2023-27
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack – PUBLIC

CP.02754
Davies Creek to Bayview Heights 275kV Transmission Line Refit

CP.02754 – Davies Creek to Bayview Heights 275kV Transmission Line Refit

Project Status: Not Approved

1. Network Need

The Davies Creek to Bayview Heights transmission line (BS1664) forms part of the 275kV double circuit between Woree and Chalumbin substations in Far North Queensland. BS1664 is over 22 years old (commissioned in 1998) and traverses a wet tropics area between Davies Creek (southwest of Cairns) and Bayview Heights in southern Cairns. BS1664 is the primary source of supply for Cairns and is critical to the supply of Far North Queensland. An outage on this line would leave up to 268MW and up to 911MWh of customer load per day at risk[2].

A Condition Assessment (CA) carried out in October 2020 identified BS1664 has reached its end of technical life[1]. A significant portion of the line's tower structures are exhibiting Grade 4 (High) corrosion, which will continue to decline further due to the microclimatic conditions of the wet tropics environment the line is located in. The current asset condition increases the risk of structural failure that may cause network outages, additional network costs to replace assets under emergency conditions and safety risks to staff maintaining the line. The CA recommends reinvestment in the asset prior to 2023 to manage these risks.

Energy Queensland forecasts confirm there is an enduring need to maintain electricity supply to the Cairns area. The removal of the BS1664 line would have a major impact on loads in the Cairns area and would violate Powerlink's Transmission Authority reliability obligations (for N-1-50MW / up to 600MWh). Failure to address the condition of this asset is likely to result in non-compliance with Powerlink's reliability and safety obligations[6].

2. Recommended Option

As this project is currently 'Not Approved', project need and options will undergo a public Regulatory Investment Test for Transmission (RIT-T) consultation process to identify the preferred option closer to the time of investment.

The current recommended option is to refit and paint poor condition components of the 275kV Davies Creek to Bayview Heights line by 2023[2].

The following options were considered but not recommended:

- Do Nothing – rejected due to non-compliance with reliability standards.
- Uprate 132kV coastal circuit (Cairns alternate supply route) to 275kV – rejected due to non-compliance with reliability standards.
- Combined 132kV coastal circuit uprating with a Non Network solution – this option is not preferred as the requirement for extensive operation periods (and often pre-contingent operation) of up to 200MW and 1200MWh is likely to incur higher costs. This may be tested through the RIT-T process.

Figure 2-1 below shows the current recommended option reduces the forecast risk monetisation profile of the Davies Creek to Bayview Heights line to less than $100k p.a.

Where a 'Do Nothing' scenario is adopted, the forecast level of risk associated with the asset escalates to over $4m p.a. by 2030. This is predominantly due to the safety risk and network risks of unserved energy[3].

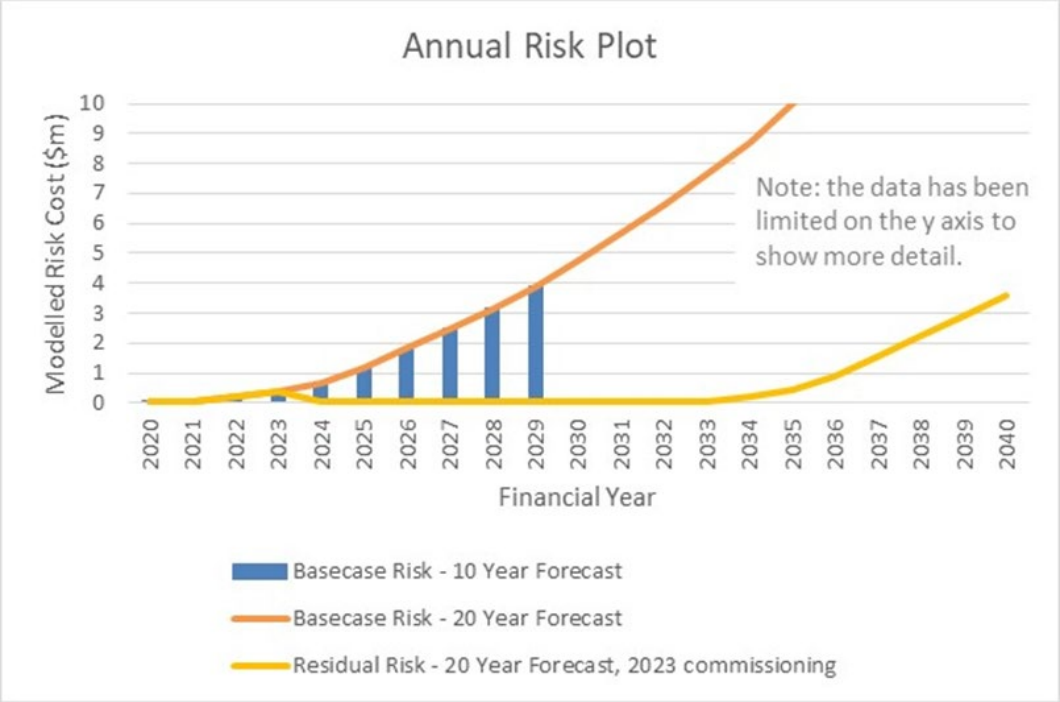

Figure 2-1 Annual Risk Monetisation Profile (Nominal)

3. Cost and Timing

The estimated cost to refit the Davies Creek to Bayview Heights 275kV line is $39.2m ($2020/21 Base) [5].

Target Commissioning Date: October 2023

4. Documents in CP.02754 Project Pack

Public Documents

1. Transmission Line Condition Assessment – Report BS1235 and BS1664 Chalumbin to Woree
2. CP.02754 Davies Creek – Bayview Heights 275kV Transmission Line Refit – Planning Statement
3. Base Case Risk and Maintenance Costs Summary Report - CP.02754 BS1664 Davies Creek to Bayview Heights Built Section
4. Project Scope Report CP.02754 BS1664 Davies Creek – Bayview Heights 275kV Refit
5. CP.02754 - BS1664 Davies Creek to Bayview Heights 275kV T/L Refit Project Proposal

Supporting Documents

6. Asset Reinvestment Criteria - Framework
7. Asset Management Plan 2021

Transmission Line Condition Assessment – Report

BS1235 and BS1664

Chalumbin to Woree

Record ID	A3171753	
Team	Delivery & Technical Solutions – Technology & Planning – Asset Strategies – Transmission Lines	
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Approved by	Asset Strategies Manager	[redacted]

Version history

Version	Date	Section(s)	Summary of amendment	Author	Approver
1.0	13/08/2019	All	Original Document	[redacted]	[redacted]
1.1	2/9/2020	All	Update to reflect name change and HI8 adjustment	[redacted]	[redacted]

Note: *Where indicator symbol ☼# is used (# referring to version number) it indicates a change/addition was introduced to that specific point in the document. If the indicator symbol ☼# is used in a section heading, it means the whole section was added / changed.*

IMPORTANT: - This Condition Assessment Report provides an overview of the SAP built section meters outlined in the Report's Scope. As it is snapshot in time based upon available data and the accuracy of the prediction methodology, any estimates of remaining life are valid for 3 years only from the date of the report's approval.

Contents

1. Executive Summary

Built Sections 1235 and 1664 together form a 275kV double circuit steel tower transmission line running from Powerlink Structure 1235-STR-0000, 53km southwest of Cairns, to the Bayview Heights transition site. The line is approximately 56km in length and was originally commissioned in June 1998 as Built Section 1235 under contract number TM169/96. In August 2019, the Built Section was split into two sections to reflect the fact that the line runs through two distinctly different environments, which has led to very different ageing characteristics within the two sections, which will require quite different management and re-investment strategies.

BS1235 and BS1664 together form part of the 275kV connection between Woree (H039) and Chalumbin (H032) substations, the other parts being an overhead section to the south, a dual underground cable section (BS1258 and BS1259) east of BS1664, and an overhead section BS1254 into Woree.

The condition of the Built Sections was re-assessed in October 2020 using data collected during helicopter and ground patrols carried out in 2018 and climbing inspections in 2020.

The Health Index overview for the towers on the line, as shown in diagrams Figures 33 and 34 (Appendix 6.16), presents the line in two distinctively different conditions and as such this report will analyse the sections separately.

Section 1 is the 40km long South - Western part of the line (STR-0000 to STR-0084) from Springmount area to Davies Creek National Park, and retains the original Built Section number, BS1235 This section has a small number of towers with notifications for G3 corrosion and G4 bolts observed in attachment areas, and an average structure health index (HI) of **4.2.** This section will exceed HI7 in 2026 approximately, with an expected end of life (EoL) before 2030 (HI8).

Section 2 is a 16.2km part of the line, from STR 085 to the Bayview transition site STR-0121), usually called the Wet Tropics section. This section has been re-numbered BS1664, and had an average structure HI of **8** at time of assessment (2020), with a significant proportion of the towers having outstanding G4 notifications. This section is already at its technical EoL and maintenance is currently being performed to maintain the asset in a serviceable condition.

NOTE: This estimate is valid for a maximum of 3 years, after which new evidence will need to be collected and analysed.

Predicted end of life summary table - South -Western Section (BS1235)												
Conductor	Hardware	Dampers	Spacers	EW	OPGW	Earthing	Foundation Bored	Foundation Grillage	Structures	Ins.Bdg.Disc	Ins.Susp.I.Disc	Ins.Ten.Disc
2078	2030	2028	2078	2026	2028	2026	2078	N/A	2029 [1]	2031	2027	2024

Predicted end of life summary table - Wet Tropics Section (BS1664)												
Conductor	Hardware	Dampers	Spacers	EW	OPGW	Earthing	Foundation Bored	Foundation Grillage	Structures	Ins.Bdg.Disc	Ins.Susp.I.Disc	Ins.Ten.Disc
2078	2036	2036	2078	N/A	2078	2026	2078	N/A	2019 [2]	2036	2036	2036

2. Purpose

This report outlines the assessed condition of Built Sections 1235 and 1664 which run between BS1600 and the Bayview Heights transition site. The document has been produced to assist in developing a future asset management strategy for the line.

The report examines the condition of the line's major component groups, using field data and maintenance records, and assigns them a corrosion grade based upon existing Asset Management classifications.

[1] BS1235 Asset HI7 will be exceeded in 2027 and HI8 exceeded in2029.
[2] BS1664 Asset HI7 was exceeded in 2018 and HI8 exceeded in 2019.

3. Scope

SAP "Built Section Meters" have been used as the basis of categorising the transmission line components in this Condition Assessment Report.

Built Section Meters			
1	Foundations	8	Earthwire Hardware
2	Structure	9	Earthwire Mid-span Joints
3	Earthing	10	Suspension Insulators
4	Conductor	11	Suspension Insulator Hardware
5	Conductor Hardware	12	Tension Insulators
6	Conductor Mid-span Joints	13	Tension Insulator hardware
7	Earthwire	14	Signage

In addition to the Built Section Meters the easement condition has also been assessed.

The Corrosion Grade assigned to each Built Section component is based on the corrosion/deterioration classifications used in Powerlink's existing Visual Guides.

3.1 Component Condition Summary:

As explained in Section 1, 'Transmission Line Condition Assessment – Report' for BS1235 – Chalumbin to Woree is laid out in two parts for the line sections:

Section 1: **South -Western Section**; STR-0000 to STR-0084 from Springmount area to Davies Creek National Park

Section 2: **Wet Tropics Section**; STR-0085 to STR-0121 from Davies Creek National Park to the Bayview transition site.

The tables below summarises the condition of each major component group of towers included in the two sections of line.

Observed Corrosion Grades are based upon existing Powerlink Visual Inspection Guides, as applied to photographic evidence collated in M drive. The estimated remaining service life has also been provided.

South-Western Section (BS1235) – Structure

Structure Zone	Average Level of Corrosion (%)				Sample Size	Installed Year	Health Index (85%)	Estimated Years (to HI7)
Structure								
Foundations	G1	G2	G3	G4		1998	2.8	12 to 15
Legs	99.7	0.3	0	0	53			
Structure Overall	G1	G2	G3	G4	56	1998	4.2	6 to 8
Fasteners	96.4	3.5	0.1	0	51			
Members	98.1	1.9	0	0	51			
Climbing Aids	G1	G2	G3	G4				
Fasteners	93.9	6	0.2	0	59			
Tower Base	G1	G2	G3	G4				
Fasteners	97.2	2.7	0.1	0	60			
Members	98.6	1.4	0	0	60			
Tower Body	G1	G2	G3	G4				
Fasteners	98	2	0	0	59			
Members	98.5	1.5	0	0	60			
Superstructure	G1	G2	G3	G4				
Fasteners	97.4	2.4	0.2	0	32			
Members	99.7	0.3	0	0	32			
Cross Arms	G1	G2	G3	G4				
Fasteners	95	4.6	0.2	0.2	60			
Members	98.3	1.7	0	0	60			
Conductor Attachment Plate	G1	G2	G3	G4				
Fasteners	93.2	6.1	0.6	0.1	59			
EW Peak	G1	G2	G3	G4	60			
Fasteners	95.6	4	0.4	0	56			
Members	98.4	1.6	0	0	56			

Wet Tropics Section (BS1664) – Structure

Structure Zone	Average Level of Corrosion (%)				Sample Size	Installed Year	Health Index (85%)	Estimated Years (to HI7)
Structure								
Foundations	G1	G2	G3	G4		1998	4.4	5 to 7
Legs	98.6	0.6	0.2	0.6	37			
Structure Overall	G1	G2	G3	G4	37	1998	8.0	-2 to 0
Fasteners	70.8	21.5	6	1.7	37			
Members	82.6	13.4	2.7	1.3	37			
Climbing Aids	G1	G2	G3	G4				
Fasteners	45.5	41	10.2	2.9	37			
Tower Base	G1	G2	G3	G4				
Fasteners	67.3	26	5.5	1.2	37			
Members	91.5	6.6	1.2	0.7	37			
Tower Body	G1	G2	G3	G4				
Fasteners	90.6	7.5	1.3	0.6	37			
Members	86.1	11.9	1.5	0.5	37			
Superstructure	G1	G2	G3	G4				
Fasteners	65.2	25.4	7.5	1.9	37			
Members	82.9	12.6	3.1	1.4	37			
Cross Arms	G1	G2	G3	G4				
Fasteners	67.7	22	7.6	2.7	37			
Members	73	21.5	3.6	1.9	37			
Conductor Attachment Plate	G1	G2	G3	G4				
Fasteners	71.7	19.4	5.3	3.6	37			
EW Peak	G1	G2	G3	G4	37			
Fasteners	66.2	23.9	7.6	2.3	37			
Members	72.5	17.9	5.6	4	37			

South-Western Section (BS1235) – OHEW

Component	Average Level of Corrosion (%)								Sample Size	Installed Year	Health Index (85%)	Estimated Years until HI of 7
OHEW - Side B										1998	3.3	10
OHEW	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	72	0	28	0	0	0	0	0	25	1998		11+
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	61.9	0	28.6	4.8	4.8	0	0	0	21	1998		4 to 7
Deadend	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	55.6	0	44.4	0	0	0	0	0	18	1998		11+
Suspension Clamp	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	20	0	0	0	0	0	20	1998		11+

* The South western section has earth wire on one side only. There are 'Twin Grip' arrangements used for securing the OHEW to the earth wire peak. There are instances of G2H corrosion on Twin Grips hardware and they are given 6 years of remaining life.

