heavy haulage vehicles over Gostwyck Bridge, which is a Transport for NSW (TfNSW) asset.

In 2016, Daracon lodged an Environmental Impact Statement (EIS) for the Martins Creek Quarry Extension Project, SSD 6621 (the Project). The EIS proposed that the Project would include up to 1.45 million tonnes per annum of quarry product transported by road.

TfNSW provided a response to the EIS in December 2016, identifying that additional heavy vehicles may result in adverse effects on the structure and operation of the Gostwyck Bridge, and in particular the fatigue life of the asset. Specifically, TfNSW indicated that with the then proposed increased traffic volumes, a new dual lane two-way bridge would be required.

Since the exhibition of the EIS, the Project has been revised to reduce the quarry product transported by road from 1.45 million tonnes per annum, to a maximum of 500,000 tonnes per annum. The detailed analysis undertaken in *Gostwyck Bridge BN1461 Strategic Bridge Options Report* (FBE, 2020) considers the potential maintenance requirements of 1.2 million tonnes per annum being transport via road across Gostwyck Bridge. This report draws on this analysis to adopt a conservative approach to identify the maintenance options available to adequately cover the current proposed road haulage of 500,000 tonnes per annum.

1.2 Scope

FBE has been engaged by Daracon to:

- Assess the potential impacts of truck movements across the Gostwyck Bridge as a result of the project.
- Identify strategic maintenance requirements.

1.3 Report format

This report has been prepared after discussions with both TfNSW and Daracon and addresses the following:

- Desktop review of available inspection and heritage data.
- Site inspection.
- Site constraints, including site investigation assumptions.
- Strategic maintenance.

1.4 Supplied information

The information supplied by TfNSW is shown in Table 1-1.

Table 1-1 TfNSW supplied documents (Source: TfNSW)

Document or reference	Date
Existing Bridge Information	
Existing bridge WAE drawings (16 sheets)	1926
Strengthening of cross girders and stringers (4 sheets)	2011 and 2016
Aerial photographs	2005
Geotechnical investigations	September 1997
Level 2 inspections	1999 – 2017
Level 3 inspection and assessment report by the RTA	October 2004
Additional Information	
Timber span replacement concept report by Connell Wagner	March 2009
Review of environmental factors by the RTA	January 2012
Supplementary review of environmental factors by Hills Environmental	February 2014
Traffic Impact Assessment Report for Martins Creek Quarry by SECA	August 2016
TfNSW's letter Martins Creek Quarry extension project	13 December 2016

The scanned WAE drawings are difficult to read and are of insufficient quality to present in this report.

2. Gostwyck Bridge

2.1 Location

Gostwyck Bridge (BN1461) crosses the Paterson River on Dungog Road approximately 60 km from Newcastle and 3 km north of Paterson in the Hunter Valley. The bridge location is circled in red in Figure 2-1.

Figure 2-1 Gostwyck Bridge over the Paterson River (Source: Google Earth)

2.2 Description

2.2.1 Truss and approach spans

The bridge comprises of six timber approach spans and one main steel Pratt truss span, with an overall approximate total length of 100.14 m (see Figure 2-2 and 2-3). There are three 10.66 m and one 11.06 m timber approach spans on the Paterson side of the bridge and two timber approach spans of 11.06 m and 9.14 m on the Dungog side. The steel truss has a span of 36.9 m and is supported on reinforced concrete piers 4 and 5.

The carriageway width is 5.48 m between kerbs and carries a narrow two lanes for light vehicles or one lane for heavy vehicles. The internal truss height clearance from the deck to the overhead bracing is 5.5 m.

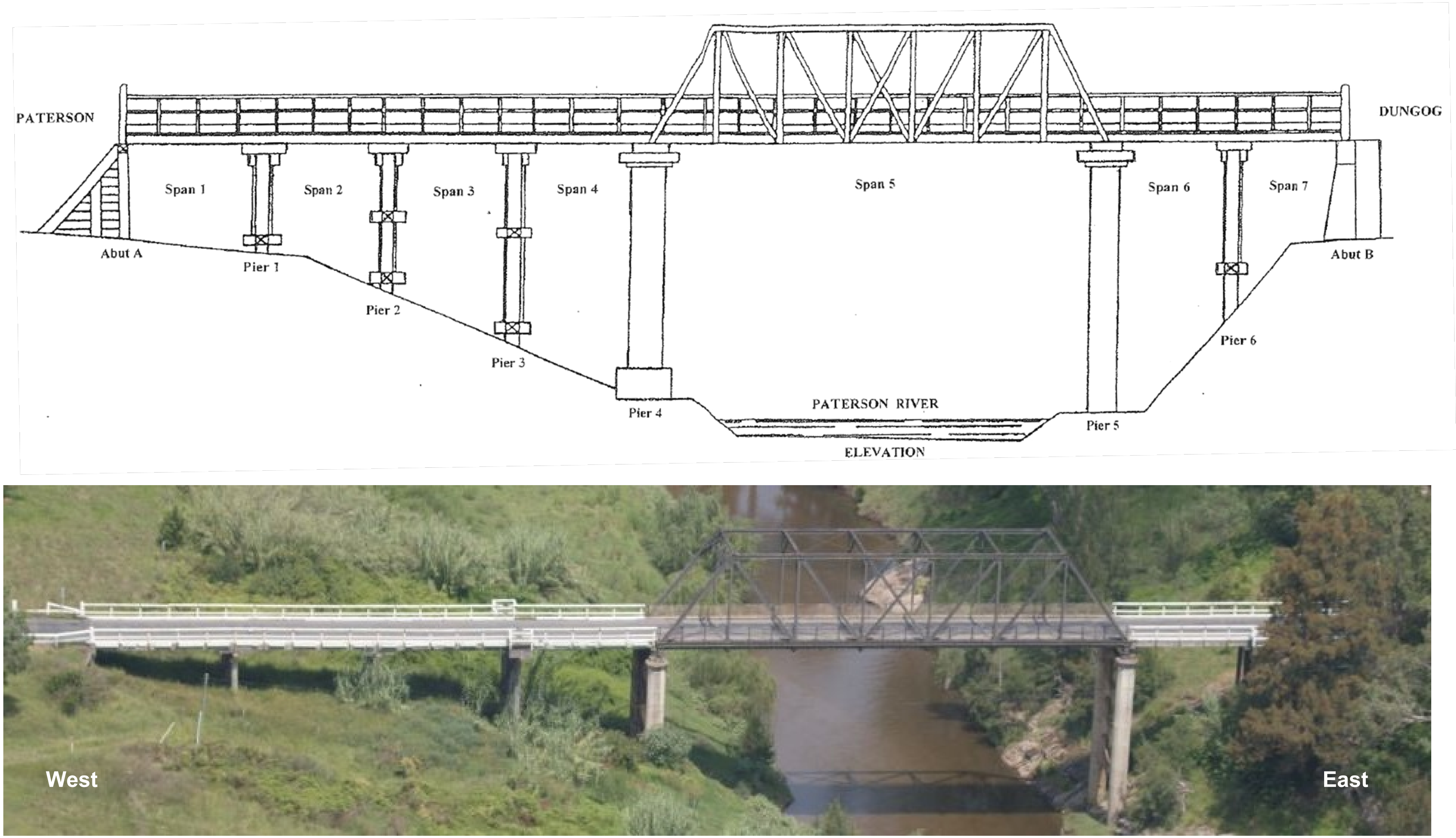


Figure 2-2 **Element diagram and aerial photograph of Gostwyck Bridge in 2005 (Source: TfNSW)**

Figure 2-3 Aerial photograph of Gostwyck Bridge in 2005 (Source: TfNSW)

2.2.2 Deck

The approach spans consist of 75 mm thick longitudinal timber sheeting supported on 120 mm thick transverse timber decking. The decking spans between seven timber girders that are spaced at approximately 1.05 m centres.

The deck of the steel truss span consists of a reinforced concrete slab supported by seven longitudinal stringers at approximately 0.99 m centres, supported in turn by cross girders at each panel point. The truss comprises seven panels of 5.24 m length and has an overall height of 7.01 m.

2.2.3 Substructure

The substructure of abutment A, piers 1 to 3, and pier 6 consists of timber corbels seated on either capwales or headstocks. These are supported in turn by timber pile trestles.

The trestles have been driven 6 to 9 m into sandy loam on the Paterson side of the bridge and fitted into potted holes in the underlying ignimbrite rock on the Dungog side.

Abutment B was replaced in 1998 with a new concrete sill wall supported on concrete cylindrical piles anchored into rock.

Piers 4 and 5 support the steel truss span with cylindrical reinforced concrete columns. The columns are interconnected by a reinforced concrete diaphragm with three oval voids to form a blade structure. Pier 4 is supported by concrete caissons and pier 5 is anchored into rock with drilled steel dowels.

2.3 Bridge usage

In 2001 the AADT was approximately 1425 vehicles per day with 13% heavy vehicles. The road is classified as regional (TfNSW, 2020).

The number of heavy vehicles using Gostwyck Bridge has been summarised in Table 2-1.

The table appears to show that the outbound number of quarry trucks has been relatively consistent over the previous seventeen years, with the noticeable exception of 2013/14 where there was a spike to 1.15 million tonnes that year.

Table 2-1 Martins Creek Quarry estimated outbound truck movements (Source: see Table)

Operator	Financial Year	Estimated tonnage per year	Estimated truck movements per year	Estimated truck movements per day
	2001 (RTA)⁺	911,400	28,043	80
RailCorp	2003/4*	772,984	23,784	86
	2004/5*	652,991	20,092	73
	2005/6*	828,684	25,498	93
	2006/7*	609,487	18,753	68
	2007/8*	687,287	21,147	77
	2008/9*	633,397	19,489	71
	2009/10*	645,821	19,871	72
	2010/11*	569,930	17,536	64
	2011/12*	834,254	25,669	93
RailCorp / Daracon	2012/13*	940,326	28,933	105
Daracon	2013/14**	1,150,434	36,528	123
	2014/15**	906,537	29,819	101
	2015/16**	848,211	27,798	93
	2016/17**	758,009	26,808	91
	2017/2018**	663,071	22,507	75
	2018/2019**	521,774	18,209	66

⁺ Based on AADT of 1245 vehicles (13% heavy vehicles) per day for 7 days for 50 weeks of the year at 32.5 tonnes per load.

* Martins Creek Quarry Traffic Impact Assessment (SECA 2016) averaged outbound truck movements only, based on 50 weeks of the year.

** Martins Creek Quarry Traffic Impact Assessment (SECA, 2020) averaged outbound truck movements, based on 32.5 tonnes per truck load.

2.4 Heritage listings

The bridge is listed on the Heritage NSW State Heritage Inventory, the *Dungog Local Environment Plan 1990* and the TfNSW Section 170 Heritage Register. See Table 2-2 below for the results of the search of statutory and non-statutory heritage registers undertaken for this bridge.

Table 2-2 Statutory and non-statutory listings (Source: see Table below)

Heritage Listing	Status 5/6/2018
Australian Heritage Database	Not listed
National Heritage List	Not listed
NSW State Heritage Register	Not listed
NSW State Heritage Inventory	Listed database number 4301676
Dungog Local Environment Plan 2014	Item number I107
NSW National Trust Register	Not listed
Engineering Heritage Australia Engineering Heritage Register	Not listed
NSW TfNSW Section 170 Heritage and Conservation Register	Listed

The statutory listings that are relevant to any proposed works are the TfNSW's Section 170 register and the Dungog LEP. As the bridge is not listed on the NSW State Heritage Register and the Project is a State Significant Development no approval from Heritage NSW is required for any proposed works.

The heritage status, schedule and assessment can be found in Appendix A.

2.5 Section 170 register

TfNSW's Heritage and Conservation Register was established in accordance with Section 170 of the Heritage Act, 1977 to record all the heritage items in the ownership or under the control of TfNSW.

The Heritage and Conservation Register has two main roles:

1. To meet TfNSW statutory requirements.
2. As an essential tool in total asset management, by listing and providing information on those TfNSW assets which have heritage significance.

Information in the Register has been prepared according to Heritage NSW, Heritage Division guidelines and corresponds with information in the State Heritage Inventory, maintained by Heritage NSW, Heritage Division.

3. Previous inspections

3.1 L2 inspections

TfNSW undertook a Level 2 (L2) visual inspection of the Gostwyck Bridge on 17 July 2017. The results of this inspection are summarised in Table 3-1 and Table 3-2.

Table 3-1 Level 2 inspection condition summary (Source: TfNSW)

BN1461	Gostwyck Bridge over Paterson River				Quantities: RMS			
Inspection Date: 17/07/2017					Inspector: Ross Rooke			
Element Code	Element Description	Health Rating	Total Qty*	Unit	Estimated quantity or percentage of total in Condition State			
					1	2	3	4
BEXP	Metal Expansion (Roller, Sliding, etc) Bearing	GOOD	2	ea	1	1	0	0
BFIX	Metal Fixed Bearing	GOOD	2	ea	1	1	0	0
CABW	Concrete-Abutment and Wingwalls	AS-BUILT	106	m2	106	0	0	0
CDSL	Concrete-Deck Slab	FAIR	225	m2	175	25	**25**	0
CPIR	Concrete-Pier (excl. any Headstock or Piles)	FAIR	260	m2	220	20	**20**	0
JNOS	Joint - No Seal	FAIR	6	m	0	0	**3**	**3**
MAPP	Approach Carriageway	AS-BUILT	2	ea	2	0	0	0
MGCL	General Cleaning	AS-BUILT	7	ea	7	0	0	0
MWES	Wearing surface	GOOD	603	m2	53	50	**250**	**250**
MWWY	Waterway	AS-BUILT	1	ea	1	0	0	0
PDBR	Protective Coating - Diaphragm/ Bracing / Secondary Member	AS-BUILT	85	m2	85	0	0	0
PTBC	Protective Coating - Truss - Bottom Chord	AS-BUILT	169	m2	169	0	0	0
PTCG	Protective Coating - Truss - Cross Girder	AS-BUILT	227	m2	227	0	0	0
PTDG	Protective Coating - Truss - Diagonals	AS-BUILT	135	m2	135	0	0	0
PTPR	Protective Coating - Truss - Principal	AS-BUILT	92	m2	92	0	0	0
PTST	Protective Coating - Truss - Stringers	AS-BUILT	311	m2	311	0	0	0

Table 3-1 (continued) Level 2 inspection condition summary (Source: TfNSW)

Element Code	Element Description	Health Rating	Total Qty*	Unit	Estimated quantity or percentage of total in Condition State			
					1	2	3	4
PTTC	Protective Coating - Truss - Top Chord	AS-BUILT	147	m2	147	0	0	0
PTVT	Protective Coating - Truss - Verticals	AS-BUILT	131	m2	131	0	0	0
RMET	Metal Railing	GOOD	75	m	60	15	0	0
RTIM	Timber Railing	AS-BUILT	126	m	126	0	0	0
SDBR	Steel - Diaphragm / Bracing / Secondary Member	AS-BUILT	85	m2	85	0	0	0
STBC	Steel - Truss Bottom Chord	AS-BUILT	169	m2	169	0	0	0
STCG	Steel - Truss Cross Girders	AS-BUILT	227	m2	227	0	0	0
STDG	Steel - Truss Diagonals	AS-BUILT	135	m2	135	0	0	0
STPR	Steel - Truss Principals	AS-BUILT	92	m2	92	0	0	0
STST	Steel - Truss Stringers	AS-BUILT	311	m2	311	0	0	0
STTC	Steel - Truss Top Chord	AS-BUILT	147	m2	147	0	0	0
STVT	Steel - Truss Verticals	AS-BUILT	131	m2	131	0	0	0
TASG	Timber-Abutment Sheeting / Gravel Board	AS-BUILT	25	m2	25	0	0	0
TCHS	Timber-Capwales / Headstock / Sill	AS-BUILT	5	ea	5	0	0	0
TCOR	Timber-Corbel	GOOD	28	ea	27	1	0	0
TDBO	Timber-Deck Bolts	AS-BUILT	5	ea	5	0	0	0
TGCG	Timber-Girder / Cross Girder	AS-BUILT	42	ea	42	0	0	0
TLSH	Timber-Longitudinal Sheeting / Decking	AS-BUILT	380	m2	380	0	0	0
TPIL	Timber-Pile	FAIR	30	ea	26	2	**2**	0
TTDK	Timber-Transverse Deck Plank	AS-BUILT	380	m2	380	0	0	0
TWBR	Timber-Wale / Brace	AS-BUILT	26	ea	26	0	0	0
* Estimated quantities								

The July 2017 L2 report identifies a number of defects and required maintenance actions for Gostwyck Bridge and a summary of these actions can be found in Table 3-3.