Wet Tropics Section (BS1664) - no OHEW

No earth wires; OPGW only. OPGW hardware and clamps up to G3L corrosion.

OPGW Route on BS1235 highlighted.

South-Western Section (BS1235) - Insulator assemblies

Component	Corrosion Grade / Condition (%)								Sample Size	Installed Year	Health Index (85%)	Estimated Years until HI of 7
Suspension - Side A*										1998	3.3	10
Insulators	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	56	0	36	8	0	0	0	0	25	1998		7 to 11
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	73.5	0	24.5	2	0	0	0	0	49	1998		7 to 11
Hanger Brackets	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	85.7	0	14.3	0	0	0	0	0	49	1998		11+
Hanger Bkt Fasteners	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	69.4	0	24.5	4.1	0	2	0	0	49	1998		1 to 7*
Clamp Fasteners	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	81.6	0	18.4	0	0	0	0	0	49	1998		11+
Clamps	Ok	Worn Rubber	Aged									
	98	0	2						49			
Insulator Shed	OK	Polluted	Dust	Moss	Fungi	Disc-cracked	Disc-chipped					
	85.7	0	14.3	0	0	0	0		49			
Suspension - Side B										1998	3.4	9
Insulators	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	24	0	72	4	0	0	0	0	25	1998		7 to 11
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	77.6	0	22.4	0	0	0	0	0	49	1998		11+
Hanger Brackets	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	85.4	0	12.5	2.1	0	0	0	0	48	1998		7 to 11
Hanger Bkt Fasteners	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	75	0	14.6	6.3	4.2	0	0	0	48	1998		4 to 7
Clamp Fasteners	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	77.6	0	22.4	0	0	0	0	0	49	1998		11+
Clamps	Ok	Worn Rubber	Aged									
	98	0	2						49			
Insulator Shed	OK	Polluted	Dust	Moss	Fungi	Disc-cracked	Disc-chipped					
	85.7	0	14.3	0	0	0	0		49			
Tension - Side A										1998	4.7	4
Insulators	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	75	0	25	0	0	0	4	1998		4 to 11
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	20	0	60	20	0	0	0	0	5	1998		7 to 11
Deadend	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	100	0	0	0	0	0	0	0	5	1998		30+
Insulator Shed	OK	Polluted	Dust	Moss	Fungi	Disc-cracked	Disc-chipped					
	60	0	20	0	0	0	0		5			
Tension - Side B										1998	3	11
Insulators	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	100	0	0	0	0	0	4	1998		11+
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	40	0	60	0	0	0	0	0	5	1998		11+
Deadend	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	100	0	0	0	0	0	0	0	5	1998		30+
Insulator Shed	OK	Polluted	Dust	Moss	Fungi	Disc-cracked	Disc-chipped					
	40	0	40	0	0	0	0		5			

*- 1 year of Estimated Remaining Service Life is relating to the 'Hanger Bracket Bolts' or tip of the cross arms that will need maintenance work.

Bridging - Side A										1998	4	7
Insulators	Nil 50	G1 0	G2L 50	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	2	1998		11+
Hardware	Nil 0	G1 0	G2L 50	G2H 50	G3L 0	G3H 0	G4L 0	G4H 0	2	1998		7 to 11
Clamp Fasteners	Nil 0	G1 0	G2L 100	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	2	1998		11+
Insulator Shed	OK 50	Polluted 0	Dust 50	Moss 0	Fungi 0	Disc-cracked 0	Disc-chipped 0		2			
Bridging - Side B										1998	3.8	7
Insulators	Nil 33.3	G1 0	G2L 33.3	G2H 33.3	G3L 0	G3H 0	G4L 0	G4H 0	3	1998		7 to 11
Hardware	Nil 50	G1 0	G2L 50	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	4	1998		11+
Clamp Fasteners	Nil 50	G1 0	G2L 50	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	4	1998		11+
Insulator Shed	OK 100	Polluted 0	Dust 0	Moss 0	Fungi 0	Disc-cracked 0	Disc-chipped 0		4			

* - On South-Western Section:

Suspension insulators on side A were replaced in 2011 and are in very good condition, however their HI is governed by the condition of original hardware that was not replaced.

Only tower STR-0000 is installed with NCI insulators. They were replaced 2016 and are in very good condition.

** Bridging insulators were assessed based on the age and comparison with suspension insulators of same age and make due to lack of good photographic evidence.

Wet Tropics Section (BS1664) – Insulator assemblies

Built Section Meter	Corrosion Grade / Condition (%)								Sample Size	Installed Year	Health Index (95%)	Estimated Remaining Service Life (years)
Suspension - Side A										2016	1	17
Insulators	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	22			
Hardware	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	21			
Hanger Brackets	Nil 0	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	16			
Hanger Bkt Fasteners	Nil 0	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	23			
Clamp Fasteners	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	23			
Clamps	Ok 100	Worn Rubber 0	Aged 0						23			
Insulator Shed	OK 100	Polluted 0	Dust 0	Moss 0	Fungi 0	Disc-cracked 0	Disc-chipped 0		22			

Suspension - Side B										2016	1	17
Insulators	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	21			
Hardware	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	14			
Hanger Brackets	Nil 0	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	11			
Hanger Bkt Fasteners	Nil 0	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	13			
Clamp Fasteners	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	21			
Clamps	Ok 100	Worn Rubber 0	Aged 0						22			
Insulator Shed	OK 100	Polluted 0	Dust 0	Moss 0	Fungi 0	Disc-cracked 0	Disc-chipped 0		21			
Tension - Side A										2016	4	17
Insulators	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	14			
Hardware	Nil 92.9	G1 0	G2L 7.1	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	14			
Deadend	Nil 50	G1 0	G2L 42.9	G2H 7.1	G3L 0	G3H 0	G4L 0	G4H 0	14			
Insulator Shed	OK 100	Polluted 0	Dust 0	Moss 0	Fungi 0	Disc-cracked 0	Disc-chipped 0		14			
Tension - Side B										2016	3	17
Insulators	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	15			
Hardware	Nil 93.3	G1 0	G2L 6.7	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	15			
Deadend	Nil 66.7	G1 0	G2L 33.3	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	15			
Insulator Shed	OK 100	Polluted 0	Dust 0	Moss 0	Fungi 0	Disc-cracked 0	Disc-chipped 0		15			
Bridging - Side A										2016	1	17
Insulators	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	5			
Hardware	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	4			
Clamp Fasteners	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	5			
Insulator Shed	OK 100	Polluted 0	Dust 0	Moss 0	Fungi 0	Disc-cracked 0	Disc-chipped 0		5			
Bridging - Side B										2016	3	17
Insulators	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	5			
Hardware	Nil 100	G1 0	G2L 0	G2H 0	G3L 0	G3H 0	G4L 0	G4H 0	5			
Clamp Fasteners	Nil 83.3	G1 0	G2L 0	G2H 16.7	G3L 0	G3H 0	G4L 0	G4H 0	6			
Insulator Shed	OK 100	Polluted 0	Dust 0	Moss 0	Fungi 0	Disc-cracked 0	Disc-chipped 0		6			

* - On Wet Tropics section:

Bridging Insulators:1 tower only installed with 3 disc insulator strings.

11 towers installed with NCI insulators in very good condition (installed 2016).

Tension Insulators:1 tower only with 12 disc insulator strings.

13 remaining towers installed with NCI insulators in very good condition (installed 2016).

Suspension Insulators:

All suspension strings are installed with NCI insulators in very good condition (installed 2016).

Built Section Meter	Installation Date	Corrosion Grade/Comment	Estimated Remaining Service Life (years)
Earthing	1998	Good condition	7
Conductor	1998	No visible deterioration	59
Conductor Hardware	1998/2016	Instances of damper aging	3/27
Conductor Mid-Span Joints	1998	No visible deterioration	59
Signage	2015	Ok	10

Notes:

Grade 2 (G2) corrosion observed will continue to be monitored and reviewed using Measurement Documents in SAP.

Grade 3 (G3) corrosion represents a loss of greater than 50% of the galvanising layer and in the worst cases unprotected carbon steel corrosion is about to commence.

Grade 4 (G4) corrosion represents the total loss of galvanising and the onset of unprotected carbon steel corrosion. ***Estimated time until loss of 0.5mm of carbon steel in this environment is within 3-6 years.***

4. Transmission Line Parameters

4.1 Overview

BS1235 and BS1664 together make up a 275kV double circuit transmission line 55.96km in length, which forms part of the 275kV transmission network supplying the Cairns region, between Chalumbin and Woree substations.

Together the built sections consist of 123 double circuit steel lattice towers. Following the division of a single built section into two in 2019 to better reflect the very different ageing characteristics of the line, 86 structures form the south eastern section (BS1235) and 37 are located in the 16.3km long World Heritage listed Cairns/Kuranda Wet Tropics section (now renamed BS1664).

The final 16.3km section of the line, from STR 085 to the Bayview transition site, traverses the environmentally sensitive World Heritage Wet Tropics area and terminates within 2.5km of the Trinity Inlet Marine Park. Out of 37 towers on this section 32 sit within the Wet Tropics area; 22 of which are installed with helicopter landing platforms in order to facilitate maintenance and reduce the need for ground access in the very difficult terrain.

The line was originally built under contract TM169/96 and energized initially in 1998 at 132kV.

Significant works under taken on this built section include the following:

In 2002 feeder 7166/3 was energized at 275kV and was renumbered feeder 877.

In 2007 Feeder 7217 was energized at 275kV and was renumbered feeder 876.

In 2011; OR.01301 replaced all suspension insulators on feeder 876 (side A) with FOG disc insulators.

In 2012; OR.01564 installed of approximately 5km of OPGW on B side (F877) between the joint boxes on structures 1235-STR-0001 and 1235-STR-0009. The new OPGW on the B side was installed as a contingency measure to decrease the outage time in the event of a failure of the A side (F876) OPGW (refer: Fibre Cable Route diagram A3-H-143933-002).

In 2016; under OR.01995, all polymer insulators were replaced on the line.

In 2018; CP.2613 established two new substations (Walkamin and Mt Emerald subs) in order to connect a wind farm; resulting in creation of feeder F8902 north of the new Walkamin connection (between Walkamin and Woree). The Feeder between Chalumbin and Walkamin retained the feeder number F876.

In 2019; OR.02262 repaired soil erosion around towers 0086, 0089 and 0094.

Figure 2: Modification the line due to Walkamin and Mt Emerald substations establishment

4.2 Summary Table

Item	Specification
Commissioning Date	6 April 1998
Voltage	275kV

Contract Number	TM169/96
No. of Circuits	2
Circuits	Feeder Wires A – 876/ 8902 Feeder Wires B- 877
Route Length (km)	55.96 km (39.73km on Section 1 & 16.23km on Section 2)
No. of Towers	28 Tension (14 on Section 1 and 14 on Section 2) 95 Suspension (72 on Section 1 and 23 on Section 2)
Type	Galvanised Steel Lattice Tower
Foundations	Standard steel reinforced concrete, Special, Mass and Rock Anchor
Conductor	ACSR/GZ (Mango 54/7/3): 2 Sub Conductors/Phase
Conductor Line Clamps	AGSU
No. of OHEW	1 from STR-0000 to STR-0085
Earthwire	SC/AC (5/3/3.0)
No. of OPGW	1 from STR-0000 to STR-0085 - 2 from STR-0085 to STR-0121
OPGW	PHILLIPS_FIT_12FIB_OPGW_11.0
OHEW Line Clamps	Twingrip
Conductor Vibration Dampers	Dogbone
Earthwire/OPGW Vibration Dampers	Spiral/Stockbridge
Suspension Insulators	Side A F876/8902: NGK_FOG DISC_125kN_SUSPENSION, 18 Discs, Installed 2011 Side B F877: NGK_NORMAL DISC_125kN_SUSPENSION, 18 Discs, Installed 1998 Sides A & B from STR-0086 to STR-0119: SEDIVER_COMP.LONGROD_160kN, Installed 2016
Bridging Insulators	NGK_NORMAL DISC_125KN_BRIDGING, Installed 1998 SEDIVER_COMP.LONGROD_160kN_BRID, Installed 2016 SEDIVER_COMP.POST_2.9kN_BRIDGING, Installed 2016 SEDIVER_COMP.POST_33kN_BRIDGING, Installed 1998
Tension Insulators	NGK_NORMAL DISC_125KN_TENSION, 19 Discs, Installed 1998 SEDIVER_COMP.LONGROD_160kN_TENSION, Installed 2016
Average Easement width	60m

5. Location and Environment

5.1 General Location

The transmission line is located in far North Queensland, and traverses the Cairns/Kuranda Wet Tropics area and includes 32 towers whose management is subject to the requirements of the Wet Tropics area. There is one crossing of the Kennedy highway and number of minor road crossings.

	Rail	Highway	Minor Roads	Urban Property (<10m from easement)
Spans undercrossing	0	1	45	1

Table 1: BS1235 and BS1664 Span undercrossing information

5.2 Land Use

The route's land use is significantly different between Wet Tropics area in the North Eastern section (BS1664) and the dry rugged country in the South West section (BS1235).

Figure 3: BS1235 and BS1664 land use area

5.3 Atmospheric Corrosion

Figure 1 presents meteorological data for a number of locations along the whole line. It is clear that the South West section (BS1235) (STR-0000 to STR-0084) located between Springmount area and Davies Creek National Park experiences much lower yearly rainfall than the line section installed in Wet Tropics area (STR-085 to STR-0121).

Examined condition of the structures in the two areas of the line reflect the significantly different conditions. Consequently, it is necessary that the asset management strategy be different for the two sections. This condition assessment document considers the two line sections (BS 1235 and 1664) separately.

The South West section of the line (BS1235) is installed in an area with around 1000mm of the rainfall and is protected from air-borne salt deposition by distance from the ocean and by a mountain range.

The Wet Tropics section of the line (BS1664) is more exposed to the ocean winds, high humidity and rainfall levels of more than 2000 mm per year.

Corrosion and maintenance records from Powerlink's old Cairns – Innisfail 132kV steel tower transmission line (BS1231) commissioned in 1957 and the Woree - Turkinje 132kV line (BS1251) commissioned in 1967, show that the towers' galvanised bolts were exhibiting extensive Grade 2 corrosion after just 5 years, light members after 8 and heavy members after only 10. Such deterioration of galvanised steel is consistent with corrosion region C5.

The highest rates of galvanised steel corrosion normally occur on sheltered or partially sheltered steel members, nuts, bolts and joint interfaces. Reduced exposure to cleansing rains and drying winds creates a microenvironment where the accumulation of air-borne pollutants and trapped moisture accelerates the corrosion process.

The thickness of the original coating also determines the subsequent service life of the coating as the rate of zinc loss is constant for a given geographical area.

This increased potential for corrosion based upon microclimatic conditions and coating thickness is consistent with the observed condition of Powerlink's galvanised steel lattice towers, with spot rusting of major members accompanied by more advanced rusting of nuts, bolts and joint nodes.

Once the galvanised coating has been damaged or deteriorated to the point where visible corrosion is evident, the steel has effectively begun to break down (AS/NZS 2312-2002 – Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings) This point has been adopted as Level 2 corrosion in Powerlink's Visual Grading Guides and triggers corrective action to prevent deterioration of the underlying steel component

The Galvanizers' Association of Australia (refer Section 7) estimates the service life of nuts, bolts and members in this locations as follows.

For the South West section (BS1235), corrosion region C4 is considered to be most appropriate

Component	Minimum coating thickness µm	Estimated life to First Service in Years *(First Appearance of Grade 2)*
Bolts & nuts	45	11
Members ≤ 6mm	70	17
Members > 6mm	85	20

For the Wet Tropics section (BS1664), corrosion region C5 is appropriate:

Component	Minimum coating thickness µm	Estimated life to First Service in Years *(First Appearance of Grade 2)*
Bolts & nuts	45	5
Members ≤ 6mm	70	8
Members > 6mm	85	10

The final stages of G4 Corrosion represent a total loss of galvanising and the onset of unprotected carbon steel corrosion. Rates of carbon steel corrosion can be between 10-300 times the rates of galvanised corrosion, depending upon the atmospheric conditions.

6. Condition Assessment

NOTE: Unless otherwise stated, any Expected Remaining Life estimates are based upon the condition of the asset at the time the main photographic evidence was collected in 2018.

Based on the photographs taken, there is extensive G2, G3 and G4 corrosion on the Wet Tropics section of BS1664. Corrosion levels are significantly lower for the South West section (BS1235).

Figures 35 and 36 in Appendix 6.17 shows the contrasting levels of G2, G3 and G4 corrosion observed along the line from the sampled structures.

6.1 Structure – Overview

The following table outlines the type and numbers of towers that make up Built Section 1235. Body extensions vary between -9 and +33 meters.

South West section (BS1235)

Tower Types	Number	Body Extensions
D2S2G (Suspension)	72	-6 TO +15
D2T70G (Tension)	5	+0 TO +12
D2T40G (Tension)	9	-9 TO +18
TOTAL	**86**	

Wet Tropics section (BS1664)

Tower Types	Number	Body Extensions
D2S0H (Suspension)	23	+6 TO +33
D2T45H (Tension)	11	+6 TO +18
D2T70J (Tension)	1	+3
D2T60E (Tension)	2	+6 & +9
TOTAL	**37**	

6.2 Foundation Condition

Steel lattice tower foundations in BS 1235 and BS1664 are mostly standard reinforced concrete type.

On the South West section (BS1235) of the line there are 12 towers installed with Rock Anchor foundations and 3 towers installed with mass foundations (STR-0003, STR-0005, and STR-0027).

The Wet Tropics section (BS1664) has 5 towers (STR-0087, STR-0089, STR-0091, STR-0096, and STR-0105) installed with 'Special' foundations. Some towers (as illustrated in Figure 4) have tall column extensions from 3 to 5m above natural ground level. As part of OR.02262 design assumptions for design of tall columns were checked and foundation records reviewed. All structural capacities were found to be satisfactory.

In 2015, a survey of all tower legs and K-points found the majority to be in a good condition. A small number of tower legs were observed to have Grade 2 corrosion and isolated examples of Grade 3 corrosion at the leg/concrete interface were noted. There is a single instance of G4 corrosion on one leg of tower STR-0020.

Figure 4: Extended columns on Structure 0116

Typically interface are found to be in good condition.

Figure 5: 1235-STR-0002 typical interface condition on the line (2015)

6.3 Structure Condition

6.3.1 Climbing Aids

BS1235 and BS1664 have conventional climbing bolts, i.e. no dedicated climbing attachment points are installed.

On the South West section (BS1235) step bolts appear to be in good condition with only occasional instances of G2 corrosion (as shown in Figure 6).

On the Wet Tropics section (BS1664), G2 corrosion has been observed on step bolts of all towers. With the common instances of G3 and even G4 corrosion levels (Figure 7).

Figure 6: Grade 1 corrosion shown on step bolts 1235-STR-0034 (2018)

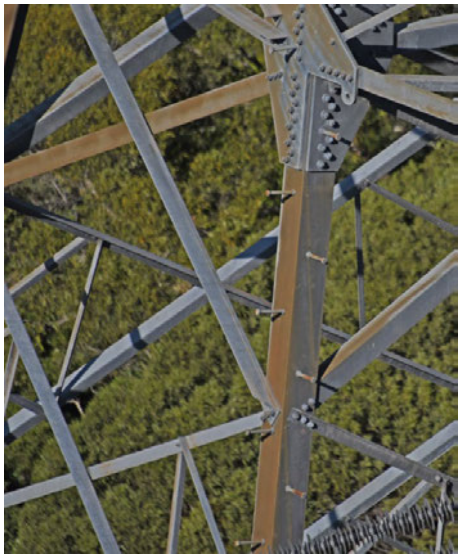


Figure 7: Grade 2 and 3 corrosion shown on step bolts 1664-STR-0102 (2018)

6.3.2 Anti-Climbing Barriers

Towers have been fitted with a selection of Type A1 and A2 barbed wire type anti-climbing barriers depending on their size. All anti-climb barriers remain in a serviceable condition. Less than 10% of steel barrier frames are showing Grade 2 corrosion (Figure 8). At the time of this report, there are no open notifications for broken barbwires on the line.

Figure 8: STR-0045; ACB barbed wire typical for towers on the line (2018)

6.3.3 Tower Base

On South West section (BS1235) there is a minimal corrosion evident on the bolts and members at the tower bases with most sheltered light members and bolts at corrosion Grade 1. Heavy members remain unaffected (see Figure 9).

Figure 9: STR-0002; Sample of corrosion on tower base bolts (2015)

The Wet Tropics section (BS1664) is showing evidence of emerging G3 corrosion levels.

Figure 10: STR-01017; Sample of corrosion on tower base members

6.3.4 Tower Body

South West section (BS1235):

Early G2 corrosion of the light body members has been observed on some towers. No evidence of G3 corrosion on the bolts (shown below in Figure 11).

Figure 11: STR-0050 Tower body in good condition (2018)

Wet Tropics section (BS1664):

G2 and G3 corrosion evident on the body members and bolts of all towers of the section of the line (shown below in Figure 12).

Figure 12: STR-0108 Tower body with widespread surface corrosion of smaller members and bronzing of larger members

6.3.5 Superstructure

South West section (BS1235):

Within the south western section, some G2 corrosion of the light members and bolts has been observed. The onset of G3 corrosion was observed on the bolts of one tower only (shown below in Figure 13).

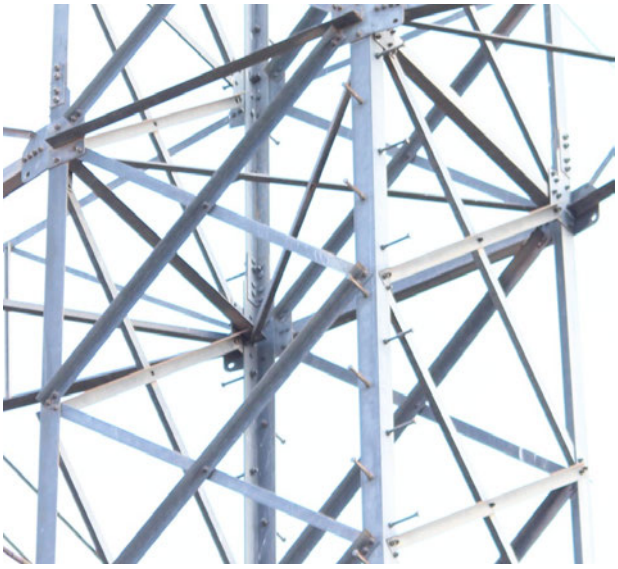


Figure 13: STR-0021 with G3 bolts and G2 on members (2018)

Wet Tropics section (BS1664):

G2 and G3 corrosion is widespread on the superstructure bolts with close to 2% of bolts at corrosion level G4 (shown below in Figure 14).

Figure 14: 1235-STR-0101 with G3 and G4 bolts and G2 on members (2018)

6.3.6 Conductor Attachment Zone Fasteners

South West section (BS1235):

It has been observed that bolt corrosion in attachment plate areas is more extensive compared to other tower fasteners on this section of the line, with grade 2 or 3 corrosion observed on almost 7% and grade 4 corrosion starting to emerge on attachment plate nuts and bolts.

Figure 15: Examples of G4L corrosion in Attachment Zone fasteners (2018)

Wet Tropics section (BS1664):

The bolt corrosion in attachment plate areas is in better condition than expected considering average condition of the whole tower. Around 9% of bolts in the attachment areas were observed to be G3 or G4.

Figure 16: STR-0101 Attachment Zone - Wet Tropics representation (2018)

6.3.7 Cross-arms

South West section (BS1235):

The cross-arms fasteners and members commonly exhibit Grade 1 or Grade 2 corrosion with very rare instances of Grade 3 and 4. The larger cross-arm members are relatively unaffected by corrosion at this stage.

Figure 17: STR-0030 cross arm corrosion (2018)

Wet Tropics section (BS1664):

On this section of the line there are more than 2% of bolts and close to 2% of members exhibiting Grade 4 corrosion.

Figure 18: STR-0115 cross arm corrosion (2018)

6.3.8 Earthwire Peak

South West section (BS1235):

Light surface rust and sometimes advanced G2 corroded nuts and bolts were observed on earthwire peaks of the towers on the South West section (BS1235) of the line.

Figure 19: STR-0030 Earth Peak corrosion (2018)

Wet Tropics section (BS1664):

Surface rust consistent with advanced G3 corrosion on members, nuts and bolts is present on earthwire peaks of the towers on the Wet Tropics section (BS1664) of the line.

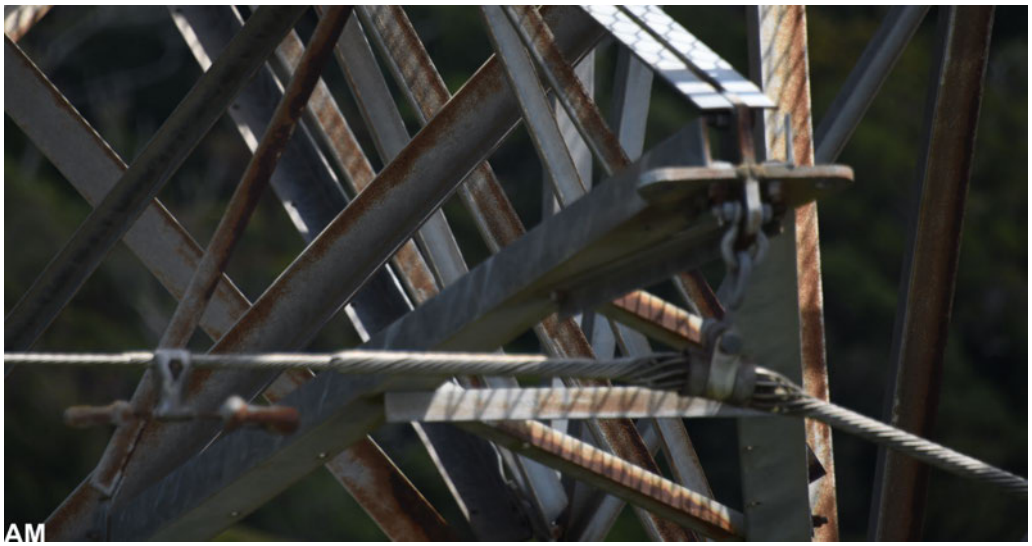


Figure 20: STR-0101 Corrosion on Earth Peak (2018)

6.4 Earthing

Earth cables and connectors are generally in good condition with no open notifications for ground earthing and only one G3 notification for a corroded connecting bolt.

Figure 21: BS1235 Examples earthing (2016)

South West section (BS1235):

Up until 2019 this section had sustained only one single circuit lightning induced trip (15/10/2011) and one double circuit lightning induced trip (2/3/2013). A future project on this section may try to improve that performance by installing additional earthing on some of the 11 towers with earthing resistances higher than 20 ohms.

Wet Tropics section (BS1664):

28 (75%) towers on this section have earthing resistances higher than 20 ohms, but lightning performance is reasonable good with only two instances of flashed insulators (STR-0120 in 2015 and STR-0113 in 2018) possibly due to the lightning.

6.5 Conductor

The transmission line is strung with single ACSR/GZ Mango, 54/7/3.00 conductor**,** containing a galvanised and greased central steel core.

Experience on ACSR conductors overseas has shown that the grease can harden after 35 to 45 years, resulting in moisture ingress and accelerated core corrosion. Previous testing of conductors on other lines has identified a small amount of corrosion in conductors of this age, but visual examination of the conductor has not indicated any major defects which could be attributable to aluminium or steel core corrosion or overloading.

The Mango ACSR/GZ conductor is terminated with a compressed dead end fitting. The end fittings are showing no signs of corrosion.

6.6 Conductor Hardware

South West section (BS1235):

Originally installed vibration dampers shown in photographs appear free of corrosion but with weathered galvanizing. The slight droop of the messenger wires may indicate that they are slightly affected by messenger wire fatigue.

Figure 22: STR-0020 Vibration Dampers and Dead Ends (2018)

Wet Tropics section (BS1664):

Vibration dampers were replaced along with NCI insulators in 2016 and are in good condition.

Figure 23: STR-0099 Vibration Dampers and AGSU (2018)

6.7 Conductor Mid-Span Joints and Spacers

On the line there are 47 spans installed with mid span joints, however there are no defect notifications recorded in SAP against mid-span joints.

The line is installed as a 'horizontal bundle' configuration of two conductors secured with a Twinlok spacer. There are no notifications recorded in SAP against spacers.

6.8 Earthwire

South West section (BS1235):

The earthwire on the South West section (BS1235) is in good condition exhibiting the appearance of weathered galvanising. 'Twingrip' connectors used to secure the earth wire to the earthwire peak exhibit G2 corrosion level on some towers.

Figure 24: STR-0057 Example of earthwire and twingrip from the line (2018)

Wet Tropics section (BS1664):

No earthwire installed. OPGW appears in a good condition.

6.9 Earthwire and OPGW Hardware

South West section (BS1235):

Figure 25: STR-0029 with corroded OHEW hardware (2018)

In addition to the above mentioned 'Twingrip' connectors with G2 corrosion, some earthwire shackles are also starting to deteriorate to a G2 corrosion level.