Table 3-2 Level 2 inspection condition summary (Source: Umwelt)

Poor condition	Fair condition	Good condition	As-built
Nil	• Concrete deck slab • Concrete pier • Joints • Timber piles	• Bearings • Wearing surface • Metal railing • Timber corbel	• Concrete abutment and wingwalls • Approach carriageway • Steel truss • Protective coating for steel truss • Timber railing • Timber abutment and abutment sheeting • Timber girders and cross-girders • Timber decking and deck bolts • Timber wale / brace

3.2 Maintenance actions

The July 2017 L2 report outlines several required maintenance actions intended for completion in July 2018 including:

1. Replacement of concrete deck slab.
2. Rehabilitation of concrete cracking at piers.
3. Rehabilitation of unsealed deck joints.
4. Reseal timber planks.

To our knowledge only item 4 has been completed as of the date of this report.

The July 2017 L2 report outlines the defects and required maintenance actions for Gostwyck Bridge and a summary of these actions can be found in Table 3-3.

Table 3-3 Defects and required maintenance actions (Source: TfNSW)

Bridge Number and Name: Gostwyck Bridge BN1461							
Description: Steel Pratt truss main and six timber approach spans							
Inspector: Deve Manchanayake							
Element Code	**Defect Number**	**Activity**	**Inspectors Comment on Defect Severity and Required Action**	**Estimated Quantity**	**Unit**	**$R_f = P_f \times C_f$**	**Activity Inaction Risk**
CDSL	1	M769 replace concrete deck slab	Deck cracking in truss span	25	m^2	1	Low
CPIR	2	M769 rehab concrete post-tension girder	Cracking occurring at piers	20	m^2	1	Low
JNOS	3	M788 rehab joint no seal	Joints in truss spans leaking	6	m	1	Low
MWES	4	R106 reseal bridge surface	No seal on timber planks	500	m^2	1	Low
TPIL	5	M762 replace/splice pile	Piles at pier 6 decaying	2	ea	1	Low

Where activity inaction risk ($R_{f)}$ = probability (Pf) x consequence (C_f), and where probability (P_f) of safety or structural problem due to inaction = 1. Rare, 2. Could, 3. Might, 4. Will, 5. Expected, and consequences (Cf$_)$ of inaction = 1. Insignificant, 2. Minor, 3. Moderate, 4. Major, 5. Catastrophic.

3.1 TfNSW 2004 Level 3 inspection

TfNSW's Bridge Evaluation and Assessment Unit (BEAU) completed a Level 3 inspection and structural assessment of Gostwyck Bridge in October 2004. Since this load assessment, significant rehabilitation has been undertaken by TfNSW, particularly on the timber approach spans

3.1.1 Structural inspection

The structural inspection was completed by Messrs Peter Ton (Project Engineer) and Shaun Hinks (Bridge Inspector) on 24 May 2004.

Steel truss span

Table 3-4 summarises the major findings for the steel truss span from the Level 3 inspection.

Table 3-4 Level 3 inspection major findings steel truss span (Source: TfNSW)

Location	Condition	General comments
Steel truss span		
Top chord	GOOD	Surface corrosion on lattice bracing, rivet heads and top of splice plates
Principals and diagonals	GOOD	Surface corrosion and pitting on lattice bracing, surface corrosion on joint rivet heads
Vertical members	FAIR	Corrosion in web connections due to entrapment of water, Joints L1 to L are in "poor" condition due to corrosion
Upper main lateral bracings	FAIR	Surface corrosion and corrosion in lattice bracings. Corrosion in couplers and tie-rods
Bottom chords	FAIR	Surface corrosion on flanges and lattice bracings
Cross girders (L2-L2, L4-L4, L6-L6)	POOR	Major corrosion and flaking top flanges and soffit of horizontal gusset plates
Cross girders (Others)	FAIR	Corrosion in web of L1-L1, L3-L3, L4-L4 and L5-L5
Stringers (Outside stringers)	POOR	Major corrosion in top flanges
Stringers (Others)	FAIR	Typical corrosion at ends and surface corrosion
Bearings	FAIR	Surface corrosion in bearing plates
Reinforced concrete piers	FAIR	Honeycomb in soffit of Pier 5 bottom diaphragm
Reinforced concrete deck slab	FAIR	Longitudinal crack and concrete spalling in soffit of deck slab

Timber elements

The timber spans were found to be mostly in “fair” condition. Some girders had deteriorated to a “poor” condition and a significant portion of transverse decking (up to 52% in Span 3) had deteriorated to a “poor and/or very poor” condition.

There was evidence of live termites in both Abutment A and Pier 6 timber piles.

FBE understands that the deteriorated timber elements identified in the L3 inspection were replaced in the recent 2014 rehabilitation work undertaken and confirmed by TfNSW.

The condition of these elements listed in the 2004 condition assessment is not relevant to ongoing works on Gostwyck bridge as these items have been replaced or rehabilitated. The presence of termites within the footprint of the bridge, however, should be noted as an ongoing risk to maintaining the timber elements. A Level 2 bridge inspection is completed every 2 years as part of TfNSW business rules.

3.1.2 Load rating assumptions

Timber spans

The assessment specifies the following assumptions for the analysis of the timber beam spans:

- 2D frame model for timber piers.
- Members and materials are in sound condition.
- The structural assessment was completed by BEAU in accordance with Bridge Branch – Load Capacity Assessment Manual for Timber Girder Bridges May 1997.
- Capacities were determined using Timber structures code AS 1720.1 – 1988.
- No other live load on the bridge except for ST42.5t Semi-Trailers.

Steel truss span

BEAU do not indicate to which standard or code the steel truss span has been rated in the Level 3 assessment.

Based on the date at which the assessment has occurred, FBE has assumed the structural assessment of the steel truss was completed to the 1996 Australian Bridge Design Code (ABDC).

The assessment specifies the following assumptions specific to the analysis of the steel truss:

- A 2D truss model.
- Members and materials are in sound condition.
- Substructure is able to carry the loads allowed on the deck.
- The member details shown on the drawings are not changed.
- No other live load on the bridge except for ST42.5t Semi-Trailers.

3.1.3 Material properties

The following material properties are stated as assumed for the structural assessment:

- Steel yield strength of 230 MPa.
- Stress grade of timber assumed as F22.

3.1.4 Rating vehicles

The three rating vehicles used in the assessment are shown in Figure 3-1, which is an excerpt from Appendix F of the TfNSW BEAU 2004 inspection and assessment report.

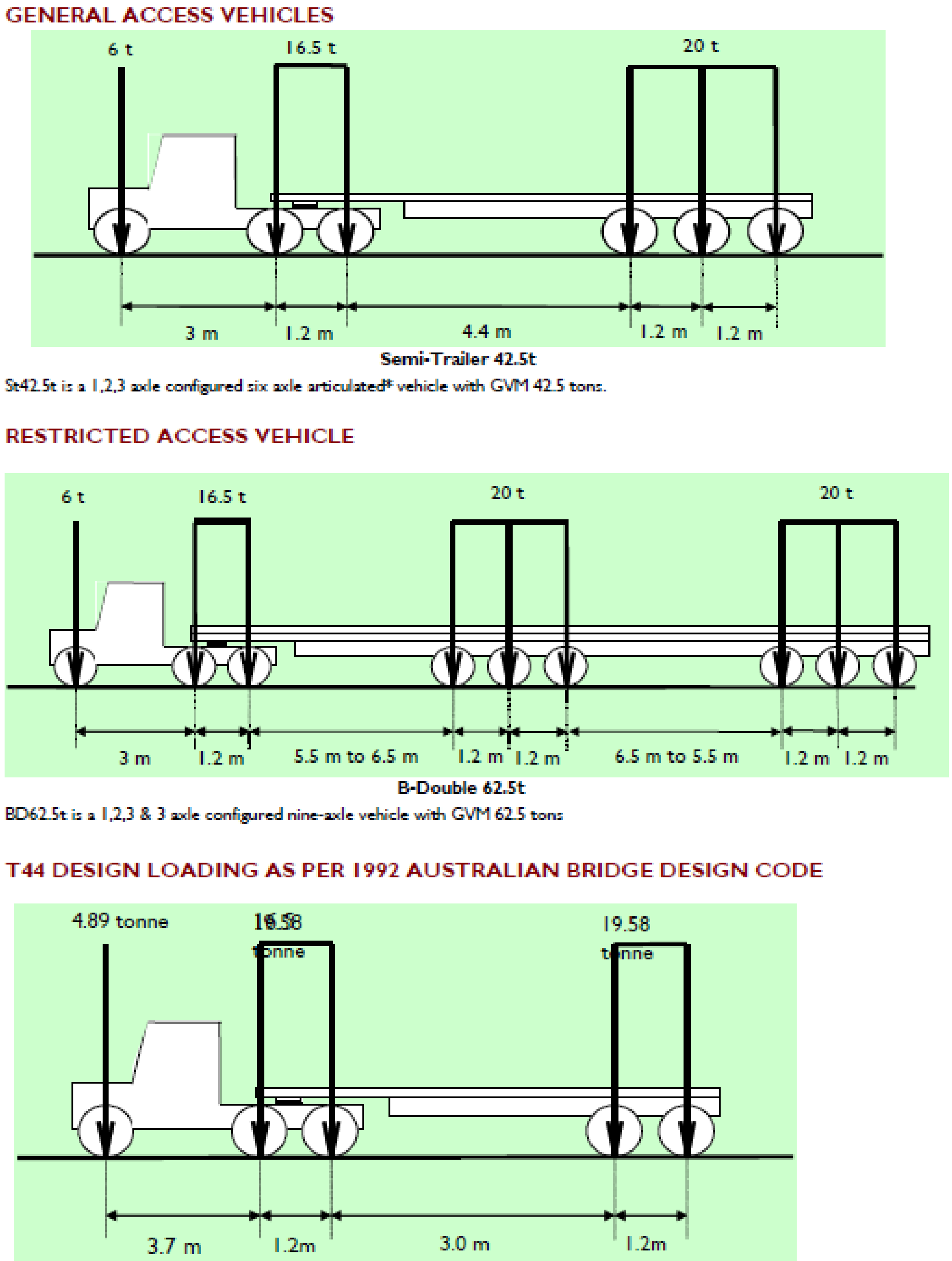


Figure 3-1 Assessment vehicles used in the BEAE 2004 L3 assessment (Source: TfNSW)

The load ratings in the 2004 BEAE L3 assessment refer to a “DT50” or “Dog Trailer 50T” vehicle. The axle arrangement of this vehicle is not described within the report.

It should be noted that the load rating assessment results for the steel truss span are given in the L3 report for two simultaneous ST42.5 vehicles. The results for the timber spans are for a single ST42.5 vehicle only.

3.1.5 Load factors

The load combinations and factors used in the assessment in accordance with AS5100.7 have not been stated. The dynamic load allowance (DLA) has been specified as 25%.

It is unclear if the assessment of the bridge was limited to ultimate limit state (ULS) dead loads and traffic loading combinations only. It is also unclear whether the analysis of other load effects including wind and braking loads were considered.

3.1.6 Element condition

The L3 assessment was performed for both the "good" and "as-is" condition.

The "good" condition is interpreted to be the "as-built" condition state of the bridge, with no reductions in capacity for elements.

The "as-is" condition is noted in the table of results for the assessment, summarised in Section 8.3 of this report, as a "10% downgrading" of both the cross girders and steel stringers. This is interpreted to be a 10% reduction in capacity of the relevant element.

3.1.7 Load rating results

The assessment results for both the steel truss and timber spans are presented below in Table 3-5 and Table 3-6. These results are presented as shown in the 2004 BEAE L3 assessment and have not been checked for accuracy.

Steel truss span

A summary of the load rating results for the steel truss span are shown in Table 3-5.

Table 3-5 Summary of level 3 load rating results for the steel truss span

Member	Two ST42.5		DT50	BD62.5
	Good	As-is	Good	Good
Top chord	ST 74.3	ST 74.3	DT 50	BD 90.6
Bottom chord (L2-L3)	>ST 42.5	>ST 42.5	DT 50	>BD 62.5
Bottom chord (L3-L4)	ST 74.3	ST 74.3	DT 50	BD 90.6
End posts	>ST 42.5	>ST 42.5	DT 50	>BD 62.5
Vertical members (U1-L1)-Tension	>ST 42.5	>ST 42.5	DT 50	>BD 62.5
Vertical members (U2-L2)-Compression	ST 55.2	ST 55.2	DT 50	BD 81.2
Diagonal members (L2-U1)-Tension	ST 57.3	ST 57.3	DT 50	BD 75
Diagonal members (L3-U2)-Tension	>ST 42.5	>ST 42.5	DT 50	>BD 62.5
Cross girders	ST 42.5	ST 36.5	DT 50	BD 62.5
Stringers	ST 55.2	>ST 42.5	DT 50	BD 81.2
Deck slab	>ST 42.5	>ST 42.5	DT 50	BD 62.5

Timber spans

The results for the timber span girders are not directly applicable to the current arrangement on Gostwyck Bridge. The rehabilitation work has increased the number of girders per span from five to seven and has replaced the outside rectangular girders with round girders similar to the inside girders. The number of piles has also been increased from four to six.