Wet Tropics section (BS1664) (OPGW hardware only):

On some towers AGSU housing and/or shackles are deteriorated to the low G3 levels. Similar corrosion levels are observed on OPGW vibration damper messenger wires.

Figure 26: STR-0115 with corroded OPGW hardware and dampers (2018)

6.10 Suspension and Bridging Insulators

South West section (BS1235):

According to SAP data, suspension insulators on feeder 877 (side B) are original 125kN NGK normal discs (18 Discs per string), installed in 1998. Based on a very small sample of good photos, these insulators are estimated to be affected with G2H pin corrosion, with an estimated minimum of 7 years of remaining life (see photo Figure 23).

Feeder 876 and 8902 had suspension insulators replaced in 2011 with 125kN NGK FOG discs (18 Discs per string) and are in very good condition.

Figure 27: STR-0026 (2018)

Wet Tropics section (BS1664):

All suspension insulators on this section are polymer. In 2016; under OR.01995, all insulators including hardware were replaced.

6.11 Suspension Insulator Hardware

South West section (BS1235):

Hardware is displaying mostly G1 and G2L corrosion with rare instances of G2H.

Figure 28: STR-0080 – Hardware in good condition (2018)

6.12 Tension Insulators

South West section (BS1235):

All tension insulators on this section are original 1998, except for tower STR-0009 that had all insulators replaced in 2010 due to the Walkamin sub connection project.

A review of the limited number of available photos did not show any pins with corrosion higher than grade G2L corrosion and mostly with G1.

Figure 29: STR-0038 Tension Insulators (2018)

Wet Tropics section (BS1664):

All tension insulators on this section are polymer insulators replaced 2016, except for tower STR-0085 that has all original disc insulators.

6.13 Tension Insulator Hardware

South West section (BS1235):

Hardware is in good condition with an occasional appearance of grade 2L or 2H corrosion on some towers.

Figure 30: Tension Hardware corrosion examples (2018)

Wet Tropics section (BS1664):

All tension hardware was replaced in 2016, except for tower STR-0085 that has all original disc insulators and associated hardware.

6.14 Signage

Signage was audited in 2015 and no issues were recorded in Built Section Meters in SAP.

6.15 Easement

South West section (BS1235):

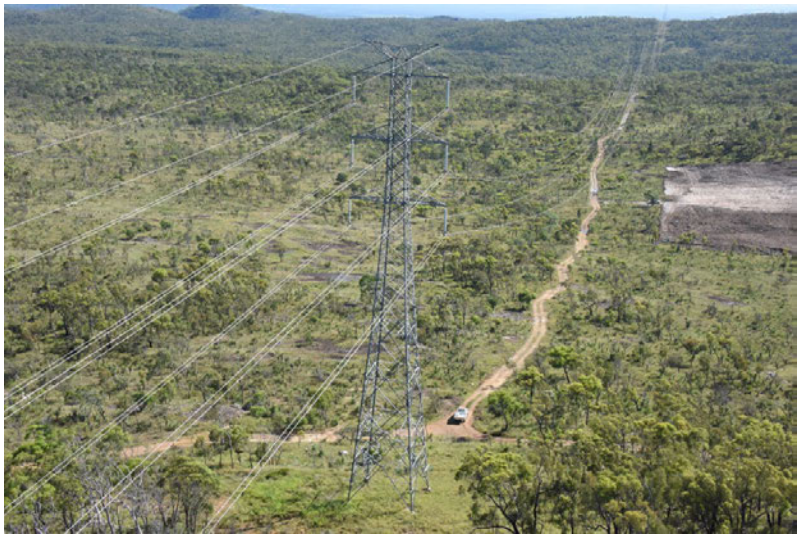


Figure 31: Typical easement outlook on South West section of BS1235 (2018)

On the South West section (BS1235) of the line, the predominant problems recorded in Notifications are related to the weed issues.

Wet Tropics section (BS1664):

Figure 32: Typical easement outlook on South West section of BS1235 (2018)

On the Wet Tropics section (BS1664) of the line, the predominant problems recorded in Notifications are related to the erosion of access tracks and around tower footings.

Appendices

6.16 Health Indexes and Levels of Corrosion

South West section (BS1235):

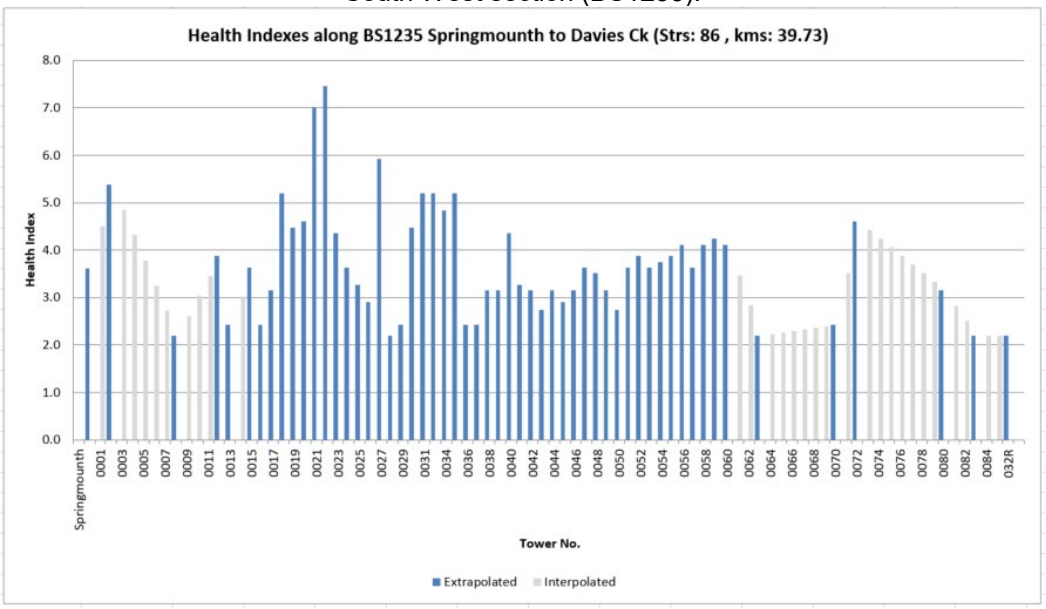


Figure 33: Graph of Health Indexes for Structures STR-0000 to STR-0084

Wet Tropics section (BS1664):

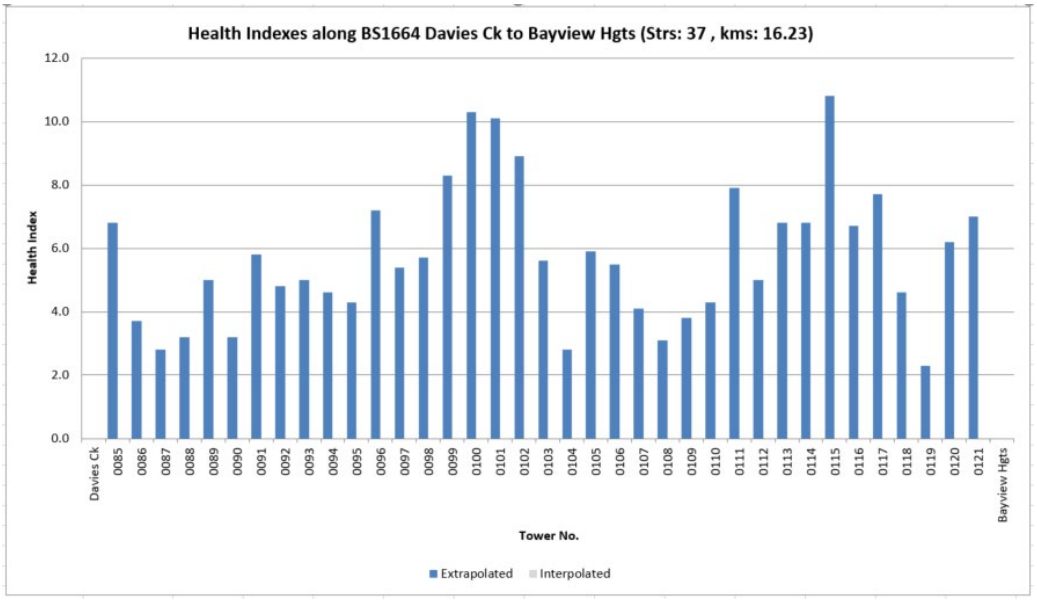


Figure 34: Graph of Health Indexes for Structures STR-0085 to STR-0121

6.17 Percentage of Structure Corrosion

South West section (BS1235):

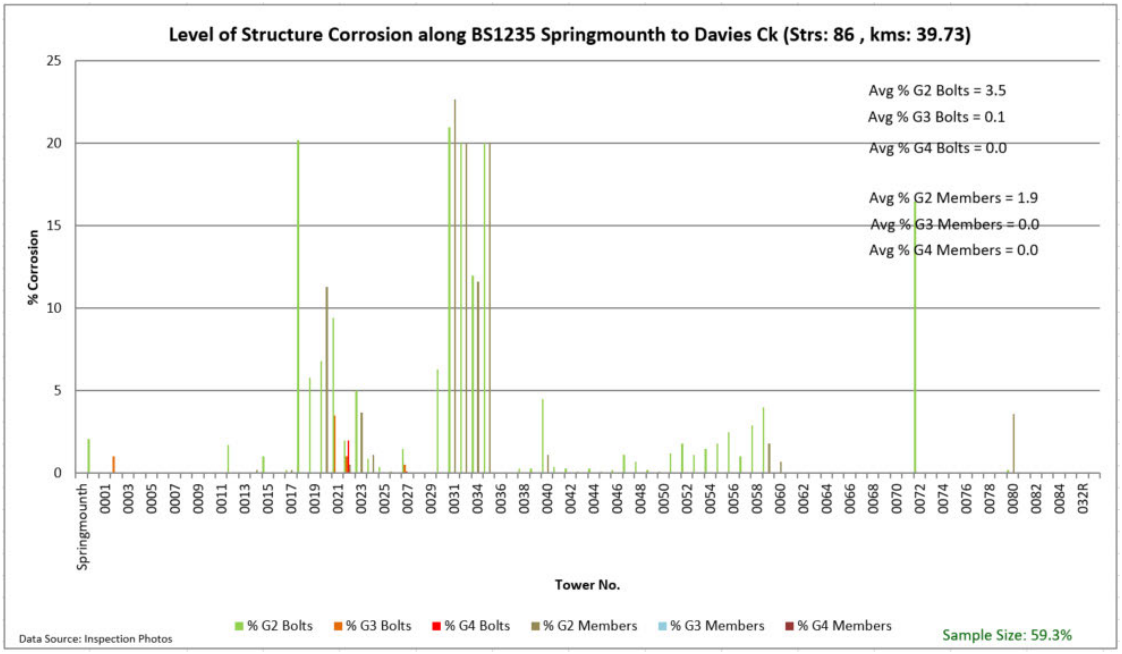


Figure 35: Percentage of Structure Corrosion STR-0000 to STR-0084

Wet Tropics section (BS1664):

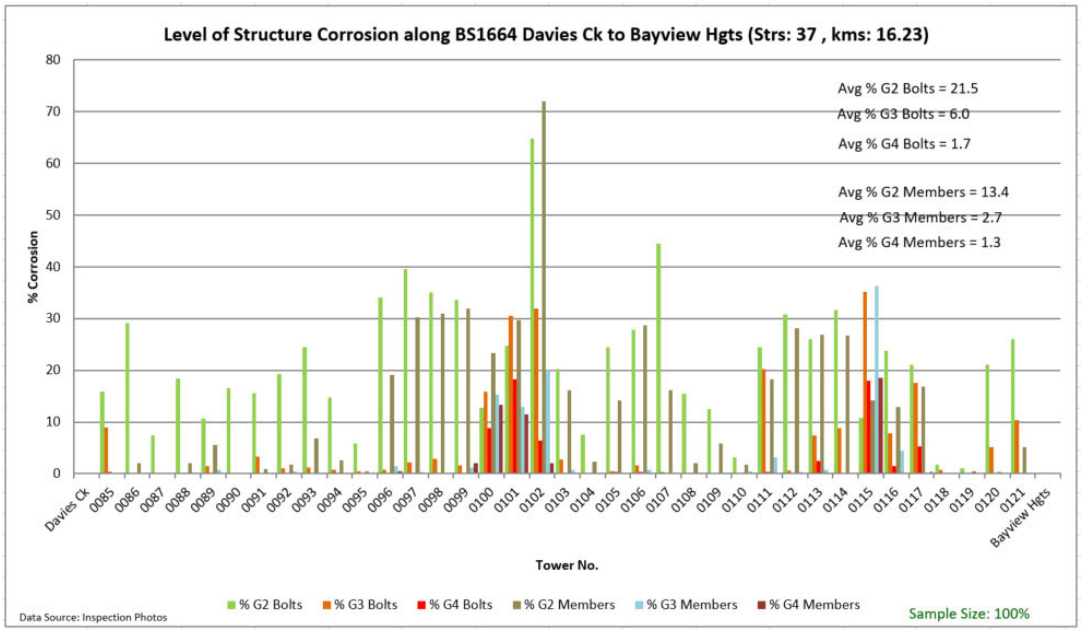


Figure 36: Percentage of Structure Corrosion STR-0085 to STR-0121

6.18 Built Section Meters

Functional Location	Meas Document	Measuring Point	Description of measuring point	Date	Valuation code	Coding code text
1235-STR	18610522	118340	FOUNDATIONS	27/07/2018	0005	INVESTIGATED FOLLOWUP REQD
1235-STR	18610523	118520	STRUCTURE (ABOVE K-POINT,ANTICLIMB,OPGW)	27/07/2018	0005	INVESTIGATED FOLLOWUP REQD
1235-STR	18610524	119060	TENSION INSULATORS	27/07/2018	0005	INVESTIGATED FOLLOWUP REQD
1235-STR	18609591	119420	OHEW H'WARE(DEADEND,H'WARE,CLAMP,DAMPER)	27/07/2018	0005	INVESTIGATED FOLLOWUP REQD
1235-SPN	18609584	120140	CONDUCTOR HARDWARE (DAMPERS, SPACERS)	27/07/2018	0005	INVESTIGATED FOLLOWUP REQD
1235-STR	18609589	118160	EARTHING (GRADING RING ETC)	27/07/2018	0006	INVESTIGATED OK
1235-STR	18609595	118700	SUSPENSION INSULATORS	27/07/2018	0006	INVESTIGATED OK
1235-STR	18609594	118880	SUSP H'WARE (HANGERS, SUSP UNIT)	27/07/2018	0006	INVESTIGATED OK
1235-STR	18609596	119240	TENSION H'WARE(H'WARE,DEADEND,GRAD TUBE)	27/07/2018	0006	INVESTIGATED OK
1235-STR	18609592	119600	SIGNAGE (CIRCUIT ID, WARNING PLATES)	27/07/2018	0006	INVESTIGATED OK
1235-SPN	18609585	119780	CONDUCTORS	27/07/2018	0006	INVESTIGATED OK
1235-SPN	18609586	119960	CONDUCTORS MIDSPAN JOINTS	27/07/2018	0006	INVESTIGATED OK
1235-SPN	18609587	120320	OHEW/OPGW	27/07/2018	0006	INVESTIGATED OK
1235-SPN	18609588	120500	OHEW/OPGW MIDSPAN JOINTS	27/07/2018	0006	INVESTIGATED OK