Table 3-6 Summary of level 3 load rating results for the timber spans

Member	Single ST42.5	
	Good	As-is
Timber girders (Edge – 340Dx300W)	ST 31.8 (sagging)	ST 24.3
Timber girders (Middle – 400D round)	ST 29.4 (sagging)	ST 29.4
Headstock (360Dx280W)	ST 42.5 (shear)	>ST 42.5
Capwales (2x290Dx150W)	ST 42.5 (shear)	>ST 42.5
Steel cross girder of approach span	>ST 42.5	>ST 42.5
Piles and trestles	>ST 42.5	*N/A
*Note: The L3 assessment did not rate the timber piles in the "as-is" condition due to termite damage		

3.1.8 Strengthening, repair and maintenance strategies

The 2004 BEAE L3 report suggests strengthening or replacing undersized or poor condition bridge elements so that the bridge would be capable of carrying one ST 42.5 load vehicle.

The report suggests two options for strengthening/rehabilitation of the timber spans:

- Option A – replace timber girders with increased size rectangular girders
- Option B – Provide two additional girders (increase from five to seven), replace edge girders if they are in poor condition.

No strengthening of the steel truss was proposed.

3.1.9 Conclusions and recommendations

The 2004 BEAE L3 report makes the following conclusions and recommendations:

1. The load rating of the bridge before any remediation work is ST 24.3
2. No strengthening of the steel truss span is required
3. Remedial work should be undertaken on the timber approach spans
4. Two additional timber girders per span should be added to the approach spans
5. Rust and corrosion should be removed from the steel truss span with grit blasting

Items 3 and 4 were actioned by the TfNSW Hunter Region.

4. Site inspection

Josh King, Bridge Engineer from Focus Bridge Engineering inspected the site during the Level 4 (L4) load testing between 09:00 am and 2:00 pm on 11 May 2018. There were 298 photographs taken, recording as many aspects of the site and bridge as time and access permitted.

4.1 General observations

Access to the bridge was from the ground, river embankments, road and deck level, and from an underslung work platform provided by TfNSW. Access was not possible to all of the bridge, for example; top chords, underside of girder spans, below ground level, etc.

4.2 Barriers

4.2.1 Traffic barriers

The approaching roads either side of the bridge have steel w-beam barriers. These connect via timber end posts to a twin rail timber bridge barrier. The timber barriers terminate at the steel truss span and are replaced with a twin rail steel barrier with mesh infill located on the inside of the truss. Figure 4-1 shows both the timber and steel barriers.

Figure 4-1 Gostwyck bridge timber and steel barriers (Source: FBE)

The steel barrier was rated as being in “good” condition and the timber barrier as being in “as-built” condition in the TfNSW 17 July 2017 Level 2 (L2) inspection.

4.2.2 Pedestrian refuge platforms

The bridge has timber pedestrian refuge platforms connected to the headstocks and deck of the timber spans. There is a refuge upstream and downstream at Pier 3, and downstream at Pier 6.

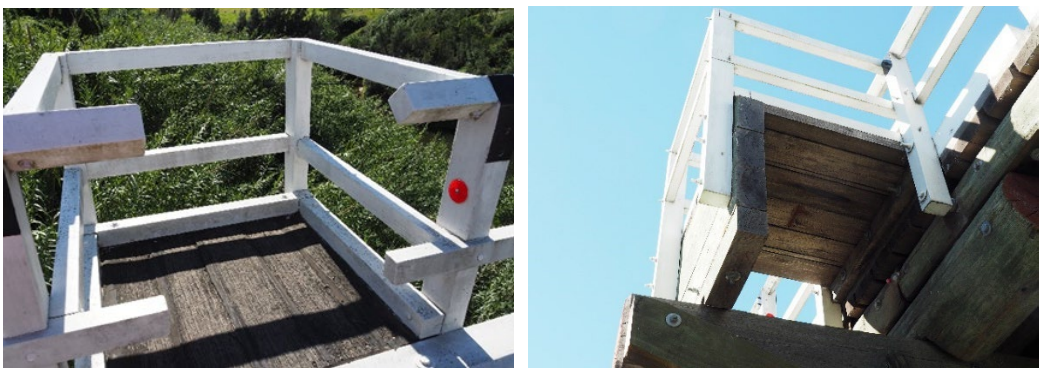


Figure 4-2 Pedestrian refuge platform (Source: FBE)

4.3 Carriageway

The bridge carriageway is composed of two timber decks and one concrete deck. There is formalised drainage on the concrete deck only. The timber decks join the Paterson side approach road and the concrete deck with unsealed joints. A new sealed joint has been installed on the Dungog side of the bridge above the newly constructed concrete abutment.

4.3.1 Timber decks

There are two timber decks: a three span continuous section over spans 1 to 3 on the Paterson side of the bridge; and a two span continuous section over spans 5 and 6. Both timber decks are composed of longitudinal timber planking bolted to transverse timber elements. Figure 4-3 shows the longitudinal deck planks viewed from the deck of the bridge.

Figure 4-3 Timber bridge decks (Source; FBE)

The timber decks were rated as being in “as-built” condition in the 17 July 2017 L2 inspection. However, it should be noted that the deck planks were rated as being in “fair” condition during the 29 March 2017 L2 inspection and were nominated for further monitoring.

Figure 4-3 and Figure 4-4 shows the transverse deck planks viewed from the upstream river bank. These were rated as being in “as-built” condition in the July 2017 L2 inspection.

Figure 4-4 Timber bridge decks (Source; FBE)

Some cracking and weathering of longitudinal decking was observed during the FBE inspection. Peeling of the tar-seal between planks was also noted. These are shown in Figure 4-5.

Figure 4-5 Timber bridge deck longitudinal cracking and weathering (Source: FBE)

4.3.2 Concrete deck

The steel truss span supports a reinforced concrete deck overlaid with asphalt. There is evidence of concrete cracking and previous repair at each panel point, as shown in Figure 4-6.

The concrete deck has been rated as being in "fair" condition in the 17 July 2017 L2 inspection.

Figure 4-6 Cracks and repairs to concrete deck (Source: FBE)

4.3.3 Drainage

The timber decks have no formalised drainage however regular gaps in the timber kerbs are provided to allow surface runoff to escape the bridge (see Figure 4-7).

Figure 4-7 Gaps in timber kerb (Source: FBE)

The concrete deck has 100 mm diameter scuppers that discharge directly into the river as shown in Figure 4-8).

Figure 4-8 Timber bridge deck longitudinal cracking and weathering (Source: FBE)

4.3.4 Deck joints

There are unsealed deck joints between the road approach on the Paterson side and the timber approach spans, and between the timber spans and the steel truss span. There is also a sealed joint between the bridge and the approach road on the Dungog side of the bridge.

The unsealed deck joints are shown in Figure 4-9. The left image shows the joint between the bridge and the approach carriageway and the right image the joint between the timber spans and the steel truss span.

Figure 4-9 Typical condition of unsealed deck joints (Source: FBE)

TfNSW has rated the unsealed deck joints as being in "fair" condition. Spalling and deterioration of the wearing course at these locations was noted during the FBE inspection.

The sealed joint, likely installed during the recent replacement of Abutment B, is shown in Figure 4-10. This joint shows no signs of deterioration or wear.

Figure 4-10 Sealed deck joint (Source: FBE)

The condition of the sealed joint is not noted in the last L2 inspection but appears to be in "good" condition.

4.4 Superstructure

The bridge is composed of three timber spans on the Paterson side of the bridge each 10.66 m in length, one primary steel truss span over the river with a span of 36.91 m, and two timber spans on the Dungog side of the bridge of 11.06 m and 9.14 m in length.

In general, the superstructure was observed as being in “as-built” to “good” condition.

4.4.1 Timber girders

The bridge has three spans of timber girders on the Paterson side of the bridge and two on the Dungog side. The timber spans are composed of timber longitudinal and transverse decking supported by seven round timber girders, as shown in Figure 4-11.

The girders are connected to the deck with bolts and to the substructure through timber corbels at timber piers.

TfNSW has rated the timber girders as being in “as-built” condition.


Figure 4-11 Typical condition of timber girders (Source: FBE)

The timber corbels, seen in the right image in Figure 4-11, have been rated as being in “good” condition by TfNSW.

At the interface with the steel truss span, the timber girders are connected directly to a steel cross-girder on top of the concrete pier, as shown in Figure 4-12.


Figure 4-12 Typical timber girder connection to steel cross girder (Source: FBE)

At the interface with the new concrete abutment the timber girders are seated on elastomeric bearings. It was not possible to inspect these bearings.

Some minor longitudinal cracking of the girders on the Dungog side of the bridge was noted.

4.4.2 Steel truss

The primary span of the bridge is a steel Pratt truss as shown in Figure 4-13.

Figure 4-13 Steel Pratt truss span (Source: FBE)

The principal, top chord, bottom chord and vertical truss members are latticed. Diagonal truss members are doubled, as shown in Figure 4-14.

Figure 4-14 Latticing on principal, diagonals, top and bottom chords (Source: FBE)

Each panel is tied to the opposite truss with a latticed cross member. The end panels at the principal truss members have a deeper latticed cross-member. This is shown in Figure 4-15.

Figure 4-15 Cross members end and typical panels (Source: FBE)

The steel truss has been recently painted and has been rated by TfNSW in the July 2017 L2 inspection as being in “as-built” condition. There were no observed areas of damage or corrosion on the truss.

4.4.3 Cross girders and stringers

The steel cross-girders and stringers, shown in Figure 4-16, were rated as being in "as-built" condition in the latest L2 inspection by TfNSW.

Figure 4-16 Typical steel cross girders (Source: FBE)

Some steel strengthening plate work and repairs have been conducted on the cross-girders and stringers, as shown in the right image in Figure 4-16 and in Figure 4-17.

Figure 4-17 Typical steel stringers (Source: FBE)

Staining from water ingress was noted as visible from the under-bridge access.

4.5 Bearings

The steel truss span has fixed bearings at Pier 4 and expansion bearings at Pier 5. These are shown as the left and right images respectively in Figure 4-18.

Figure 4-18 Typical condition of steel span bearings (Source: FBE)

Both sets of bearings were listed as being in "good" condition in the July 2017 L2 inspection report.

4.6 Substructure

The bridge was originally constructed with timber abutments on both the Paterson and Dungog sides. TfNSW has replaced the Dungog side abutment, Abutment B, with reinforced concrete in 1998.

The timber spans of the bridge on the Paterson side of the river were rehabilitated in 2014 by TfNSW. During this rehabilitation much of the timber was replaced and is subsequently still in “good” to “as-built” condition.

The timber bridge spans are supported by timber piers and piles. The timbers piles are generally rated as being in “fair” condition, however the piles on Paterson side of the bridge were observed as being in “as-built” condition while the piles on the Dungog side were observed as deteriorated.

The main steel truss span is supported by reinforced concrete piers.

4.6.1 Timber abutment – Abutment A

The timber abutment, headstock and sheeting are identified as being in “as-built” condition by the July 2017 L2 inspection. These elements are shown in Figure 4-19.

Figure 4-19 Timber abutment (Source: FBE)

Much of Abutment A was replaced during the 2014 rehabilitation of the timber spans on the Paterson side. Figure 4-20 shows an excerpt from the Supplementary Review of Environment Factors February 2014 supplied to FBE by TfNSW. This excerpt identifies the extents of Abutment A replacement.

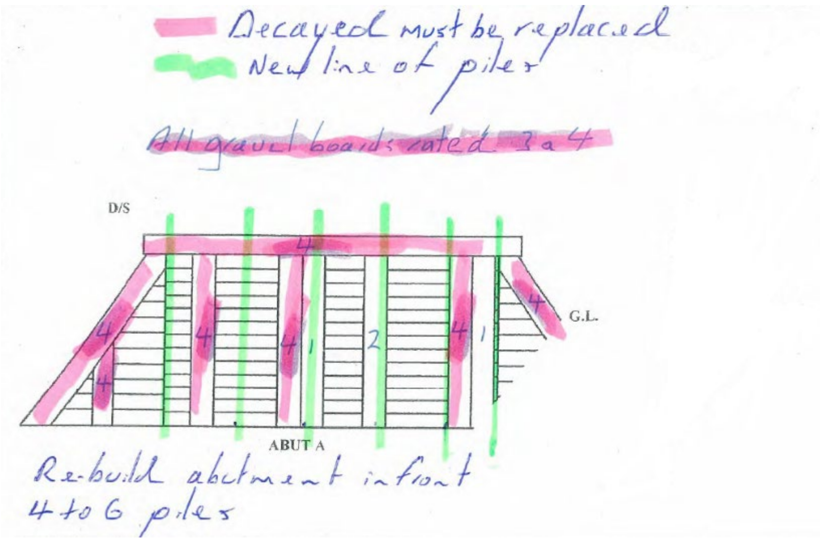


Figure 4-20 Timber abutment replacement (Source: TfNSW)

4.6.2 Timber piers on Paterson side of bridge – Piers 1 to 3

The timber piers on the Paterson side of the bridge are observed as being in "as-built" condition in the 2017 L2 inspections. Typical pier conditions are shown in Figure 4-21.

Figure 4-21 Typical condition of Piers 1 to 3 (Source: FBE)

The number of piles per pier on the Paterson side of the bridge has been increased from 4 to 6 for each pier. This is shown in Figure 4-22 which is an extract from the Supplementary Review of Environment Factors February 2014 supplied to FBE by TfNSW.

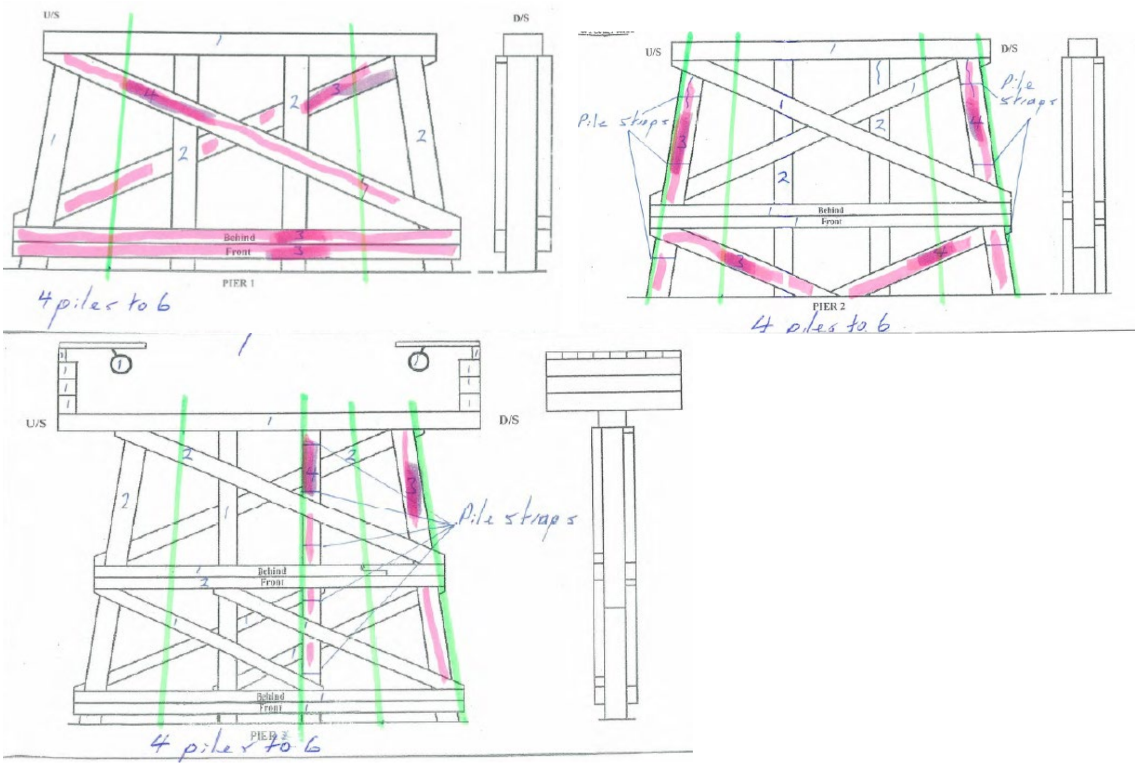


Figure 4-22 Timber pier rehabilitation for Pier 1 to 3 excerpt (Source: TfNSW)

Figure 4-22 shows in green where the new timber piles have been installed on these piers, and where deteriorated timber has been replaced.

4.6.3 Timber pier on Dungog side of bridge – Pier 6

The timber piles on the Dungog side of the bridge have not been rehabilitated. This was either due to the poor access on this side of the bridge or these piles were not considered as badly deteriorated as those on the Paterson side of the bridge.

Figure 4-23 shows the typical condition of Pier 6.

Figure 4-23 Typical condition of Pier 6 (Source: FBE)

The piles on this pier are not specifically identified in the L2 inspection report as being deteriorated, however two timber piles are listed as being in condition state 2 and two timber piles are listed as being in condition state 3. It can be assumed that this refers to the deteriorated piles on Pier 6.

The pile straps/braces and timber wales were observed as being in “good” to “as-built” condition and appear to be part of a previous remediation.

Figure 4-24 shows longitudinal cracking and deterioration of the Pier 6 piles.

Figure 4-24 Deterioration of Pier 6 piles (Source: FBE)

4.6.4 Concrete piers – Piers 4 and 5

Piers 4 and 5 are reinforced concrete cylinders joined with an oval voided diaphragm and Figure 4-25 shows the typical condition of these concrete piers. The July 2017 L2 inspection lists the concrete piers as generally being in “fair” condition.

Figure 4-25 Typical condition of concrete piers (Source: FBE)

Figure 4-26 shows spalling and exposed reinforcement observed on Pier 4. These damaged patches are on the diaphragm, above the top oval void.

Figure 4-26 Spalling of concrete and exposed reinforcement on Pier 4 (Source: FBE)

Some cracking of the concrete cylinders was observed on Pier 5. Figure 4-27 shows the cracks as viewed from Pier 4.

Figure 4-27 Cracks near top of Pier 5(Source: FBE)

Damage to the bottom of the concrete diaphragm on Pier 5 was observed. This is shown in Figure 4-28.

Figure 4-28 Damage to bottom of reinforce concrete diaphragm on Pier 5 (Source: FBE)

4.6.5 Concrete abutment – Abutment B

Abutment B has been replaced with a reinforced concrete structure. The 2017 L2 inspection lists both the concrete abutment and wingwalls as being in "as-built" condition. Figure 4-29 shows the general condition of the abutment.

Figure 4-29 Typical condition of Abutment B (Source: FBE)

The inspection observed cracking of the abutment inspection platform, shown in Figure 4-30. Driven steel casings were used in the construction of the replacement abutment and the crack appears to emanate from the remnants of one of these casings. The platform is not a structural element of the bridge and the cracking is not considered detrimental to the bridge's performance.

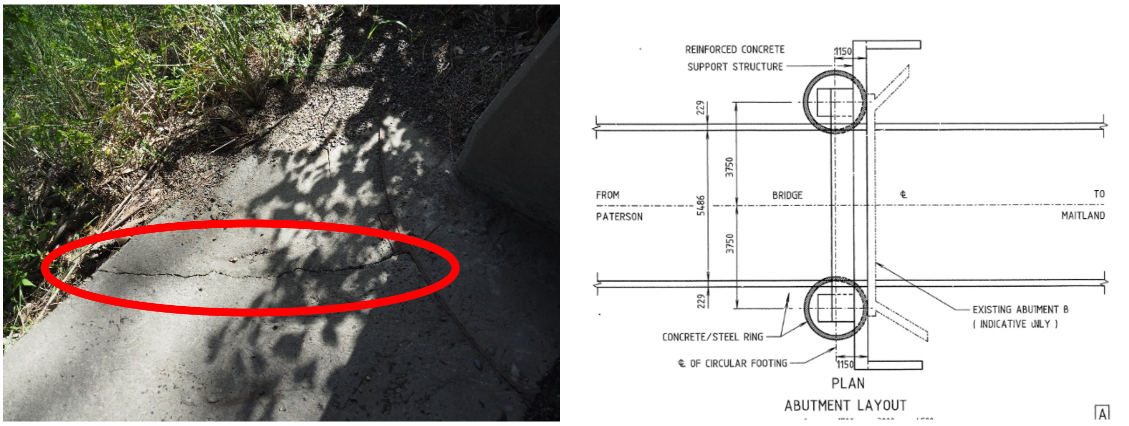


Figure 4-30 Cracking of abutment inspection platform (Source: FBE)

5. Summary of Level 4 load testing

5.1 Overview

FBE undertook a detailed Level 4 (L4) load rating assessment of the steel truss span of Gostwyck Bridge.

The assessment was performed by calibrating finite element models (FEM) of the main steel truss to the observed behaviour of the bridge during the application of loads by an assessment vehicle. Strain gauges and tiltmeters were used to record the physical behaviour of the bridge during controlled tests using a typical fully loaded 50.5 tonne truck and quad dog trailer vehicle supplied by Daracon. Other rating vehicles were then assessed using the calibrated and refined FEM.

Figure 5-1 shows an example FEM developed for the assessment.

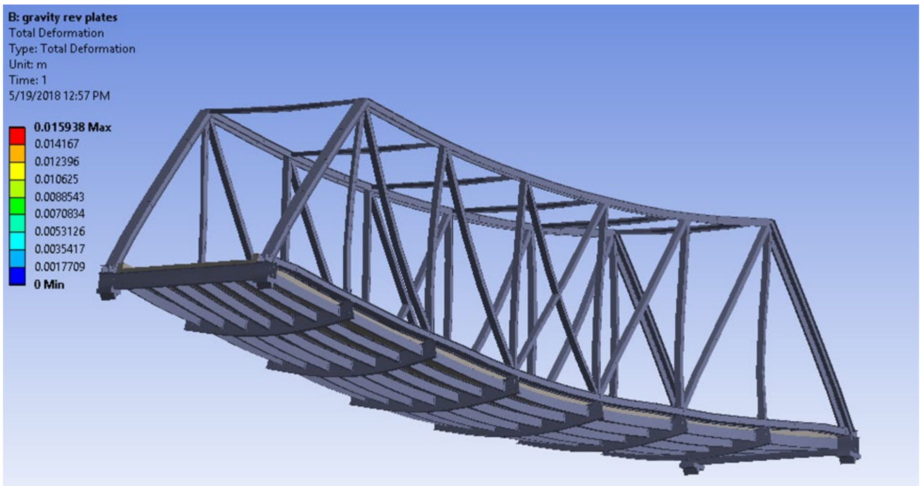


Figure 5-1 View of refined beam element model

5.2 Load testing results

Based on the measured results of the load tests, stress calculations and finite element modelling, FBE concluded that the structural capacity of Gostwyck Bridge is adequate for:

- 50.5T – Truck and quad dog trailer configurations presently in use by Daracon.
- ST42.5 – Semi trailer vehicle (General Access Vehicle (GAV) – GVM 42.5 tonnes).
- ST45.5 – Semi trailer vehicle (Restricted Access Vehicle (RAV) – GVM 45.5 tonnes).
- BD68 – B-double vehicle (Restricted access vehicle (RAV) – GVM 68 tonnes).

This assessment was made under the following provisions:

1. The vehicles be strictly limited to the HML axle limits as set out by TfNSW.
2. The heavy vehicle traffic be limited to one vehicle only on the bridge at any one time.
3. The speed restriction on the bridge remain at 40km/hr.
4. The bridge performance should be monitored by regular annual inspections.

The element with the lowest rating factor for all vehicles was the steel cross girder. The cross girders had a calculated rating factor of 1.34 for the worst load case BD68 design vehicle.

6. Summary of fatigue life assessment

6.1 Overview

The fatigue life assessment of the impacts of increased heavy vehicle usage on the steel truss span of Gostwyck Bridge has been performed.

In addition, a fatigue life assessment of the impacts of existing and proposed change in heavy vehicle usage on the steel truss span of Gostwyck Bridge has also been calculated.

The fatigue life predictions were based on the following methodology:

- Strain gauges were left on the steel truss following the load testing for one week of continuous monitoring. During this monitoring period the bridge carried the equivalent of a nominal 800,000 tonnes per annum.
- The annual stress spectra were then assessed against the relevant fatigue category SN curve from AS5100.6 (2017) in order to calculate the total fatigue life of critical members.
- Past fatigue damage was conservatively estimated on the assumption that the extrapolated stress spectra for the transportation of 900,000 tonnes per annum has existed and unchanged since the bridge construction.

Figure 6-1 shows an example of the fatigue life calculation spreadsheet used in this assessment.

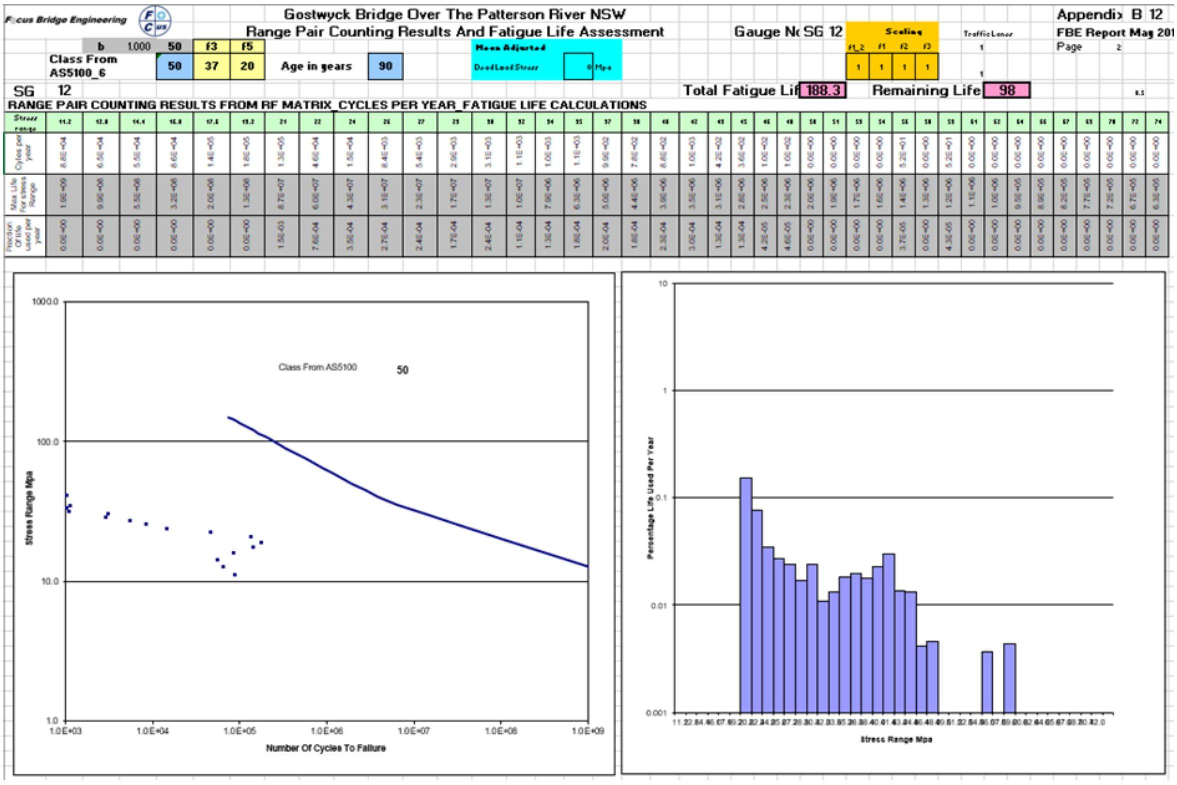


Figure 6-1 **Sample fatigue life calculation output**

6.2 Fatigue life assessment results

The estimated remaining fatigue life of the steel truss span is:

- Greater than 90 years under a usage of approximately 900,000 tonnes per year.
- Greater than 160 years under a usage of approximately 500,000 tonnes per year.

Additionally, the assessment indicates that if BD68 vehicles are used in place of the current TD50.5 vehicles, the estimated remaining fatigue life of the structure is still greater than 100 years at the proposed transportation rate of 500,000 tonnes per annum.

These results are based on the L4 load testing and fatigue assessment report for Gostwyck Bridge.

7. Maintenance strategy

The purpose of this section is to determine the viability, risk and strategic cost to maintain the bridge for the next 25 years until 2045. The deterioration and maintenance intervention levels for Gostwyck Bridge can be found in Appendix B.

7.1 TfNSW condition information

The following maintenance strategy is based on the latest TfNSW Level 2 and Level 3 inspections, including estimated quantities and activity inaction risks. Additionally, in 2014 TfNSW completed timber girder approach span maintenance works. It is estimated that the major rehabilitation of the approach spans completed recently by TfNSW involved around 115 m^3 of timber for the girders, corbels, headstocks and piles and around 45 m^3 for the deck.

7.2 Maintenance until 2045

The maintenance scope of works has been developed to retain the bridge until at least 2045 at a haulage rate **of up to** 1.2 million tonnes per annum and extend the remaining service life of the bridge to 25 years. This would give the bridge a total design life of 107 years which is beyond the usually anticipated 100 years.

Early and direct intervention of the current bridge maintenance issues would extend the bridge's life. A good example of this strategy is the steel bridge strengthening and re-painting activities recently undertaken by TfNSW.

This option considers activities required to maintain the bridge for 25 years until 2045.

7.2.1 Inspections

- Level 2 inspections every 2 years.
- Level 3 inspections every 10 years
- Underwater inspections every 4 years

7.2.2 Routine maintenance

Annual activities:

- Clean bridge scuppers and remove vegetation.
- Minor repairs to traffic barriers and hand rails.
- Replace damaged signs.
- Termite treatment.

7.2.3 Minor maintenance

- Deck bolt tightening.
- Replace damaged transverse and longitudinal deck sheeting
- Seal timber planks.
- Minor steel bridge repairs.
- Replace unsealed expansion joint in truss span.
- Maintain, clean and patch paint truss span as required.
- Patch repair concrete deck and abutments.

- Clean bridge bearings.

7.2.4 Major maintenance

Steel truss span

Every 20 years:

- Injection seal at locations of deck cracking.
- Apply water proof membrane and asphalt over to seal the deck.

Timber approach spans

Every 10 years:

- Deck replacement, 100%.
- Pedestrian refuge repairs, approx. 50%.
- Rehabilitate deteriorated girders, approx. 50%.
- Rehabilitate deteriorated headstocks, approx. 50%.
- Rehabilitate deteriorated piles to piers and abutment A, approx. 25%.