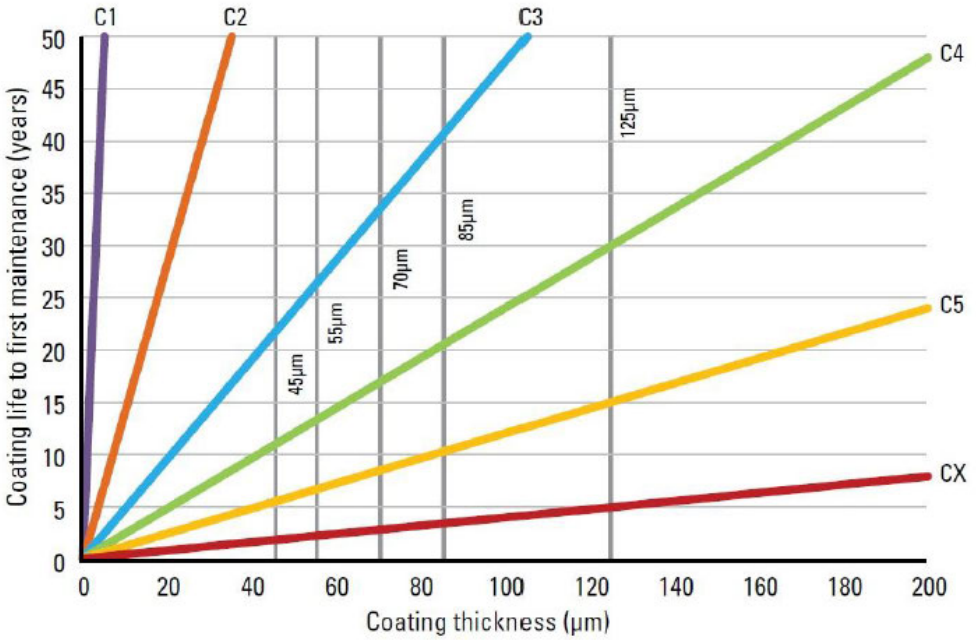
Figure 37 - Recent Built Section Meters Measurement Document List

6.19 Estimated Service Life of Galvanised Steel

BS1235 Transmission Line

Corrosivity Category	Corrosivity	Example
C4 (D)	High	Moderate corrosion environment, such as in low density urban development or high activity rural areas, inland coastal regions, moderate to high humidity and rainfall, and/or moderate to heavy vegetation encroachment into the easement.
C5 (E)	Very High	Aggressive corrosion environment and/or close proximity to high salt coastal regions. Average Annual Rainfall may vary. Moderate to dense urbanised area with high public exposure will be included in this category.

Chart 1: Life to First Maintenance of Hot Dip Galvanized Steel



The LFM range for a particular hot dip galvanizing coating thickness and each corrosivity zone can be read from the chart. For example, the LFM range for a hot dip galvanized article with an 85 µm thickness and located in the C4 (High) corrosivity zone is 20 to 40 years.

This chart is supported by case history evidence in Australia, where service life records of 50 years are common and up to 110 years are recorded.

The Life to First Maintenance chart is available as a standalone document directly from the Galvanizers Association of Australia.

Figure 38 - Time to First Maintenance of Galvanised Steel

6.20 Estimated Service Life of Carbon Steel

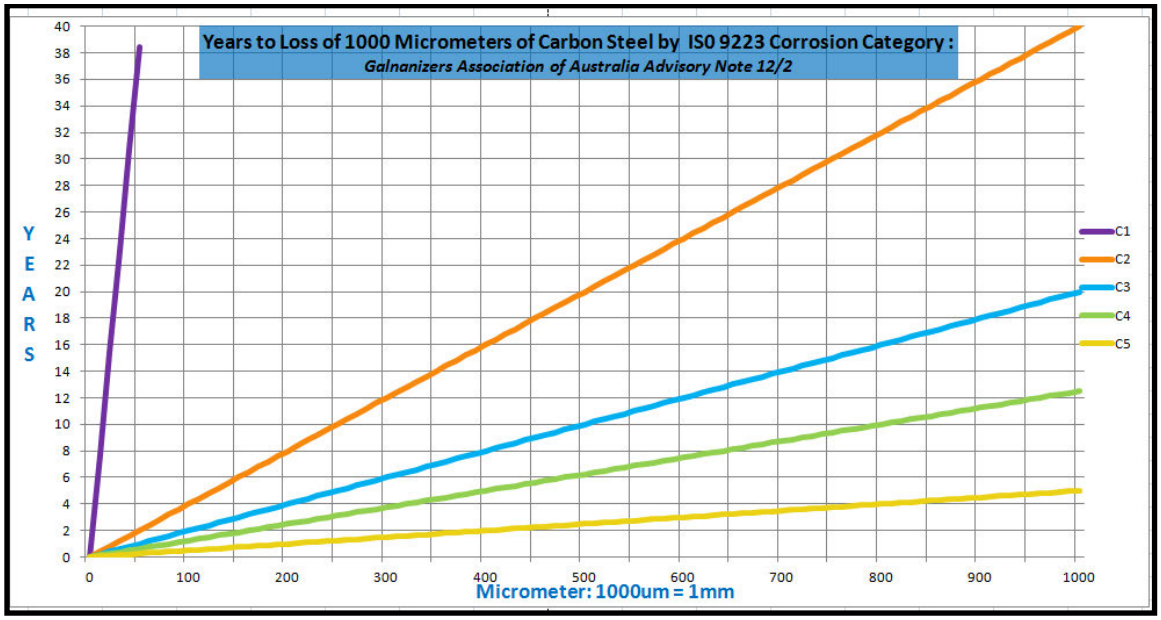


Figure 39 - Rate of Carbon Steel Loss

Source: Extrapolated from Table 2: Corrosion Rates for Steel and Zinc for the first year of exposure for different corrosivity categories. Galvanizers Association of Australia – Advisory Note GEN12/2 April 2012

6.21 References

Inspection Guides and Corrosion Models

- A2628257 Asset Strategies – Line Maintenance Principles – Specification
- A2791823 OSD – Transmission Line Patrol and Inspection – Guideline
- Galvanizers Association of Australia – Advisory Note GEN12/2 *"Atmospheric Corrosion Resistance of Hot Dipped Galvanized Coatings"* April 2012.

Built Section Configuration

- SAP Reports

Condition Assessment Data

- M Drive Photos
- SAP IK17 Measurement Documents

Planning Statement	**09/07/20**
Title	CP.02754 Davies Creek – Bayview Heights 275kV Transmission Line Refit – Planning Statement [1]
Zone	Far North Queensland
Need Driver	A condition assessment of the Chalumbin – Woree 275kV Transmission Lines carried out in 2019 recommended refurbishment by October 2023 to maintain ongoing compliance with requirements of the Electricity Act 1994, Electrical Safety Act 2002 and Electricity Safety Regulation 2013[2].
Network Limitation	Needed to meet Powerlink Queensland's N-1-50MW/600MWh reliability obligations.
Pre-requisites	None

Executive Summary

The Chalumbin to Woree 275kV circuits (BS1235) form part of the North Queensland main transmission system and facilitate power flow from Central and Northern Queensland to Far North Queensland and, increasingly, in the opposite direction following the commissioning of several inverter-based generators in the area.

Built section 1235 was first established 1998. It is a double circuit cyclone rated steel tower transmission line. This transmission line is critical for the supply of power into Cairns and the Far North Queensland region. Energy Queensland's forecasts confirm an enduring need to maintain electricity supply into Far North Queensland.

A 2019 assessment of the line confirms a number of emerging safety and network risks arising from the condition of the ageing asset. Removal of the Chalumbin to Woree 275kV transmission line to address the emerging condition risks would result in Powerlink breaching its N-1-50MW/600MWh reliability obligations.

Planning has assessed several options to address the network risks arising from the ageing asset and has recommended maintaining the existing topology as the most effective solution to meeting Powerlink's jurisdictional and Rules obligations.

[1] *This report contains confidential information, which is the property of Powerlink, and the Registered Participant mentioned in the report, and has commercial value. It qualifies as Confidential Information under the National Electricity Rules (NER). The NER provides that Confidential Information:*

- *must not be disclosed to any person except as permitted by the NER;*
- *must only be used or copied for the purpose intended in this report;*
- *must not bade available to unauthorised persons*

[2] Electrical Safety Act 2002, section 29. Electrical Safety Regulation 2013, section 198(a). Electrical Safety Regulation 2013, section 198(d)

Table of Contents

1. Introduction

Built section 1235 between Chalumbin and Woree was first established 1998. It is a 136km double circuit cyclone rated steel tower transmission line.

The development of Woree Substation in early 2002 completed the establishment of 275kV supply into Cairns in Far North Queensland. BS1235 now supports dual 275kV circuits from H032 Chalumbin to H039 Woree substations. This transmission line is critical for the supply of power into Cairns and the Far North Queensland region.

The Mt. Emerald Wind Farm (180 MW) also connects to Feeder 876 at Powerlink's Walkamin Substation.

The built section traverses some challenging terrain with sections of unexploded ordinance (UXO) prominent along this line. An area of the original Built Section has been allocated a different built section number to reflect the distinctively different environment. This section, 1664-STR-0085 to 1664-STR-0121, is described as Davies Creek to Bayview Heights and passes through the Wet Tropics Management Area (WTMA) and requires a high level of environmental security.

A geographical map is shown in Figure 1.

Figure 1 – Geographical Map of feeders 876 & 877

The network single line diagram shows (Figure 2) both the 275kV and 132kV network between the Townsville and Cairns region. BS1235 is the two lines between H032 Chalumbin and H039 Woree, and BS1664 is the section from Davies Creek to Bayview heights. BS1664 is shown in a red circle below.

Figure 2: Single Line Diagram of FNQ Region

A Condition Assessment of the lines in 2019 identified significant corrosion, resulting in a need to undertake immediate reinvestment to address condition issues. Enhanced maintenance was being relied upon to maintain the section in a serviceable state until more significant reinvestment could take place.

This report assesses the impact that removing the at-risk lines would have on the performance of the network and Powerlink's statutory obligations. It also establishes the indicative requirements of any potential alternative solutions to the current services provided by the Chalumbin to Woree feeders.

2. Cairns Area Demand Forecast

The Cairns area maximum demand forecast is shown in Figure 3. The Cairns area consists of the following Energy Queensland bulk supply points (Cairns, Cairns City, Cairns North, Kamerunga and Edmonton)

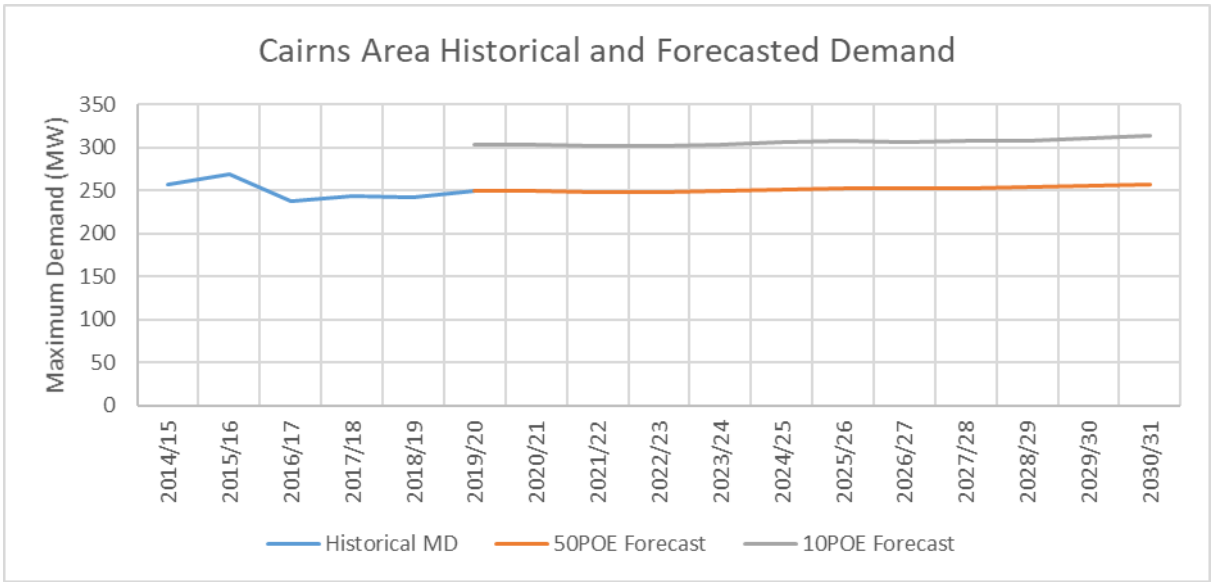


Figure 3: Cairns Region Forecasted Loading

Historical load duration curves for the Cairns area are shown in Figure 4.

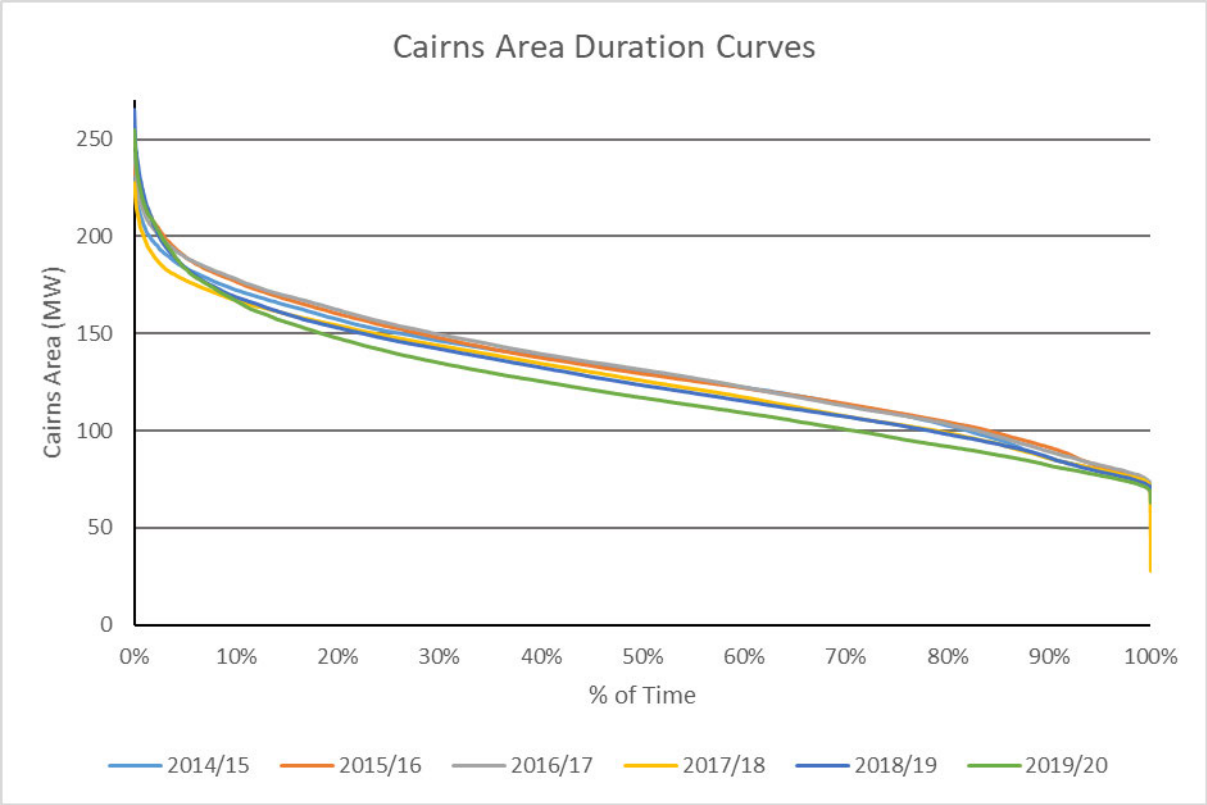


Figure 4: Historical Load Duration Curves for FNQ

3. Statement of Investment Need

Energy Queensland's forecasts have confirmed there is an enduring need to maintain electricity supply to the Cairns area.