7.3 Traffic controls

The following traffic controls are suggested to limit overloading and mitigate potential future fatigue risks:

- Load limit bridge to ST45.5, TD50.5 and BD68 in accordance with the findings of the L4 load testing and load rating report.
- Limit travel to one lane centred on the bridge.

7.4 CPI adjusted future maintenance rates

The strategic maintenance rates have been extracted and adjusted by the consumer price index (CPI) adopted mean of 3% to produce the equivalent 2045 rates (see Figure 7-1 and Appendix C).

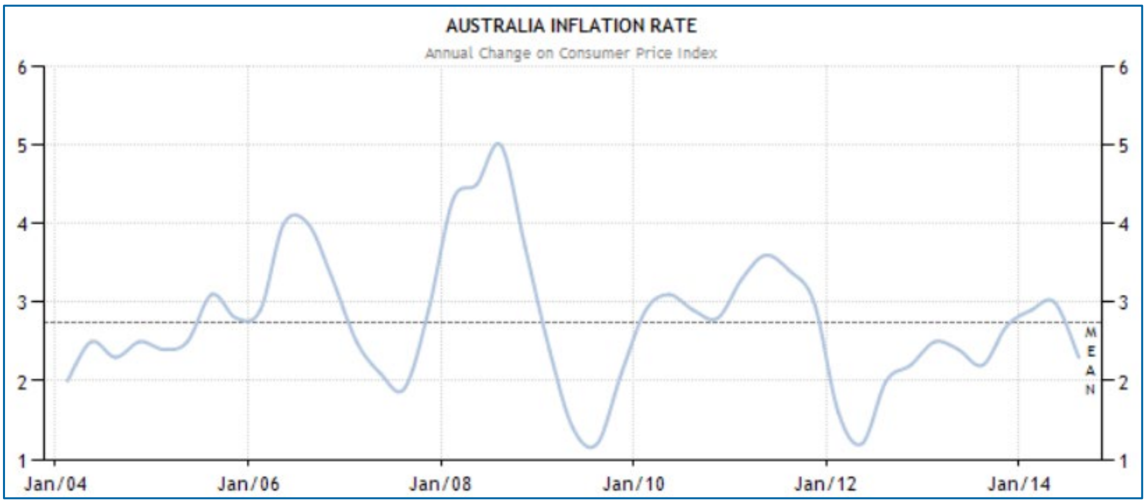


Figure 7-1 CPI trend and mean (Source: Australian Bureau of Statistics)

7.5 Strategic maintenance cost estimates

The full strategic maintenance cost estimates with a 30% cost contingency are attached to this report in Appendix C.

7.5.1 Maintenance costs until 2045 CPI adjusted

This equates to a total cost over the next 25 years of **$9,079,600**, excluding GST or an annualised cost of $363,200 per year, excluding GST.

Please note that the forward costs quoted here have been CPI adjusted.

7.5.2 Maintenance costs until 2045 not CPI adjusted

This equates to a total cost over the next 25 years of **$4,977,700**, excluding GST or an annualised cost of $199,100 per year, excluding GST.

Please note that the forward costs quoted here have not been CPI adjusted.

8. Assumptions

This report may only be used and relied on by Daracon for the purposes agreed to between FBE and Daracon and as set out in this report.

FBE otherwise disclaims responsibility to any person other than Daracon arising in connection with this report. The services undertaken are limited to those specifically detailed in the report and are subject to the scope and limitations set out herein. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report.

FBE has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared and issued.

FBE excludes and disclaims all liability for all claims, expenses, losses, damages and costs, including indirect, incidental or consequential loss, legal costs, special or exemplary damages and loss of profits, savings or economic benefit that Daracon may incur as a direct or indirect result of this report for any reason being inaccurate.

To the extent permitted by law FBE excludes any warranty, condition, undertaking or term, whether express or implied, statutory or otherwise, as to the condition, quality, performance, merchantability or fitness for purpose of this report.

FBE has assumed that the information supplied by Daracon, TfNSW and their sub-consultants is accurate. This information forms the basis of our report.

FBE has prepared this report on the basis of information provided by Daracon, TfNSW and others, including Government Authorities, which we have not independently verified or checked beyond the agreed scope of work. FBE does not accept liability in connection with such information including any resultant errors and omissions in the report.

The opinions, conclusions and any recommendations in this report are based on assumptions and FBE disclaim any liability arising from any of these assumptions being incorrect.

Where information provided was not sufficient, assumptions have been made to complete the assessment. These assumptions have been made based on discussions with Daracon, TfNSW, historic information, and guidelines or limitations within current Australian Standards.

Appendices

Appendix A – Heritage status, schedule and assessment

1. Heritage status

1.1 History of metal truss bridges in NSW

Cardno MBK completed the Study of Heritage Significance of Pre-1930 RTA Controlled Metal Road Bridges in NSW in 2001. The following is an extract from their historical review which can be found on the Roads and Maritime website:

http://www.rms.nsw.gov.au/documents/about/environment/bridge-types-historical-overviews-2006-pre1930metal.pdf

The chronological list of metal bridges supplied with the Brief provides a convenient framework for this historical review for which there are the following principal papers:

- *The First 60 Years of Metal Bridges in New South Wales (Fraser D.J. 1986);*
- *Moveable Span Bridges in New South Wales prior to 1915 (Fraser D.J. 1985);*
- *Curved-tracked Bascule Bridges in New South Wales and their relationship to the Cardioid (M A B Deakin and D. J. Fraser 1995);*
- *The Roadmakers (Department of Main Roads New South Wales 1976);*
- *Bridge Building in New South Wales 1788-1938 (Department of Main Roads New South Wales);*
- *All About Bridges (Department of Main Roads New South Wales 1970);*
- *Issues of Main Roads (Department of Main Roads New South Wales);*
- *Highway Bridge Construction. The Practice in New South Wales 1924 six-part series (Percy Allan 1924).*

Other references are cited where they are relevant. However, the supplied list does not indicate what type of bridge each entry is (arch, truss, girder/beam or moveable span), nor the material used (cast iron (CI), wrought iron (WI) or steel). This limits the ability of the list to convey a historical overview or to give any evidence of trends in the use of each type of bridge.

Table 1-1 Types, materials and eras of metal bridges in NSW (Source: Cardno)

Bridge type	Number	Sub-type	Age	Material
Arches	*1*	*N/A*	*1889*	*CI*
Trusses	*27*		*1865 – 1930*	*WI then steel*
Including:	*14*	*Lattice trusses*	*1874 - 1893*	*WI*
Movable	*7*		*1888 - 1906*	*WI then steel*
Including:	*4*	*Lift*	*1888*	*WI*
	1	*Swing*	*1903*	*Steel*
	2	*Bascule*	*1905 - 1906*	*Steel*

The following history, assessment of significance and statement of significance are extracts from the NSW Office of Environment and Heritage (OEH) State Heritage Inventory listing for Gostwyck Bridge (database number 4301676).

1.2 History of Gostwyck Bridge

"This Bridge, completed in 1928, gains its name from the historic house (see Figure 1-1) and property, Gostwyck, on the eastern side of the river. Apart from being on a useful link road from the Paterson-Vacy Road across the Paterson River to Dungog, there are no special historic features.

With the intervention of World War I and the subsequent inability of BHP (Newcastle) to meet local demands, the importing of large amounts of steel continued into the 1920s. However, as the situation improved by the late 1920s, a mix of steels occurred, and once AI&S (Port Kembla) began production, the local product dominated the home market. At Gostwyck, the mix of steels is evident with some steel from Hallside, England, and some supplied by BHP Co. Ltd.

The bridge consists of a steel Pratt truss with timber beam spans on the western approach. Given the combined used of steel truss and reinforced concrete approaches at Glenreagh (No. 2681) in 1918 and across the Gwydir River near Gravesend (No. 2767) in 1930, it seems odd that this similar structure in 1928 should have timber approach spans. The initial explanation would be the effect of the Great Depression and the need to contain costs, but the Gwydir Bridge is of the same period.

However, the steel truss has all the features of the new standard for steel truss bridges, including longitudinal steel stringer and a reinforced concrete running slab.

The piers are interesting. In earlier photographs of various bridges in the colonial period a regular feature of the piers was the use of oval-pierced metal diaphragms tying the pairs of iron cylinders together. This was displaced by the simpler and cheaper method of cross bracing using iron or steel sections. With the introduction of concrete piers the most common tie was a solid unit like a deep beam, refer to Gunnedah (No 4050) in 1916 and Glenreagh (No 2681) in 1918. But here at Gostwyck there is a return to the oval-pierced method.

If cost savings were behind the use of timber for the approach spans then the cost of forming the oval holes within the concrete diaphragms is a contrary decision."

Figure 1-1 Gostwyck House (LHS) and view of the bridge from Gostwyck House (RHS) (Source: Cardno MBK Study)

1.3 Assessment of significance

Items assessed against the SHR criteria:

Table 1-2 OEH Inventory assessment (Source: OEH and Cardno MBK study)

Criteria a	*Historical significance*	*The Bridge over the Paterson River has historic associative value based on its ability to represent the endeavours of the local settlers in the region, and their need for safe, reliable access across the river.* *The Bridge, therefore, has made a significant contribution to the social and commercial development of the Dungog area.*
Criteria c	*Aesthetic significance*	*The Bridge exhibits the technical excellence of its design, as all of the structural details are clearly visible. It is a high structure over an inland river. It is visually attractive and aesthetically distinctive. Unlike many bridges, it is particularly striking to those who use the Bridge because users are enveloped in the truss.*
Criteria d	*Social significance*	*The Bridge is valued by the community, both because it is a major crossing of the Paterson River, and because it contributes to the community's sense of identity and place.*
Criteria e	*Research potential*	*The Gostwyck Bridge consists of a steel Pratt truss including longitudinal steel stringers and a reinforced concrete running slab with timber beam approach spans.* *The piers are the older style oval-pierced diaphragms tying pairs of cylinders together, but here it is an all concrete pier.* *Because of its integrity and good condition, the Bridge has the ability to demonstrate aspects of the time's technology, design and style in bridge construction.*
Criteria f	*Rarity*	*Not assessed*
Criteria g	*Representativeness*	*It is a representative example of a steel Pratt truss.*
	Integrity/Intactness	*Intact*
	Assessed significance	*LOCAL significance*

1.4 Statement of significance

“The Gostwyck Bridge, completed in 1928, is of local significance and is a representative example of a steel Pratt truss. It is a high-level structure over an inland river and has technical and aesthetically merit. It has contributed significantly to the social and commercial development of Dungog.

The Gostwyck Bridge has significance because:

- *it is a high-level structure over an inland river;*
- *it has technical merit and is aesthetically distinctive;*
- *it has contributed significantly to the social and commercial development of Dungog;*
- *it is a representative example of a steel Pratt truss.*

The Gostwyck Bridge is assessed as being of local heritage significance."

1.5 Heritage listings

The bridge is listed on the State Heritage Inventory, the *Dungog Local Environment Plan 1990* and the Roads and Maritime Section 170 Heritage Register. See Table 1-3 below for the results of the search of statutory and non-statutory heritage registers undertaken for this bridge.

Table 1-3 Statutory and non-statutory listings (Source: see Table below)

Heritage Listing	Status 2018
Australian Heritage Database	Not listed
National Heritage List	Not listed
OEH State Heritage Register	Not listed
OEH State Heritage Inventory	Listed database number 4301676
Dungog Local Environment Plan 2014	Item number I107
NSW National Trust Register	Not listed
Engineering Heritage Australia Engineering Heritage Register	Not listed
NSW Roads and Maritime Services' S170 Heritage and Conservation Register	Listed

The statutory listings that are relevant to any proposed works are the Roads and Maritime section 170 register and the Dungog LEP. As the bridge is not listed on the State Heritage Register a Section 60 application to the Office of Environment and Heritage would not be required for any proposed works.

1.6 Section 170 register

Roads and Maritime's Heritage and Conservation Register was established in accordance with Section 170 of the Heritage Act, 1977 to record all the heritage items in the ownership or under the control of Roads and Maritime Services.

The Heritage and Conservation Register has two main roles:

1. To meet Roads and Maritimes statutory requirements.
2. As an essential tool in total asset management, by listing and providing information on those Roads and Maritime Services assets which have heritage significance.

Information in the Register has been prepared according to OEH Heritage Division guidelines and corresponds with information in the State Heritage Inventory, maintained by the OEH Heritage Division.

2. Schedule of significant forms and fabric

2.1 Criteria for assigning levels of significance to bridge elements

To facilitate a better understanding of the manner in which each of the elements of a bridge contributes to its overall significance, it is a useful management tool to separate a bridge into its components and examine the heritage significance of each. This process allows for more informed analysis of what constitutes significant form and fabric, or what fabric is of little significance, or intrusive.

Table 2-1 Grading system used for heritage significance (Source: OEH)

Grading	Justification	Status
EXCEPTIONAL	Rare or outstanding element directly contributing to an item's local or State significance.	Fulfils criteria for local or State listing.
HIGH	High degree of original fabric. Demonstrates a key element of the item's significance. Alterations do not detract from significance.	Fulfils criteria for local or State listing.
MODERATE	Altered or modified elements. Elements with little heritage value, but which contribute to the overall significance of the item.	Fulfils criteria for local or State listing.
LOW	Alterations detract from significance. Difficult to interpret.	Does not fulfil criteria for local or State listing.
INTRUSIVE	Damaging to the item's heritage significance.	Does not fulfil criteria for local or State listing.

Table 2-1 above provides a guide to the grading of significance of items or places of heritage value and is directly derived from the OEH Heritage Division *NSW Heritage Manual* (revised 2001).

2.2 Schedule of significant forms and fabric Gostwyck Bridge

2.2.1 Abutment A

The form and fabric of Abutment A is of LOW significance.

Both abutment A and B were originally designed with four main driven timber piles that supported a square headstock and retained the soil using sheeting between the vertical piles. The headstock supported three internal round girders and two external square girders. There was a conventional timber deck and ordnance railing with king posts at the abutment.

Abutment A has been modified by the introduction of two additional piles, new headstock, replacement sheeting and repaired wing walls (see Figure 2-1).

Figure 2-1 Abutment A (Source: FBE)

2.2.2 Abutment B

The form and fabric of Abutment B is of LOW significance.

The original timber abutment was replaced in 1998 by a new reinforced concrete abutment. The new abutment forms part of the ongoing narrative of the bridge.

2.2.3 Timber approach spans 1 to 4 plus 6 and 7

The form and fabric of the timber approach spans is of MODERATE significance.

The Cardno MBK study comparing similar steel Pratt truss bridges stated that "*it seems odd that this similar structure in 12928 should have timber approach spans. The initial explanation would be the effect of the Great Depression and the need to contain costs*". Notwithstanding, the original design of the approach spans is common to that of almost every timber truss road bridge in NSW and was not an uncommon form of design and construction.

The approach spans have been modified by changing from five girders to seven girders and the piers have been changed from four piles to six piles, the capwales have also been changed to a square headstock (see Figure 2-2).

Figure 2-2 Approach spans typical (Source: FBE)

The approach spans do not have any technical or aesthetic significance.