The removal of the Chalumbin to Woree 275kV double circuit transmission line to address emerging condition-based safety issues would have a major impact on loads in the Cairns area and violate Powerlink's N-1-50MW/600MWh reliability obligations.

Powerlink must therefore preserve the functionality of the Chalumbin to Woree transmission lines to ensure ongoing compliance with its Transmission Authority reliability obligations for the supply of electricity to the Cairns area.

3.1 System Strength in Far North Queensland

FNQ has experienced high interest in connecting inverter-based renewable generation in the past 3 years, and these trends are likely to continue. Apart from the local hydro power stations, this region is remote from conventional synchronous generation. Adverse system strength impacts may be caused by the aggregation of multiple electrically close inverter-based renewable generating units.

Currently the Mt. Emerald Wind Farm is connected to Powerlink's network in FNQ. The wind farm is connected to a single 275kV circuit between Chalumbin and Woree. To address system and plant stability issues a Special Protection Scheme (SPS) trips the wind farm for a double circuit outage/trip of either the Ross-Chalumbin or Chalumbin-Woree lines. Currently the Ross-Chalumbin 275kV double circuit line is classified as 'proven' under AEMO's Power System Security Guidelines and as a result, a double circuit trip will be declared credible during lightning storms in the vicinity of the line.

The above, reinforces the importance of the 275kV double circuit lines into FNQ from a system strength perspective. The removal of this double circuit transmission line to address emerging condition-based safety issues would also have a major impact on system strength and the continued operation of the Mt. Emerald Wind Farm.

4. Network Risk

Table 2 presents the load and energy at risk for loads in the Cairns area supplied from the 275kV feeders between Chalumbin and Woree substations. The loss of the double circuit 275kV line Davies Creek and Bayview Heights results in all of FNQ load (less Turkinje and Kidston) being supplied from the double circuit 132kV coastal circuit (refer to Figure 2). This 132kV double circuit has limited capacity due to voltage stability limitations (nominally 170MW - including operational reactive power safety margin).

An outage of the double circuit outage between Davies Creek and Bayview Heights also results in the Mt Emerald Wind Farm being disconnected from the Cairns area. As a result, the Cairns area loads can only be supplied from the 132kV coastal double circuit and output from the Barron Gorge (run of river) Power Stations.

As shown in Figure 3, the combined capacity of the 132kV coastal network and the output from the Barron Gorge Hydro Power Station (notwithstanding that this power stations is 'run of river' and therefore very energy limited) is not sufficient to meet the Cairns area load.

In addition, whilst operating with this reduced network into the Cairns area a contingency on the coastal 132kV network could also occur, further reducing the supportable load (approximately 70MW).

Table 1 summarises the results of analysis to quantify the load and energy at risk.

Table 1 – Far North Queensland Load at Risk

At Risk	Contingency	Metric	2026
Cairns area loads	Chalumbin to Woree 275kV feeder (877) + Walkamin to Woree 275kV feeder (8902)	Max (MW)	268
		Average (MW)	3
		24h Energy Unserved Max (MWh)	911
		24h Energy Unserved Average (MWh)	68
Cairns area loads	Chalumbin to Woree 275kV feeder (877) + Walkamin to Woree 275kV feeder (8902) + coincident outage of Yabulu South to Tully 132kV feeder (7132)	Max (MW)	268
		Average (MW)	53
		24h Energy Unserved Max (MWh)	2538
		24h Energy Unserved Average (MWh)	1126

5. Non Network Options

Potential non-network solutions would need to provide reliable supply to the Cairns area loads. To meet the demand of the combined FNQ loads, the non-network solution must be capable of delivering up to 268MW of power at peak and up to 911MWh per day (Refer Table 2). The non-network solution would be required to be capable of operating continuous basis.

Powerlink is not aware of any Demand Side Solutions (DSM) in the Cairns area capable to meet the requirement. However, Powerlink will consider any proposed solution that can contribute significantly to the requirements of ensuring that Powerlink continues to meet its required reliability of supply obligations as part of the formal RIT-T consultation process prior to project approval.

6. Network Options

6.1 Preferred Option to address the identified need

The recommended solution is to refit of the double circuit transmission line between Davies Creek and Bayview Heights.

Further details of the condition assessment for the transmission lines can be found in Reference 1.

6.2 Option Considered but Not Proposed

This section discusses alternative options that Powerlink has investigated but does not consider technically and/or economically feasible to address the above identified issues, and thus are not considered credible options.

6.2.1 Do Nothing

“Do Nothing” would not be an acceptable option as the primary drivers (primary system condition) and associated safety, reliability and compliance risks would not be resolved. Furthermore, the “Do Nothing” option would not be consistent with good industry practice and would result in Powerlink breaching their obligations with the requirements of the System Standards of the National Electricity Rules and its Transmission Authority.

6.2.2 Uprate Coastal circuit to 275kV operation

The coastal line between Ross and Woree is constructed double circuit with both circuits operating at 132kV. However, one of the circuits is insulated for 275kV operation. Upgrading this circuit to 275kV, without preserving the section between Davies Creek and Bayview Heights, only provides these two coastal circuits (plus the output from the Barron Gorge Power to meet the Cairns area load.

Although there is sufficient system intact network capacity to meet the peak Cairns area load following the uprating of this coastal circuit, the critical contingency would be an outage of the uprated 275kV circuit. This is very similar outcome to the second scenario summarised in Table 2.

As a result, this option alone is not technically viable as it will not meet Powerlink’s N-1-50MW/600MWh reliability criteria.

6.2.3 Uprate Coastal circuit to 275kV operation with non-network support

In addition to uprating the coastal circuit to 275kV operation, non-network support would also be required to meet the required N-1-50/600MWh reliability criteria.

If BS 1664 was decommissioned at end of life, and there was a single 275kV feeder, the non-network solution would be require day and night injection in the Cairns area of up to 200MW and 1200MWh. In order to ensure compliance with Powerlink’s Transmission Authority a large portion of this would need to be operating pre-contingent.

7. Recommendations

There is an investment need to maintain the functionality of the Davies Creek and Bayview Heights 275kV transmission lines for Powerlink to continue to meet its reliability of supply obligations.

It is recommended the lines be refurbished by October 2023 to ensure Powerlink's ongoing compliance the Electrical Safety Act 2002, Electrical Safety Regulation 2013 and its Transmission Authority.

8. References

1. BS1018 & 1019 Greenbank to Mudgeeraba Line Condition Assessment – Report 2020

2. Transmission Annual Planning Report 2020

3. Asset Planning Criteria Framework

Appendix A – Network Risk methodology

Feeders 877 & 8902

For calculating the Risk Costs, it is assumed that:

- If there is an outage of the 275kV Ross to Chalumbin double circuit, FNQ load will be only connected through the 132kV coastal circuits, and limited to a nominal 170MW. If the outage occurs at a time where the FNQ flow (excluding MEWF) is above 170MW, all load fed from Woree substation (down to El Arish) will be lost initially, and assumed to be restored up to 170MW in 1 hour.

- If the 132kV is not intact (e.g. for unrelated planned work), the FNQ load that can be supported will be significantly reduced (e.g. nominal 70MW for Yabulu South to Tully outage). If the 275kV double circuit outage occurs at a time where the FNQ flow (excluding MEWF) is above 70MW, the entire FNQ load will be lost initially. It is then assumed that the planned 132kV outage would be recalled, and load restored up to 170MW in 4 hours.

Base Case Risk and Maintenance Costs Summary Report

CP.02754 BS1664 Davies Creek to Bayview Heights Built Section

Version Number	Objective ID	Date	Description
1.0	A3331325	25/06/2020	Original document.
2.0	A3331325	16/11/2020	Planning report updated
3.0		26/11/2020	Updated to include safety risks
4.0		11/12/2020	Updated to align with BAU

1 Purpose

The purpose of this model is to quantify the base case risk cost profiles and maintenance costs for BS1664 Davies Creek to Bayview Heights which is a candidate for reinvestment under CP.02754.

Base case risk costs and maintenance costs have been analysed over a ten year study horizon.

2 Topography

The Davies Creek to Bayview Heights built section is part of the double circuit transmission line between Chalumbin and Woree 275kV substations. The built section traverses the wet tropics area within far north Queensland as shown below.

Woree substation is the primary supply to the wider Cairns area, and the Barron Gorge hydro-electric power station. There is a coastal 132kV sub-transmission supply from Ross substation to the Cairns area, which supplies local regional load centres and townships along the route.

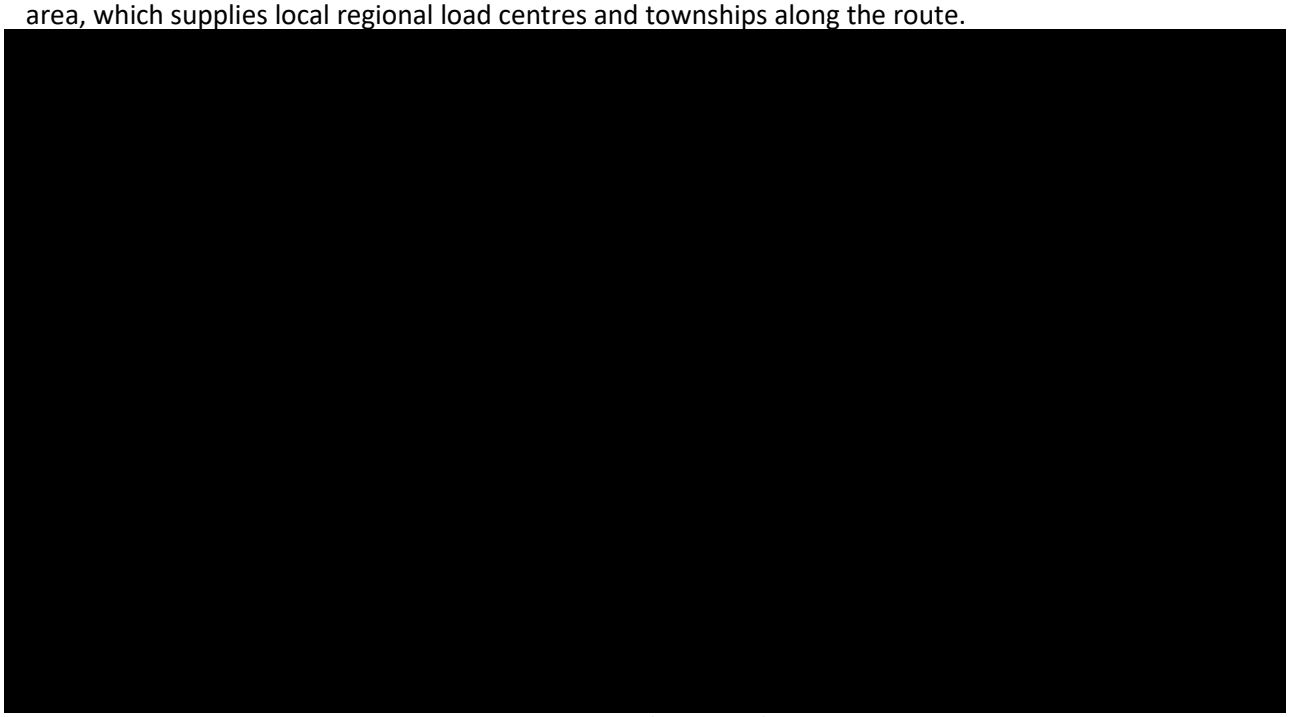


Figure 1 – Network Topography

3 Key Assumptions

In calculating the potential unserved energy (USE) arising from a failure of the ageing structures within BS1664, the following modelling assumptions have been made:

- Historical load profiles have been used when assessing the likelihood of unserved energy under concurrent failure events;
- Unserved energy generally accrues under concurrent failure events, and consideration has been given to potential failure events within the wider far north Queensland network;
- BS1664 supplies a mixture of residential, commercial and tourist load types within the Cairns area. Historical load data has been analysed to approximate the proportion of load for each customer category, resulting in a weighted VCR of $28,064/MWh; and
- The most relevant residential and commercial VCR values published within the AER's 2019 Value of Customer Reliability Review Final Report have been used to determine the VCR.

4 Base Case Risk Analysis

4.1 Risk Categories

Four main categories of risk are assessed within Powerlink's risk approach; safety, network, financial and environmental of which, network and financial relate to BS1664.

4.2 Transmission Line Analysis

This section analyses the risks presented by BS1664.

Table 1 – Risks associated with at risk structures

	Mode of failure	
Equipment	**Peaceful**	**Explosive**
Transmission Line Structure	Network risks (unserved energy) due to a failed structure Financial risks to replace a failed structure in an emergency manner within the environmentally sensitive wet tropics rainforest area.	Not applicable

The main source of risk associated with the built section relates to safety risks to the public due to failed structures, following by network risks (unserved energy) within the greater Cairns area, since the 275kV transmission line is the primary source of supply capacity to the area.

The probability that a structures will fail includes the probability that a wind event, sufficient to bring the tower down, has occurred.

- BS1664 is a double circuit which means that failure of a structure will result in loss of both 275kV transmission feeders to Woree substation (i.e. n-2 event).
- In the event of a widespread outage of the greater Cairns area, generation at Barron Gorge may not be able to be dispatched. The market impacts associated with this scenario have not been included since they are not considered significant compared to the unserved energy risks.
- The built section traverses the sensitive World Heritage wet tropics area. Any emergency rectification work will need to be carried out by helicopter and aerial crews, and will incur a premium compared to rectification of transmission structures within conventional rural areas.

4.2.1 Structures – Risk Cost by Year

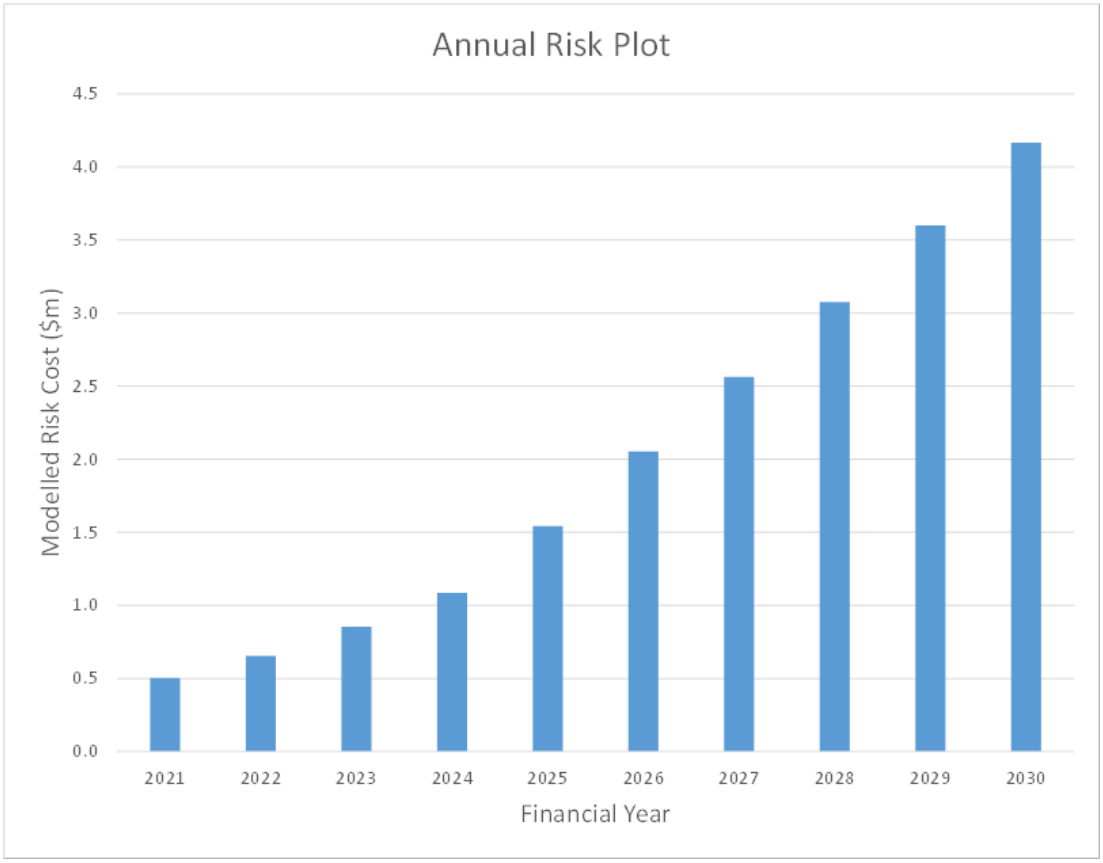


Figure 2 – Structure risk (10 years)

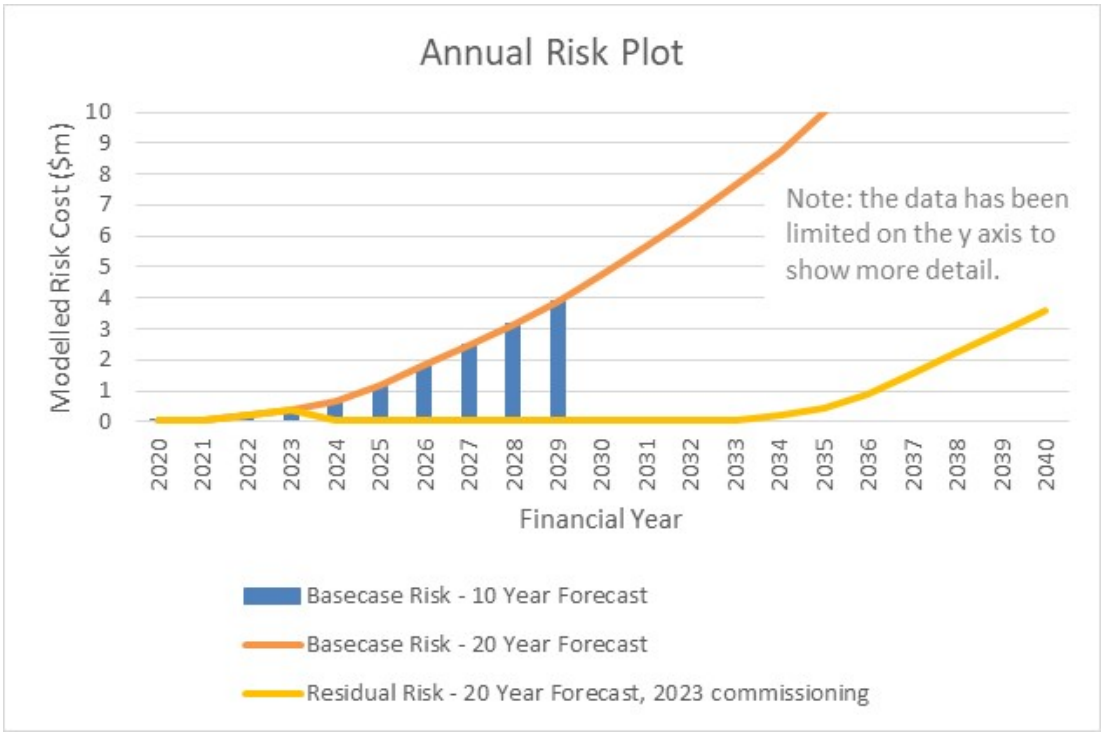


Figure 3 – Structure risk (10 and 20 years)

4.2.2 Structures – Risk Breakdown by Risk Category

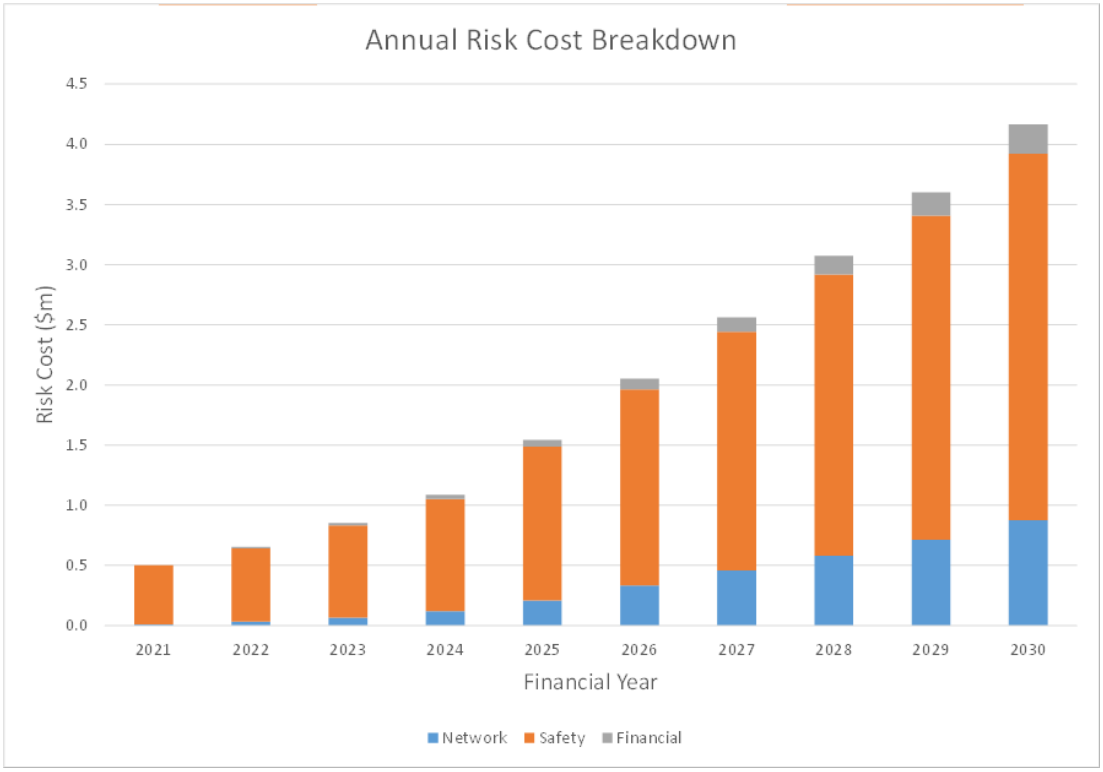


Figure 4 – Structure risk by category

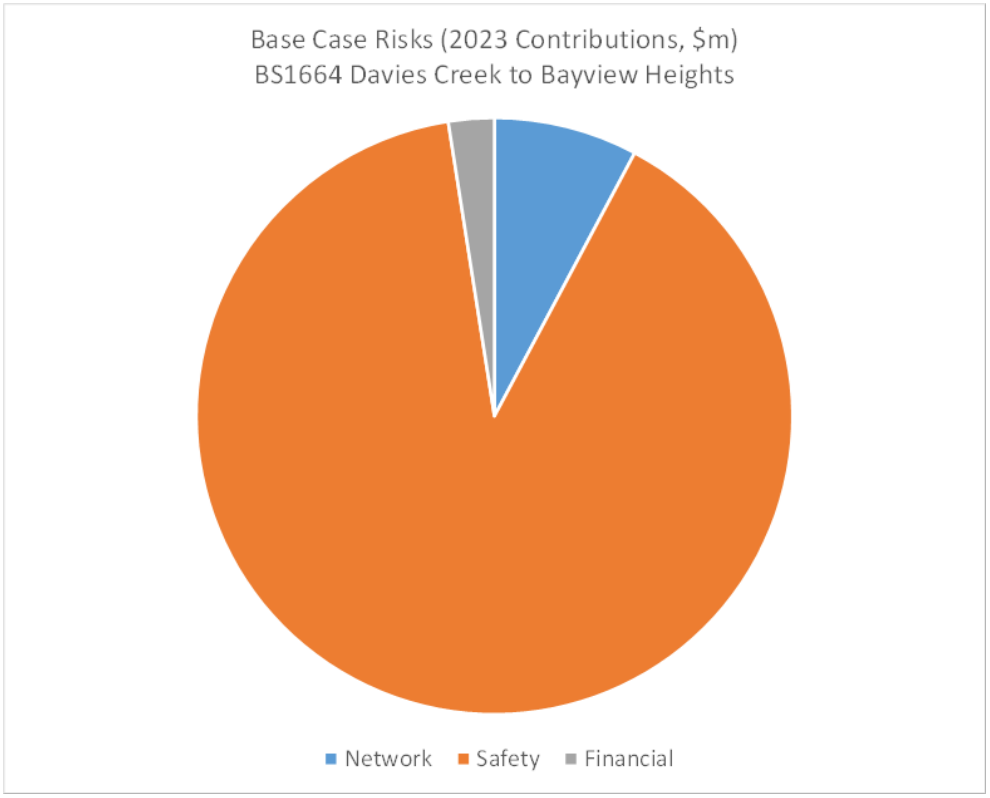


Figure 5 –Structure risk in 2024 by category

4.3 Base case risk statement

The main base case risks for the BS1664 Davies Creek to Bayview Heights reinvestment are safety risks to the public due to failed structures, and network risk (unserved energy).

5 Maintenance costs

Two categories of maintenance costs are included in Powerlink's base case approach; routine maintenance and corrective / condition based maintenance.

The routine and corrective / condition based maintenance costs and total base case costs (maintenance plus risk) are shown in figures below.

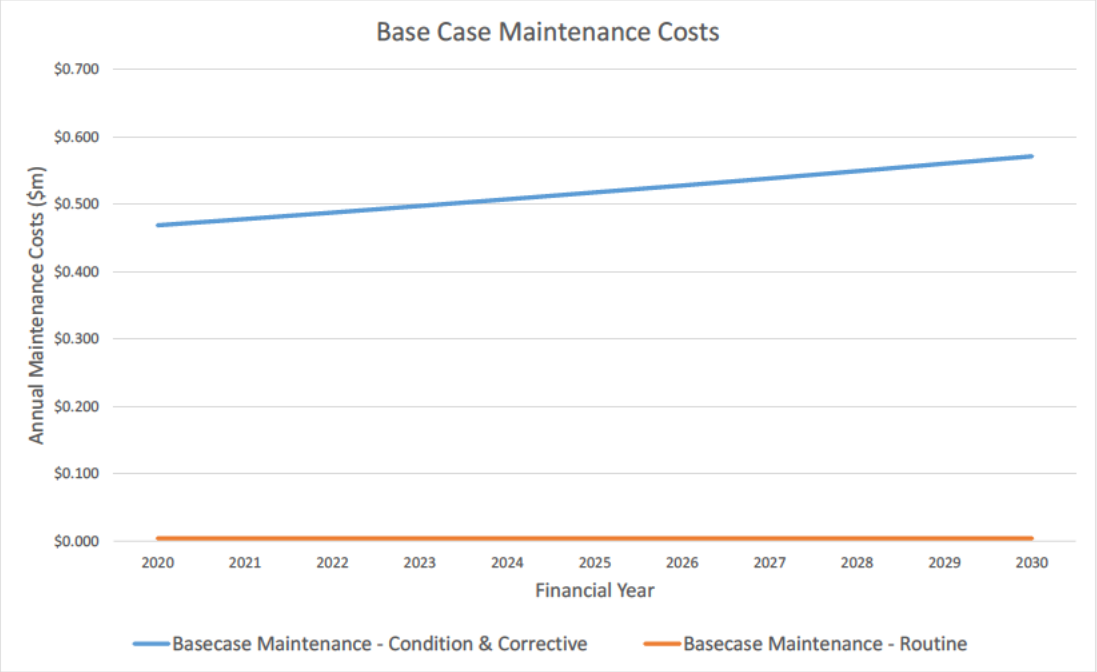


Figure 6 - Base Case maintenance Costs 2021– 2030

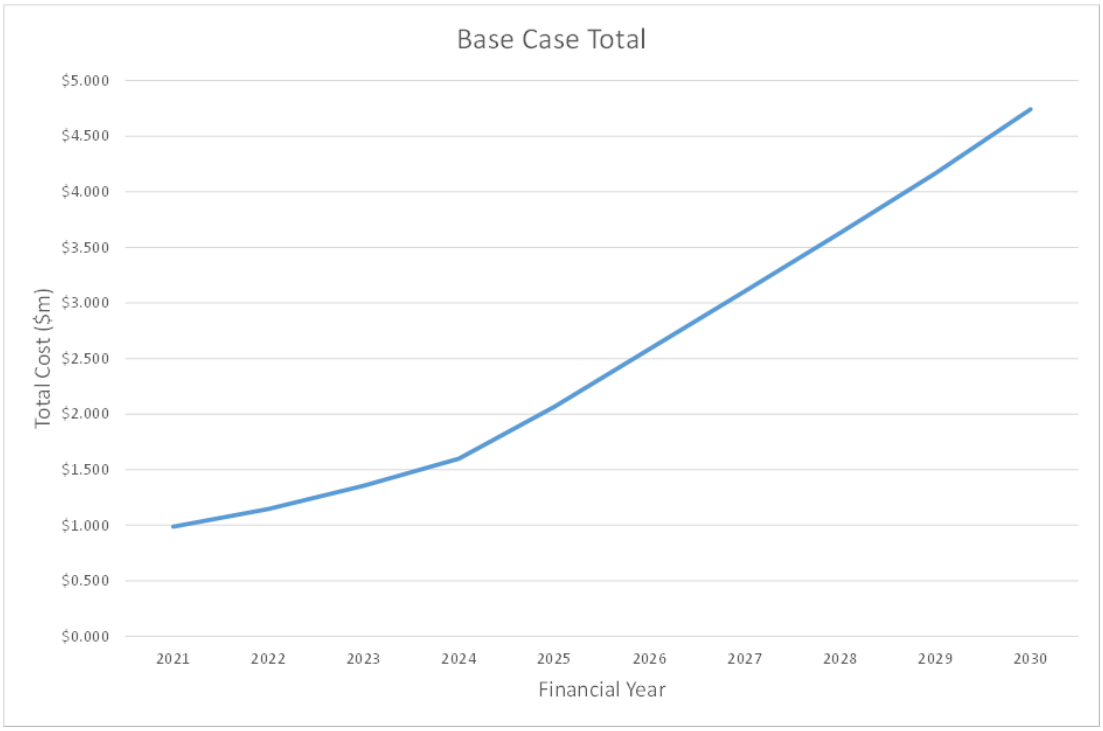


Figure 7 - Base case Total (Risk Cost + Maintenance) 2021 to 2030

6 Input participation

Sensitivity analysis has been carried out to determine which inputs the model is most sensitive to (how does a change in input value effect the modelled risk).