2.2.4 Steel truss span 5

The form and fabric of the Pratt steel truss span is of HIGH significance.

The Cardno MBK study noted that *"the steel truss has all the features of the new standard for steel truss bridges, including longitudinal steel stringers and a reinforced concrete deck slab".*

The Pratt truss was by far the most common used followed by the Howe truss type and Gostwyck Bridge truss spans is shown in Figure 2-3.

Figure 2-3 Main truss span 5 (Source: FBE)

The MBK study also noted that *"with the intervention of World War I and the subsequent inability of BHP (Newcastle) to meet local demands, the importing of large amounts of steel continued into the 1920s. However, as the situation improved by the late 1920s, a mix of steels occurred, and once A I & S (Port Kembla) began production, the local product dominated the home market. At Gostwyck, the mix of steels is evident with some steel from Hallside, England, and some supplied by BHP Co. Ltd"* and is shown in Figure 2-4.

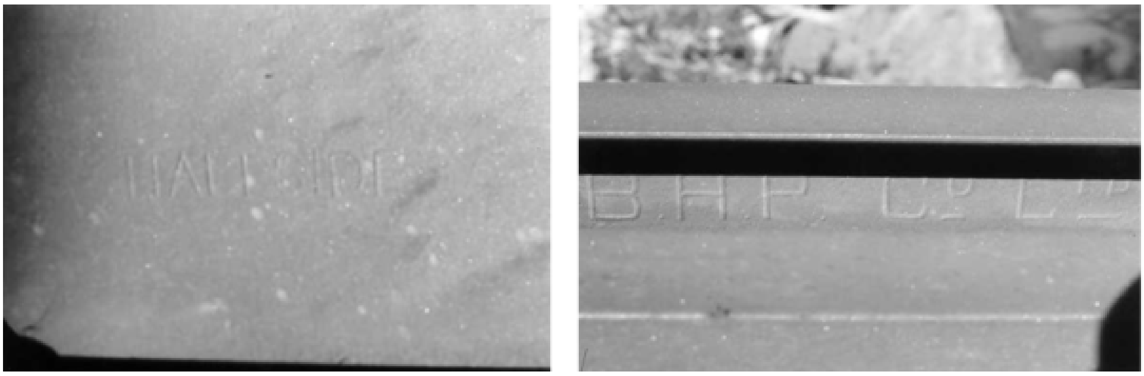


Figure 2-4 Section of wrought iron truss span typical (Source: Cardno)

There have been some modifications to strengthen the truss hangers, cross girders and stringers as detailed in section 5.

The truss span has aesthetic and technical significance.

2.2.5 Piers 1 and 2

The form and fabric of the concrete piers 4 and 5 is of HIGH significance.

The twin piers are tied together by an oval shaped diaphragm which is relatively uncommon and more complex construction than a simple deep tie beam (see Figure 2-5).

The Cardno MBK study notes that *"with the introduction of concrete piers, the most common tie was a solid unit like a deep beam, refer Gunnedah (No 4050) in 1916 and Glenreagh (No 2681) in 1918. However, at Gostwyck there was a return to the oval-pierced method. If cost savings* *were behind the use of timber for the approach spans then the cost of forming the oval holes within the concrete diaphragms was a contrary decision".*

Figure 2-5 Main piers typical views (Source: FBE)

The reinforced concrete piers have technical and aesthetic significance.

2.3 Summary of heritage significance

We have summarised the significance of each bridge element or section in Table 2-2.

Table 2-2 Summary of heritage significance (Source: FBE)

Bridge component	Significance grading
Abutment A	Low
Abutment B	Low
Timber approach spans 1-4, 6-7	Moderate
Truss span 5	High
Piers 4 and 5	High
Overall significance	High

Appendix B – Durability discussion and assessment

1. Bridge durability

The purpose of this Appendix is to establish the likely deterioration and maintenance intervention levels for Gostwyck Bridge.

1.1 Deterioration modelling

Deterioration modelling of bridges is a complex subject. The simple model in Figure 1-1 shows the effect of intervention in the life of the bridge and assumes that a bridge has a measurable or expected performance profile up to its design life and/or limit of serviceability. However, the bridges performance is often less than anticipated due to:

- Material degradation
- Over loading
- Foundation failures
- Construction faults
- Design faults
- Use of outdated codes and design loads

Therefore at a time T(1, 2) the damage is deemed to be such that intervention is required in the form of repairs or upgrades in order to arrest the decline. The expected performance and deterioration for a normal bridge without intervention would proceed as per the curved dashed red line and reach the unacceptable level at the end of its design life.

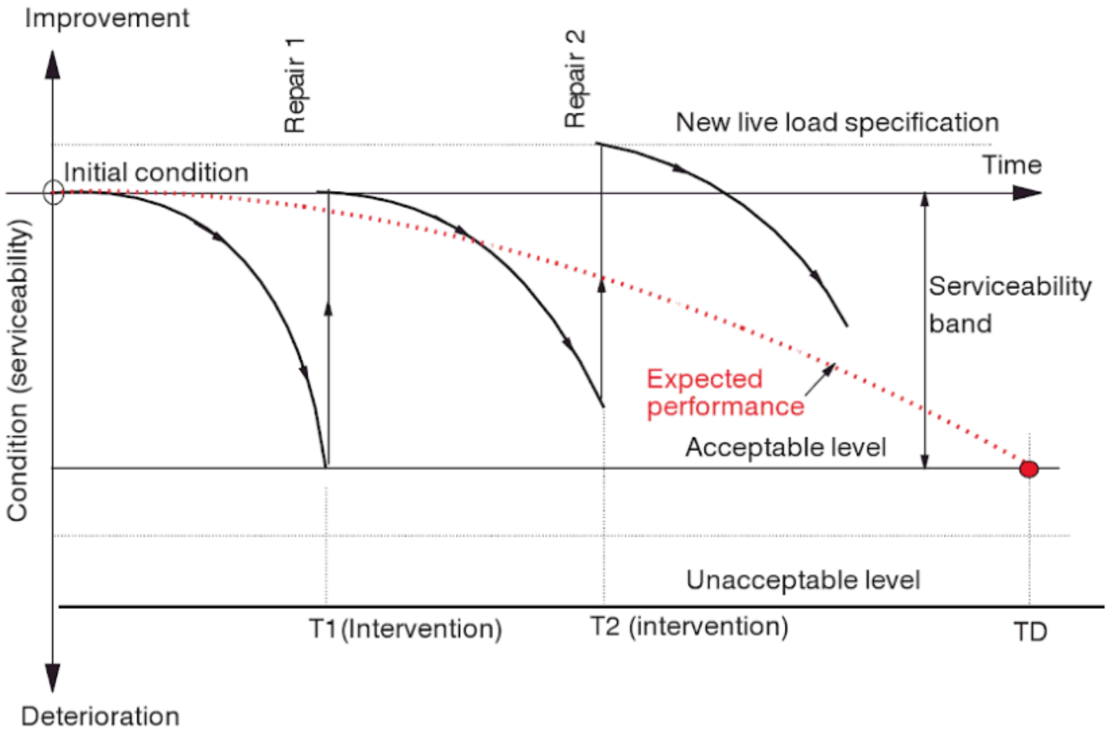


Figure 1-1 Deterioration model example (Source: MJ Ryall)

Typically, bridge elements are usually of varying quality and subject to different exposure conditions. This means the deterioration model will vary for each element, such as the traffic barriers, deck, joints, bearings, sub and superstructure.

Gostwyck Bridge comprises of the following main elements:

- Large steel truss span with concrete deck.
- Large size reinforced concrete cylindrical piers with ovoid shape diaphragms.
- Timber abutment and timber girder approach spans.
- Concrete abutment.

The primary materials used in these elements are steel, timber and concrete.

The steel span is 90 years old and in good condition for its age.

Establishing appropriate and detailed deterioration models for this bridge is outside the scope of this project. However, for the purposes of this strategic options comparison, FBE have made the following assumptions.

1.2 Steel

1.2.1 Existing paint deterioration, condition and assessment

There are many forms of steel corrosion including pitting, inter-granular, crevice, galvanic and erosion. Most coating systems under atmospheric exposure perform and degrade through their life in a predictable manner.

Figure 1-2 shows a typical degradation curve where the steel coating system remains at a level of less than 0.01% breakdown for about seven years before it progressively starts to lose its protective properties. It must be noted that the percentage of breakdown on the left hand axis is logarithmic.

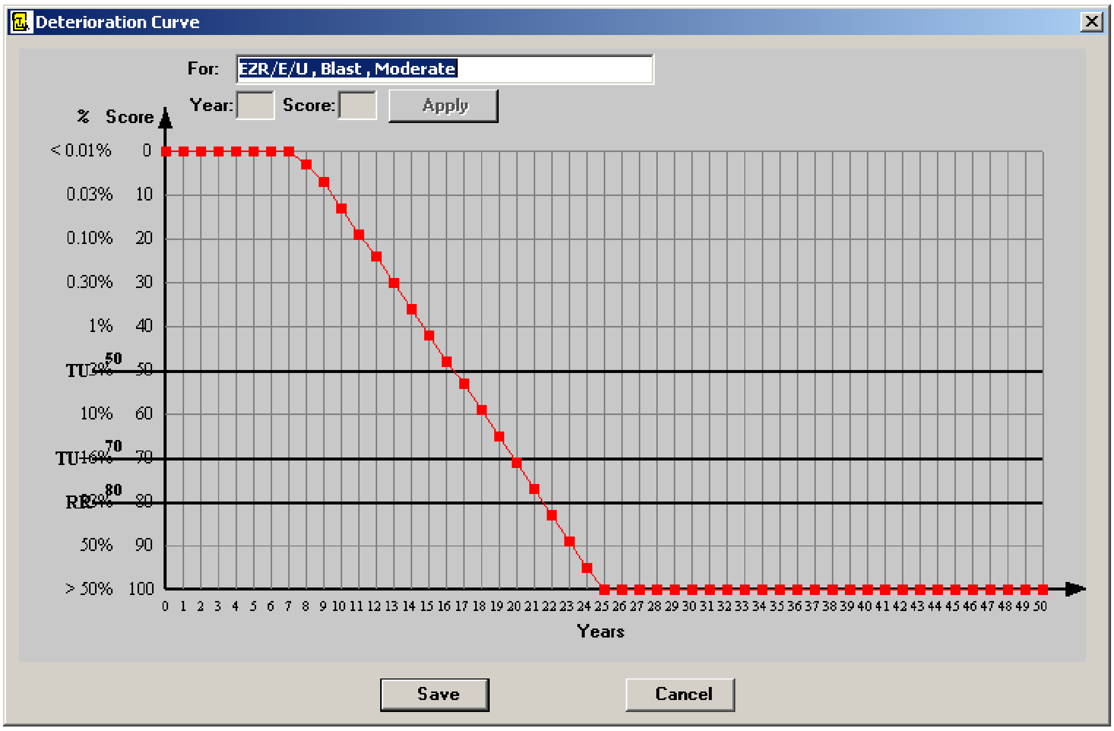


Figure 1-2 Coating degradation curve (Source: KTA-Tator)

The degree of breakdown reaches 1% in about 15 years, 10% by 18 years, 16% by 20 years, 50% by 23 years and so on. The deterioration curve depicts that the rate of breakdown of many coating systems in later years is faster than when the system is new.

The three heavy horizontal lines across the graph are intended to provide some guidance on the optimum times to undertake coating maintenance and what that should consist of. These selected levels nominally correspond to:

- < 3% breakdown which suggests a spot repair procedure.
- < 16% breakdown which suggests spot repair plus a full topcoat.
- ≈ 33% breakdown at which time it is recommended that a full removal and replacement of the coating system is required.

Importantly, none of the trigger or turning points on the graph are absolute as this is simply an example. It is the pattern and the inevitability of the degradation that is important.

For Gostwyck Bridge the entire structure has recently been abrasively cleaned back to bare metal and re-painted to Roads and Maritime's bridge protective coating specification B220.

1.2.2 Cost, durability and maintenance

The cost to re-paint a bridge varies depending on the location, access, height, deterioration and the structures age and type. We have provided in Table 1-1 some indicative blast and re-painting costs per m^2 of steelwork from some recent Roads and Maritime projects.

Table 1-1 Roads and Maritime example re-painting steelwork costs per m^2 (Source: RMS)

Bridge	Date	Description	$ per m^2 (excluding GST)
Ralfes Creek	2014	Single span half through truss	$1,300
Wardell	2012	Lift span Pratt truss and towers	$1,450
Dunmore	2009	Lift span towers and piers	$850
Dalgety	2007	Two span half through lattice truss	$550
Tom Uglys	2006	Six span Pratt truss	$750

Most well designed, properly specified and applied protective coating systems can realistically provide, in this environment and under optimum conditions, at least 30 years of protection.

In practice, most paint systems are neglected until considerable breakdown or failure is observed. Poorly chosen or incorrectly applied coatings can fail in 12 months or less leading to expensive maintenance activities or even asset replacement.

On Gostwyck Bridge, there is an estimated 1297 m^2 of structure to re-paint over a period of around 6 months. At an estimated cost of around $1,000/$m^2$ this equates to approximately $1,300,000 excluding GST and any contingencies.

This rate is based on the fact that the bridge is in a regional area and has relatively complex steel members, difficult access over the Paterson River and will require traffic management and potentially road closures.

1.3 Concrete

Gostwyck Bridge is approximately 40 km from the coast in a benign and rural environment. The concrete deck is approximately 90 years old and the new concrete abutment B is about 20 years old.

Concrete itself is a relatively inert material. However, concrete may decay when in contact with embedded steelwork, such as reinforcement bars or steel beams, or when it is composed of reactive aggregates, which can induce effects such as Alkali Aggregate Reaction (AAR).

The durability of concrete depends upon its ability to withstand attack from internal (such as AAR) and external agents (such as sulphates and chlorides). Its vulnerability to these attacks depends primarily upon its permeability.

The aggressiveness of the environment may cause concrete to crack, spall, delaminate and crumble. These effects are often influenced by the quality of the concrete and the surface proximity of any corroding reinforcement. Concrete repairs can range from simple crack injection to wholesale replacement.

Steel reinforced concrete is attacked primarily by carbonation and chloride contamination causing corrosion of the steel. For corrosion damage to occur, carbonation or chlorides, fresh or salt water, oxygen, and low resistivity concrete must all be present in sufficient quantity. This method of deterioration can be simplified into two stages:

1. Stage 1 when chloride contamination and/or carbonation has reached the reinforcement.
2. Stage 2 when corrosion due to the oxidation of the reinforcing steel has expanded the corrosion products sufficiently to cause spalling and delamination. The corrosion products occupy a volume about five times greater than that of the un-corroded steel which leads to cracking, spalling and delamination.

Stage 1 of this deterioration mechanism results in little to no observable deterioration in the structural element. However, once the corrosion of reinforcement begins to spall and crack the concrete, the rate of deterioration rapidly increases. This is shown in Figure 1-3.

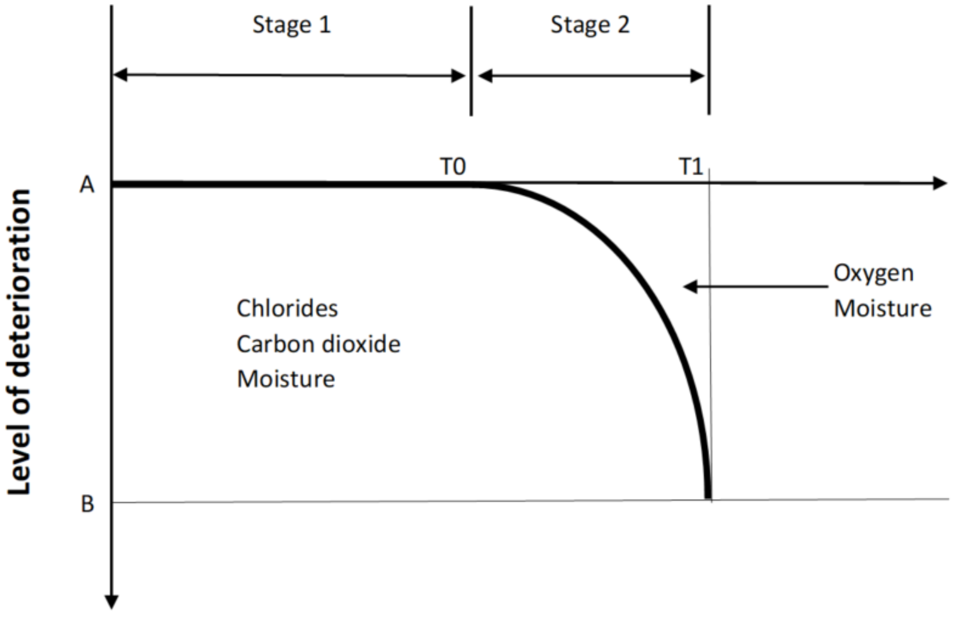


Figure 1-3 Deterioration mechanism in concrete (Source: MJ Ryall)

The concrete deck is rated in “fair” condition and is potentially reaching the end of its useful service life. This may be prolonged by patch repairs, applying a waterproof membrane and an asphalt overlay.

The service life of abutment B may be extended by minor repairs and protective anti-carbonation coating. This element is in “as-built” condition with an estimated 80 years remaining design life.

1.4 Timber

1.4.1 Timber exposure

Timber bridges are exposed to varying and often harsh environmental conditions. Over time, this exposure can lead to deterioration from decay, insect attack, weathering and mechanical damage.

Gostwyck Bridge is in an area of Australia identified as having a high risk of termite infestation as shown in Figure 1-4. Evidence of termite attack has been noted in previous L2 and L3 assessments of the bridge.

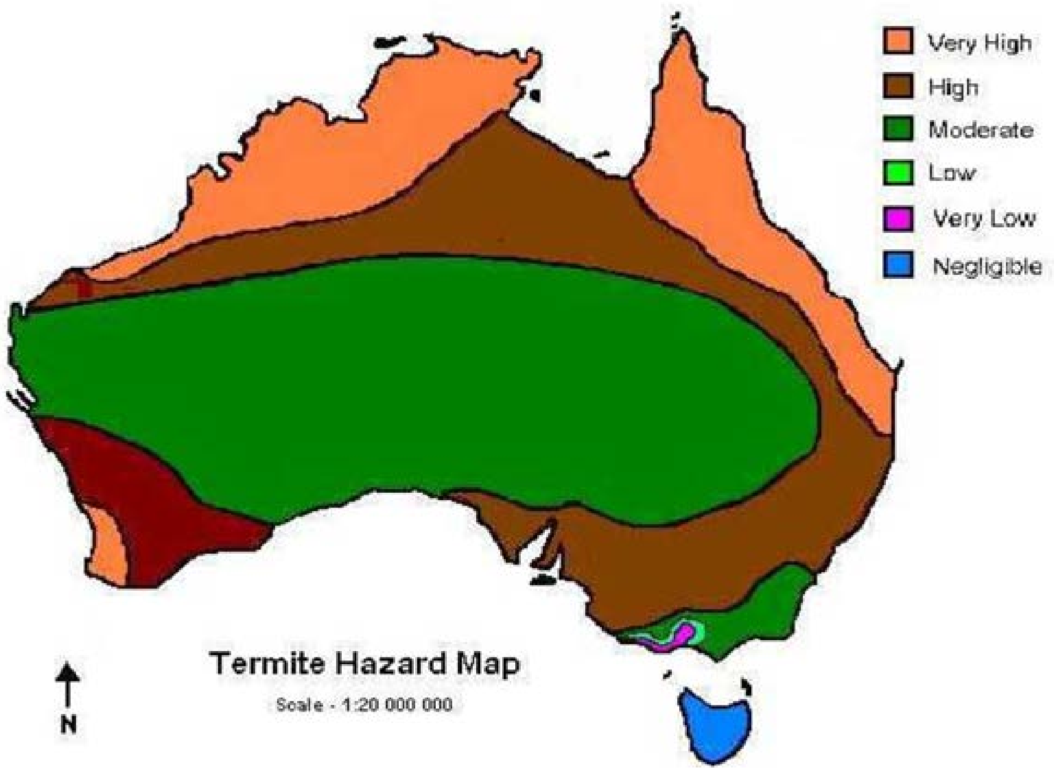
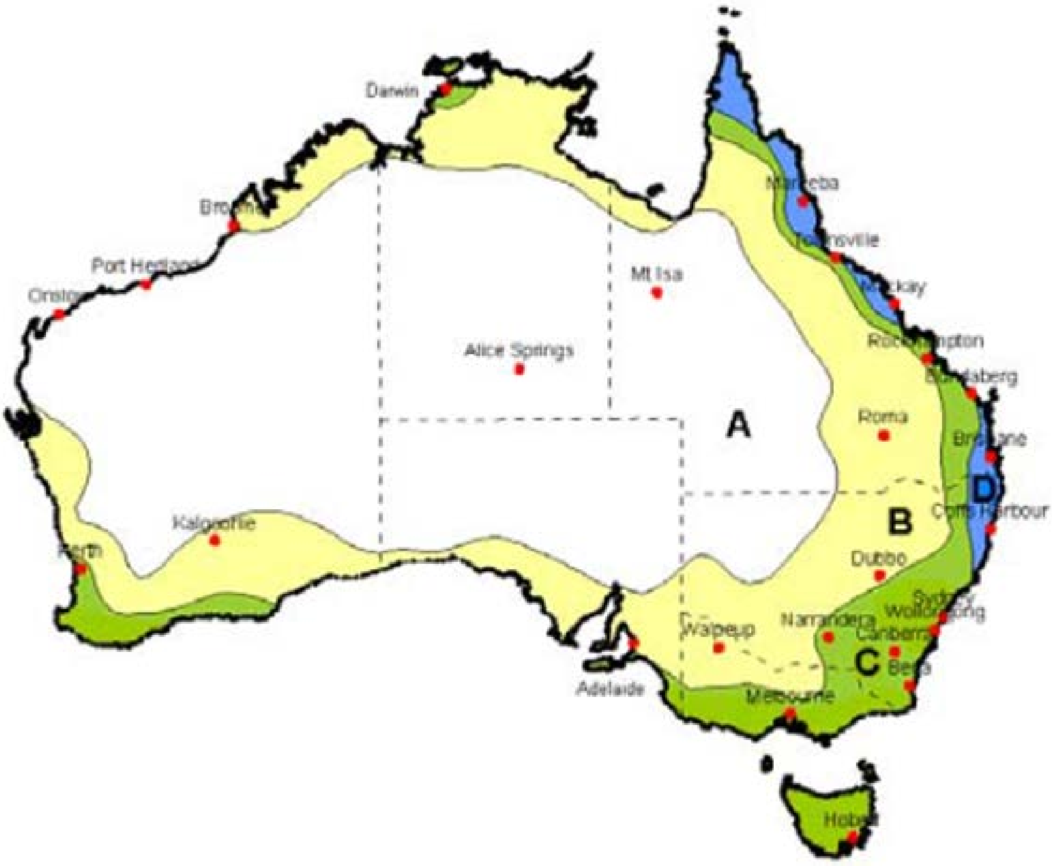


Figure 1-4 Termite hazard map (Source: National Association of Forest Industries 2003)

The bridge is also in an area identified as having a high decay potential as shown in the Figure 1-5. This is due to environmental conditions including temperature, moisture and rainfall which are all known causes of distress in timber.



Decay Hazard Zone	A	B	C	D
Potential	Low	Moderate	High	Very High

Figure 1-5 Decay hazard map (Source: Leicester et al 2009)

1.4.2 Timber deterioration

S Ranjith from RMIT University produced a thesis on the “Tools for Diagnosis and Prediction of Deterioration of Timber Bridges in Australia” in 2010. This document has been referenced to assist with predicting the deterioration of timber elements in Gostwyck Bridge. The deterioration models described in this thesis are for bridges still in service but they do not account for the increase in damage associated with heavy vehicles.

The annual tonnage from Martins Creek Quarry carried by Gostwyck Bridge, as shown in Table 2-1, appears fairly consistent for the last seventeen years. As there is little change to the AADT expected from the proposal, it is difficult to anticipate any change in damage or deterioration to the timber bridge spans as a direct result of Daracon’s proposal.

Establishing exact deterioration models for the timber elements of this bridge is outside the scope of this project. For the purposes of this report it has been assumed that the bridge deteriorates at rates similar to those shown in Figures 1-6 to 1-9, which are taken from the aforementioned thesis on timber deterioration. These deterioration curves reflect the general levels of deterioration anticipated and experienced on timber bridges.

The deterioration models presented, engineering judgement and FBE’s experience with timber bridges have been used to estimate the level of deterioration of the timber.

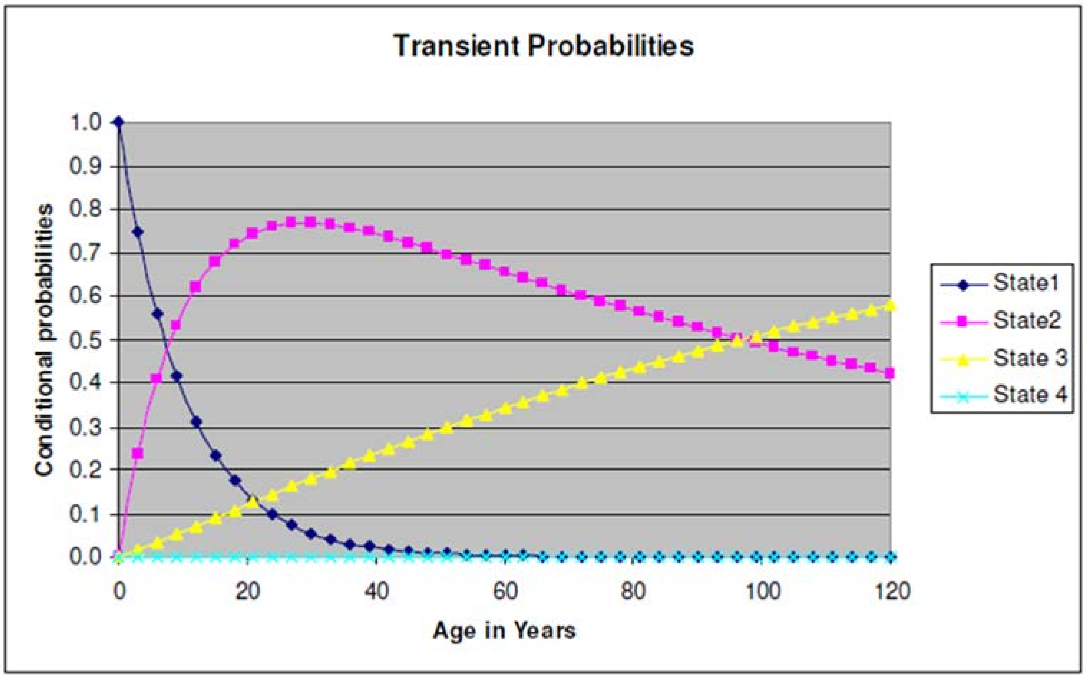


Figure 1-6 Timber pile deterioration curves percentage prediction method (Source: S Ranjith)

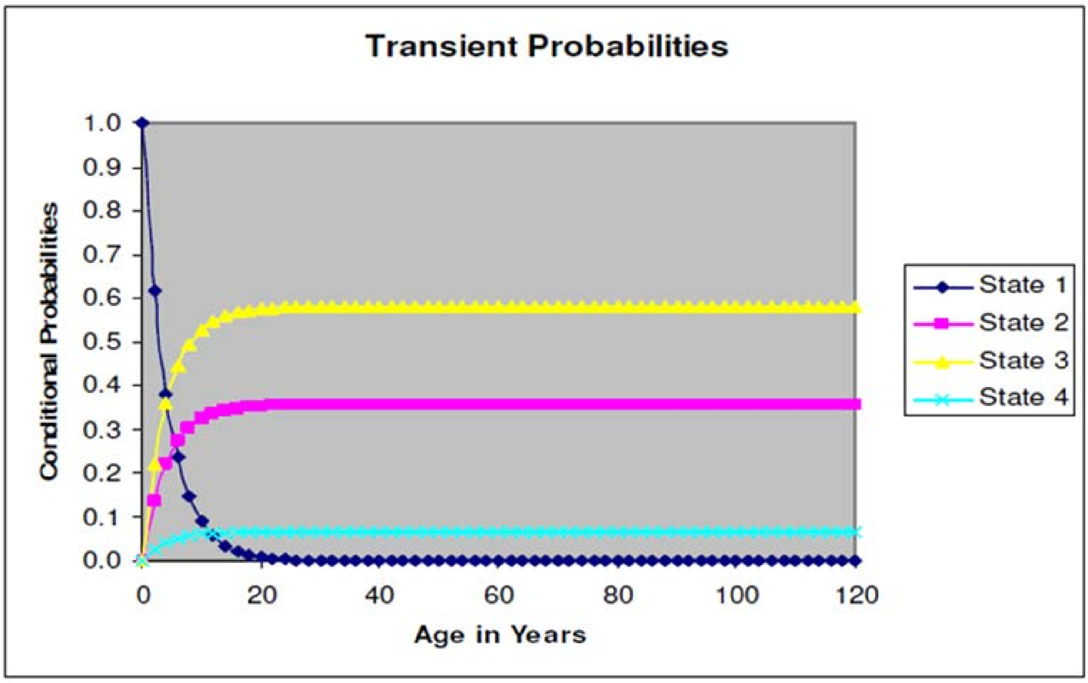


Figure 1-7 Timber girder deterioration curves percentage prediction method (Source: S Ranjith)

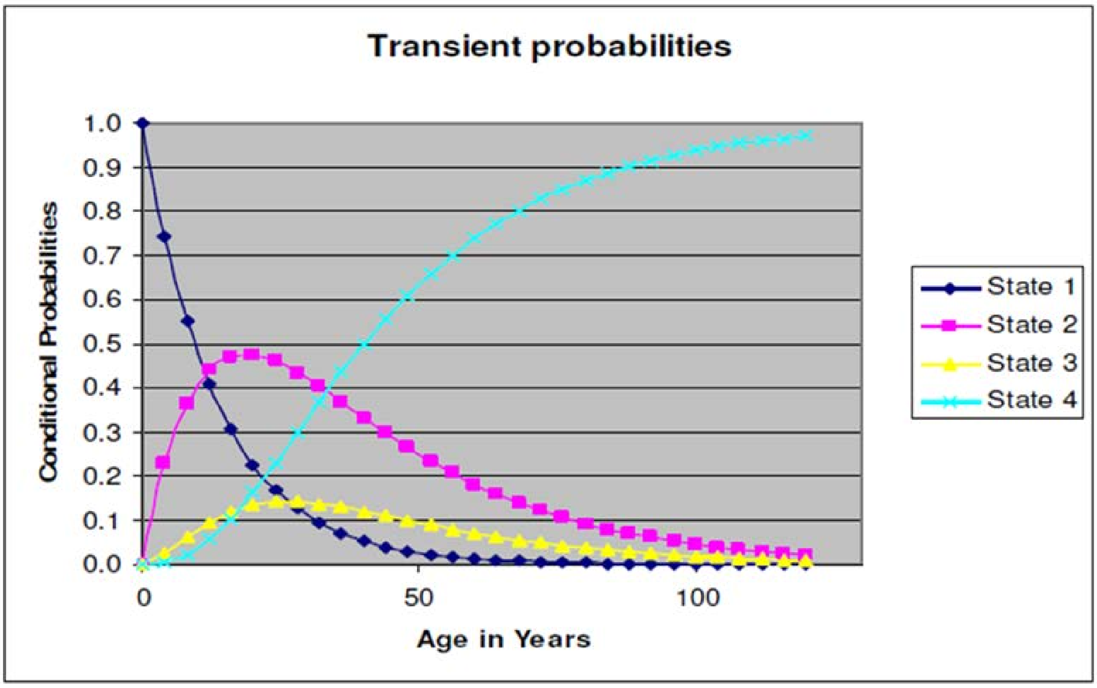


Figure 1-8 Timber abutment curves percentage prediction method for timber abutments (Source: S Ranjith)

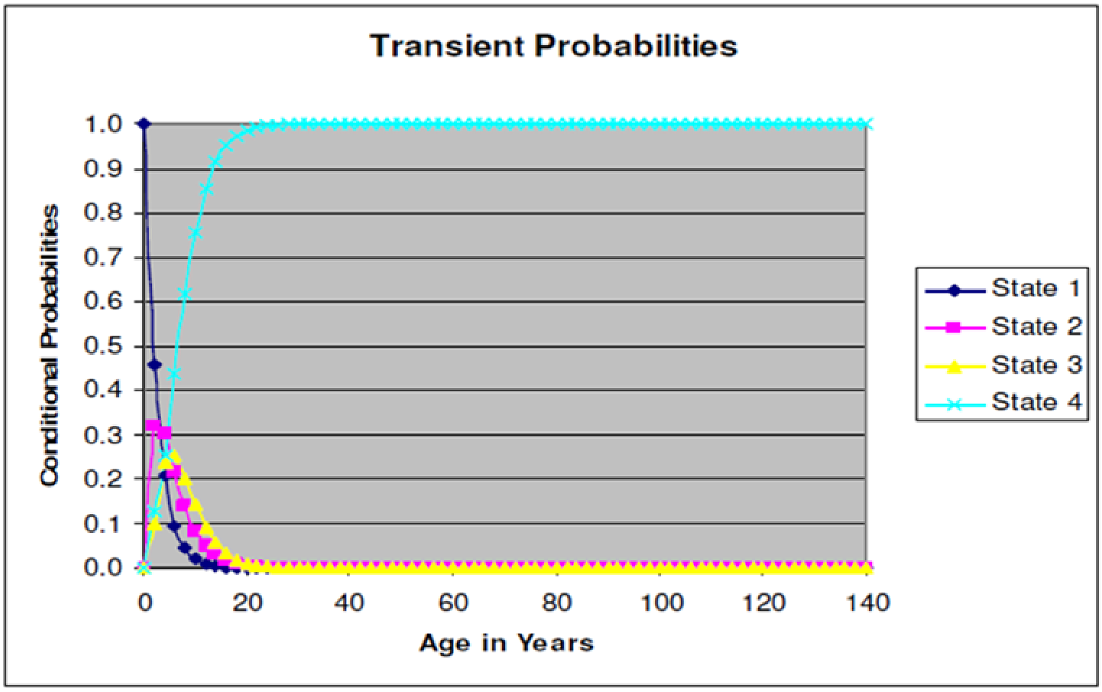


Figure 1-9 Timber decks deterioration curves percentage prediction method (Source: S Ranjith)

Where:

- Condition State 1: None or minimal damage.
- Condition State 2: Minor damage that should not affect performance of the bridge.
- Condition State 3: Average damage that may potentially affect the bridge operation.

- Condition State 4: Significant damage that is likely to affect the bridge performance.

1.4.3 Timber durability assumptions

The service life of timber elements varies greatly. For example, termite attack on a new timber element may force its replacement within 6 months of being installed; while submerged timber piles in a non-aggressive environment may last in excess of 50 years.

The approach spans on Gostwyck Bridge consist of the following main timber elements, shown with their “as-new” expected service life:

- Deck – up to 10 years.
- Girders – 10 to 20 years.
- Corbels – 10 to 25 years.
- Headstocks – 10 to 25 years.
- Piers – 10 to 25 years.
- Piles – 10 to 50 years.
- Wales and braces – 10 to 20 years.

On average, most timber components are replaced at least once every 25 years.

Appendix C – Strategic maintenance costs

Strategic Cost Estimate

Bridge: Gostwyck Bridge
Project: Maintenance Strategy

CPI
3.00%

Note: Estimate does not include either historical or proposed Project Management and Contract Administration, Design, Environmental Studies, Approvals, Community Consultation, Planning, Survey, Geotechnical Investigation, etc.

Pay Item	Description of work	Quantity	Unit	2018 Rate	2020 Rate adj CPI	2020 Est cost	2030 Rate adj CPI	2030 Est cost	2040 Rate adj CPI	2040 Est cost	2045 Rate adj CPI	2045 Est cost
MAINTENANCE STRATEGY TO 2040												
2.1	**Inspections**											
2.1.1	Level 2 - every 2 years	1.0	no	$7,500	$3,978	$7,957	$5,347	$53,466	$7,185	$71,854	$8,330	$41,649
2.1.2	Level 3 - every 10 years	1.0	no	$87,500	$9,283	$18,566	$12,475	$124,754	$16,766	$167,659	$19,436	$97,181
2.1.3	Underwater - every 4 years	1.0	no	$24,000	$6,365	$12,731	$8,555	$85,546	$11,497	$114,966	$13,328	$66,639
2.2	**Routine Maintenance**											
2.2.1	Clean scuppers	8.0	no	$110	$117	$233	$157	$1,568	$211	$2,108	$244	$1,222
2.2.2	Prune trees and remove vegetation	1.0	no	$1,500	$1,591	$3,183	$2,139	$21,386	$2,874	$28,742	$3,332	$16,660
2.2.3	Termite treatment	1.0	ls	$2,350	$2,493	$4,986	$3,351	$33,505	$4,503	$45,028	$5,220	$26,100
2.2.4	Traffic barrier and hand rail repairs (10%)	41.0	m	$55	$58	$117	$78	$784	$105	$1,054	$122	$611
2.2.6	Replace damaged signs	4.0	no	$150	$159	$318	$214	$2,139	$287	$2,874	$333	$1,666
2.3	**Minor maintenance**											
2.3.1	Deck bolt tightening	6.0	ea	$3,500	$3,713	$22,279	$4,990	$29,941	$6,706	$40,238	$7,775	$46,647
2.3.2	Replace damaged timber deck 5%	19.0	m^2	$1,565	$0	$0	$2,231	$42,395	$2,999	$56,975	$3,476	$66,050
2.3.0	Re-seal timber deck	19.0	m^2	$85	$90	$1,713	$121	$2,303	$163	$3,095	$189	$3,587
2.3.1	Minor steel repairs (2.5%)	30.3	m^2	$350	$0	$0	$499	$15,120	$671	$20,320	$777	$23,557
2.3.2	Patch paint repairs (5% condition state 1)	64.9	m^2	$425	$0	$0	$606	$39,296	$814	$52,810	$944	$61,222
2.3.3	Clean bearings	4.0	no	$1,250	$1,326	$5,305	$1,782	$7,129	$2,395	$9,581	$2,777	$11,106
2.3.4	Replace expansion joints every 10 years	16.0	m	$185	$196	$3,140	$264	$4,220	$354	$5,672	$411	$6,575
2.3.5	Patch repair concrete deck and abutments (5%) every 20 years	16.6	m^2	$550	$583	$9,657	$784	$12,978	$1,054	$17,441	$1,222	$20,219
2.4	**Major maintenance**											
2.4.1	Seal deck, apply water proof membrane and asphalt	225.0	m^2	$275			$392	$88,219	$527	$118,559	$611	$137,442
2.4.2	Deck replacement 100%	380.0	m^2	$1,565			$2,231	$847,900	$2,999	$1,139,507	$3,476	$1,321,001
2.4.3	Re-seal timber deck 100%	380.0	m^2	$85			$121	$46,052	$163	$61,890	$189	$71,748
2.4.4	Rehabilitate timber approach spans 50%	38.0	m^3	$12,500			$17,822	$677,236	$23,951	$910,149	$27,766	$1,055,112
2.4.5	Rehabilitate abutment 25%	5.5	m^3	$12,500			$17,822	$98,021	$23,951	$131,732	$27,766	$152,714
2.5	**Contingency**	30.0	%	Annual	$13,527.67	$27,055	$12,843	$169,425	$17,259	$186,893	$20,008	$141,142
10 YEAR TERMS			**Sub-Totals:**		$43,482	**$117,240**	$94,824	**$2,403,384**	$127,435	**$3,189,146**	$147,732	**$3,369,849**
25 YEARS	**ANNUALISED MAINTENANCE COSTS =**	**$363,200.00**	**per year**								**2050 TOTAL**	**$9,079,600**

Strategic Cost Estimate

Bridge: Gostwyck Bridge
Project: Maintenance Strategy

CPI
0.00%

Note: Estimate does not include either historical or proposed Project Management and Contract Administration, Design, Environmental Studies, Approvals, Community Consultation, Planning, Survey, Geotechnical Investigation, etc.

Pay Item	Description of work	Quantity	Unit	2018 Rate	2020 Rate adj CPI	2020 Est cost	2030 Rate adj CPI	2030 Est cost	2040 Rate adj CPI	2040 Est cost	2045 Rate adj CPI	2045 Est cost
MAINTENANCE STRATEGY TO 2040												
2.1	**Inspections**											
2.1.1	Level 2 - every 2 years	1.0	no	$7,500	$3,750	$7,500	$3,750	$37,500	$3,750	$37,500	$3,750	$18,750
2.1.2	Level 3 - every 10 years	1.0	no	$87,500	$8,750	$17,500	$8,750	$87,500	$8,750	$87,500	$8,750	$43,750
2.1.3	Underwater - every 4 years	1.0	no	$24,000	$6,000	$12,000	$6,000	$60,000	$6,000	$60,000	$6,000	$30,000
2.2	**Routine Maintenance**											
2.2.1	Clean scuppers	8.0	no	$110	$110	$220	$110	$1,100	$110	$1,100	$110	$550
2.2.2	Prune trees and remove vegetation	1.0	no	$1,500	$1,500	$3,000	$1,500	$15,000	$1,500	$15,000	$1,500	$7,500
2.2.3	Termite treatment	1.0	ls	$2,350	$2,350	$4,700	$2,350	$23,500	$2,350	$23,500	$2,350	$11,750
2.2.4	Traffic barrier and hand rail repairs (10%)	41.0	m	$55	$55	$110	$55	$550	$55	$550	$55	$275
2.2.6	Replace damaged signs	4.0	no	$150	$150	$300	$150	$1,500	$150	$1,500	$150	$750
2.3	**Minor maintenance**											
2.3.1	Deck bolt tightening	6.0	ea	$3,500	$3,500	$21,000	$3,500	$21,000	$3,500	$21,000	$3,500	$21,000
2.3.2	Replace damaged timber deck 5%	19.0	m^2	$1,565	$0	$0	$1,565	$29,735	$1,565	$29,735	$1,565	$29,735
2.3.0	Re-seal timber deck	19.0	m^2	$85	$85	$1,615	$85	$1,615	$85	$1,615	$85	$1,615
2.3.1	Minor steel repairs (2.5%)	30.3	m^2	$350	$0	$0	$350	$10,605	$350	$10,605	$350	$10,605
2.3.2	Patch paint repairs (5% condition state 1)	64.9	m^2	$425	$0	$0	$425	$27,561	$425	$27,561	$425	$27,561
2.3.3	Clean bearings	4.0	no	$1,250	$1,250	$5,000	$1,250	$5,000	$1,250	$5,000	$1,250	$5,000
2.3.4	Replace expansion joints every 10 years	16.0	m	$185	$185	$2,960	$185	$2,960	$185	$2,960	$185	$2,960
2.3.5	Patch repair concrete deck and abutments (5%) every 20 years	16.6	m^2	$550	$550	$9,103	$550	$9,103	$550	$9,103	$550	$9,103
2.4	**Major maintenance**											
2.4.1	Seal deck, apply water proof membrane and asphalt	225.0	m^2	$275			$275	$61,875	$275	$61,875	$275	$61,875
2.4.2	Deck replacement 100%	380.0	m^2	$1,565			$1,565	$594,700	$1,565	$594,700	$1,565	$594,700
2.4.3	Re-seal timber deck 100%	380.0	m^2	$85			$85	$32,300	$85	$32,300	$85	$32,300
2.4.4	Rehabilitate timber approach spans 50%	38.0	m^3	$12,500			$12,500	$475,000	$12,500	$475,000	$12,500	$475,000
2.4.5	Rehabilitate abutment 25%	5.5	m^3	$12,500			$12,500	$68,750	$12,500	$68,750	$12,500	$68,750
2.5	**Contingency**	30.0	%	Annual	$12,751.13	$25,502	$9,008	$118,831	$9,008	$97,538	$9,008	$63,540
10 YEAR TERMS			**Sub-Totals:**		$40,986	**$110,510**	$66,508	**$1,685,685**	$66,508	**$1,664,392**	$66,508	**$1,517,069**
25 YEARS	**ANNUALISED MAINTENANCE COSTS =**	**$199,100.00**	**per year**								**2050 TOTAL**	**$4,977,700**

Focus Bridge Engineering Pty Ltd

Link Business Hub, 271 Brunker Road, Adamstown, NSW 2289
E: mail@focusbridges.com W: www.focusbridges.com

Document Status: Job No. 220090

Rev No.	Authors	Reviewed		Authorised		
		Name	Signature	Name	Signature	Date
1	M Tilley J King	A Kelly J Cannon T McDonald	On file	M Tilley		10/11/20
0	M Tilley J King	A Kelly B Crossley	On file	M Tilley		28/10/20

www.focusbridges.com