One of the main dependencies of this risk cost model is the Value of Statistical Life (VSL) since this forms the key input to the safety risk cost. Accordingly assumptions relating to VSL are one of the key salient inputs to the calculation of risk cost.

The transmission line risk model is dependent on three other input values; time to restore supply following a structure failure (**restoration time**), **VCR** and **tower restoration cost**.

There is a weaker dependency between these input values and network and financial risk cost. For example, if VCR increases by 100%, network risk will only increase by ~2.43%.

Early in the modelling (from 2021), safety risks dominate the risk cost. As a result, the model is almost insensitive to the values of **restoration time**, **VCR** and **tower restoration cost**. As the modelled year increases, the model becomes more sensitive to these input values because network and financial risks represent a larger component of the overall risk.

Risk category	Input	Value	Unit
Network	VCR	28064	$/MWh
	Restoration time	72	Hours
Financial	Tower restoration	1000000	$/tower

Figure 8 - Transmission line risk model inputs

Project Scope Report

CP.02754

BS1664 Davies Creek – Bayview Heights 275kV Refit

Proposal– Version -5

Document Control

Change Record

Issue Date	Responsible Person	Objective Document Name	Background
23/05/2019	[redacted]	BS1235 Chalumbin – Woree 275kV Refit	Initial Issue
23/07/2019	[redacted]	BS1235 Chalumbin – Woree 275kV Refit	Improving scope clarity
31/07/2019	[redacted]	BS1235 Chalumbin – Woree 275kV Refit	Refining scope
20/08/2019	[redacted]	BS1664 Davies Creek – Bayview Heights 275kV Refit	Change of Built Section and project Description
27/12/2019	[redacted]	BS1664 Davies Creek – Bayview Heights 275kV Refit	Proposal request for recommended option

Related Documents

Issue Date	Responsible Person	Objective Document Name
13/08/19	[redacted]	Transmission Line Condition Assessment Report BS1235 and BS1664 Chalumbin to Woree

Project Contacts

Project Sponsor	[redacted]	[redacted]
Lines Strategist	[redacted]	[redacted]
Project Manager	[redacted]	[redacted]

Project Details

1. Project Need & Objective

Built section 1235 Chalumbin to Woree was first established 1998, it is a double circuit cyclone rated steel tower transmission line. The development of H039 Woree substation in the early 2002 completed the establishment of 275kV supply into Cairns in Far North Queensland. BS1235 now supports dual 275kV feeders from H032 Chalumbin to H039 Woree. This transmission line is critical for the supply of power into Cairns and the Far North Queensland region.

The built section traverses some challenging terrain with sections of unexploded ordinance (UXO) prominent along this line. An area of the original Built Section has been allocated a different built section number to reflect the distinctively different environment. This section 1664-STR-0085 to 1664-STR-0121 is to be known as Davies Creek to Bayview Heights and passes through the Wet Tropics Management Area (WTMA) and requires a high level of environmental security.

A recent condition assessment carried out in 2019 identified significant levels of deterioration, with a number instances of grade 3 and 4 corrosion on structure members, conductor hardware, bolts and nuts reported.

BS1235 has been split into 2 separate built sections with different financial asset lives. BS1235 and BS1664. This work is to address the condition of the northern part of the line between Davies Creek and Bayview Heights BS1664.

The objective of this project is to address the condition of the dual circuit 275kV transmission line by refitting and painting a section (BS1664) between Davies Creek and Bayview Heights by 30 October 2023.

2. Project Drawing

3. Project Scope

3.1. Original Scope

The following scope presents a functional overview of the desired outcomes of the project. The proposed solution presented in the estimate must be developed with reference to the remaining sections of this Project Scope Report, in particular *Section 5 Special Considerations*.

Briefly, the project involves transmission line refit with paint to address plant condition issues affecting Built Section 1664 for the Davies Creek – Bayview Heights 275kV double circuit line.

3.1.1. Transmission Line Works - Line Refit (Grades 3 & Greater replacement) with Paint

This option involves the refit the existing structure components identified with Grade 3 or higher corrosion on the existing built sections with painting by October 2023, as follows:

Design, procure and carry out refit work including:

- Corridor verification including a check of easement conditions, co-use, encroachments and property owner consultation
- Site Establishment.
- Allow for constrained access arrangements to existing transmission line.
- Review of the electrical design to confirm electrical clearances.
- Review the structural design and upgrade as necessary to meet operational maintenance requirements.

- Replacement of
    - All original OPGW hardware (estimate 100% on average per tower)
    - Downlead OPGW clamps
    - All G3 and G4 tower bolts (estimate 25% on average per tower)
    - All G3 and greater members (not suitable for blasting and painting), (estimate 10% light members and 0.1% heavy members replaced per tower)
    - Replace all climbing bolts and climbing aids to present standard
    - Record number of replaced components on tower per tower basis.
- Perform a pre and post climbing inspection of towers recording data using the LAMP tool and load condition data into SAP using measurement documents.
- Procurement and replacement signage including new ID plates with new BS number 1664
- Restore structure earthing as per original condition.
- Switching
    - Decisions on deliverability should address the impact of feeder outage recall time and load at risk.
- Update BOM data
- Raise project notifications for all bolts and members that are replaced.
- Update SAP records accordingly including measurement documents for condition data.
- Surface Preparation and Painting of 37 Towers as per Powerlink current standard.
    - Containment of Materials Used – surface treatment of structures located near residential or environmentally sensitive areas may require the construction of scaffold and plastic sheeting to protect residences and capture water and residue.

3.1.2. Substation Works

Not Applicable

3.1.3. Telecoms Works

Not applicable

3.1.4. Easement/Land Acquisition & Permits Works

Easement rights and approvals must be considered with the Property team for any work to be carried out on this built section.

3.2. Key Scope Assumptions

The following assumptions should be included in the estimating of this scope:

- Sufficient suitably authorised Refit contractors will be available to undertake the works;
- Powerlink / Refit contractor – WTMA authorisation remains current and does not have to be secured before commencing works;

3.3. Variations to Scope (post project approval)

Not applicable

4. Project Timing

4.1. Project Approval Date

The anticipated date by which the project will be approved is December 2020.

4.2. Site Access Date

The expected site access date (SAD), when the site is available for Powerlink construction works to commence, is December 2020.

4.3. Commissioning Date

The latest date for the commissioning of the new assets included in this scope is 30 October 2023.

5. Special Considerations

- Access to existing structures is extremely constrained and appropriate consideration should be included in the cost estimate for the constructability of each option.
- Consideration should be given to the level of community consultation that will be required for the work to proceed.
- Work on easement approvals should be considered.
- Include an allowance for any specific safety related activities required in the delivery phase of the project.
- The Cultural Heritage Team should be consulted to provide a preliminary assessment of cultural heritage risks, with an allowance included within the estimate for a full assessment, if required, in addition to the preliminary mitigation measures identified.
- A high level project implementation plan including staging and outage plans should be considered and produced as part of the estimate.
- An assessment of stakeholder and landholder risks in consultation with the Stakeholder Relations and Landholder Relations teams should be undertaken to identify potential issues and appropriate mitigation measures to be included within the project estimate.

6. Asset Management Requirements

Equipment shall be in accordance with Powerlink equipment strategies.

Unless otherwise advised [redacted] will be the Project Sponsor for this project. The Project Sponsor must be included in any discussions with any other areas of Investment & Planning.

[redacted] will provide the primary customer interface with Ergon. The Project Sponsor should be kept informed of any discussions with the customer.

Asset information shall be captured in accordance with Asset Strategies Line Maintenance Principles Specification objective reference A2628257.

7. Asset Ownership

The works detailed in this project will be Powerlink Queensland assets.

8. System Operation Issues

Operational issues that should be considered as part of the scope and estimate include:

- interaction of project outage plan with other outage requirements;
- likely impact of project outages upon grid support arrangements; and
- likely impact of project outages upon the optical fibre network.

9. Options

As detailed

10. Division of Responsibilities

Not Applicable

11. Related Projects

Project No.	Project Description	Planned Comm Date	Comment
Pre-requisite Projects			
Co-requisite Projects			
Other Related Projects			
OR.02246	BS1235 Bayview Heights – Davies Creek Rd Tower Refurbishment	October 2019	

Attachment 1 - List of towers for refit

Functional location	Description of functional location	Tension or Suspension
1664-STR-0085	Structure D2T60E+9	Tension
1664-STR-0086	Structure D2S0H+24	Suspension
1664-STR-0087	Structure D2S0H+30	Suspension
1664-STR-0088	Structure D2S0H+21	Suspension
1664-STR-0089	Structure D2S0H+30	Suspension
1664-STR-0090	Structure D2S0H+27	Suspension
1664-STR-0091	Structure D2T45H+12	Tension
1664-STR-0092	Structure D2S0H+15	Suspension
1664-STR-0093	Structure D2S0H+12	Suspension
1664-STR-0094	Structure D2S0H+27	Suspension
1664-STR-0095	Structure D2T45H+18	Tension
1664-STR-0096	Structure D2S0H+33	Suspension
1664-STR-0097	Structure D2T45H+15	Tension
1664-STR-0098	Structure D2S0H+24	Suspension
1664-STR-0099	Structure D2S0H+12	Suspension
1664-STR-0100	Structure D2S0H+6	Suspension
1664-STR-0101	Structure D2S0H+12	Suspension
1664-STR-0102	Structure D2T45H+9	Tension
1664-STR-0103	Structure D2T45H+12	Tension
1664-STR-0104	Structure D2S0H+6	Suspension
1664-STR-0105	Structure D2S0H+15	Suspension
1664-STR-0106	Structure D2S0H+21	Suspension
1664-STR-0107	Structure D2S0H+33	Suspension
1664-STR-0108	Structure D2T45H+15	Tension
1664-STR-0109	Structure D2T45H+15	Tension
1664-STR-0110	Structure D2S0H+27	Suspension
1664-STR-0111	Structure D2S0H+6	Suspension
1664-STR-0112	Structure D2T45H+12	Tension
1664-STR-0113	Structure D2S0H+15	Suspension
1664-STR-0114	Structure D2T45H+6	Tension
1664-STR-0115	Structure D2S0H+33	Suspension
1664-STR-0116	Structure D2S0H+30	Suspension
1664-STR-0117	Structure D2T45H+12	Tension
1664-STR-0118	Structure D2T60E+6	Tension
1664-STR-0119	Structure D2S0H+15	Suspension
1664-STR-0120	Structure D2T45H+12	Tension
1664-STR-0121	Structure D2T70J+3	Tension

CP.02754 - BS1664 Davies Creek to Bayview Heights 275kV T/L Refit

Project Proposal

Record ID	A3289469	
Authored by	Project Manager	[redacted]
Reviewed by	Project Manager	[redacted]
Approved by	Team Leader Projects	[redacted]

Version History

Version	Date	Section(s)	Summary of amendment
1	24/08/2020		Approved for Issue

Table of Contents

1. Executive Summary

- *Project background*

The newly created Built Section 1664 consists of 37 structures (1664-STR-0085 to 1664-STR-0121) and forms a portion of the existing Built Section 1235, which is a 275kV, double circuit transmission line constructed between the Chalumbin and Woree substations.

275kV Feeders;

- 877, and
- 8902.

The transmission line was commissioned in 1998 and there are initial signs of corrosion developing on the structural steel and components.

- *Project objective*

The objective of CP.02754 is to address the declining condition of the 37 E and H type steel lattice structures on Built Section 1664 by completing the following;

- selective replacement of corroded elements of corrosion grade 3 and above;
- installation of new climbing aids and fall arrest brackets;
- repairs to the foundation interface and tower footing earthing systems;
- surface preparation and the application of a sacrificial zinc rich painting system to the entire surface area of each structure;
- procurement and replacement of signage including new ID plates with new BS number 1664; and
- the replacement of the OPGW hardware and the down-lead clamps.

The required commissioning date for this project is October 2023.

	Date
Project Scope Report (version 5) - date received	14/01/2020
Project Proposal and Project Estimate - date submitted	28/08/2020
Project Approval Advice (PAA) - date received	TBA

1.1 Overview of Estimated Costs

The following table summarises the breakdown of the project estimate.

	Project Proposal (escalated)	Project Development Phase 2 (PDP2) Estimate		
		Estimated Cost (escalated)	Cost Change form Proposal	Rational for Changes
Base Cost	$40,746,921	N/A	N/A	N/A
Estimating Allowance	$902,737	N/A	N/A	N/A
Project Risk	[redacted]	N/A	N/A	N/A
Contingency Allowance	[redacted]	N/A	N/A	N/A
Total	[redacted]	$	$	

2. Project Definition

2.1 Project Scope

2.1.1 Transmission Lines Condition Assessment Scope

The transmission line is a critical feeder for the Far North Queensland region and both circuits will remain operational during the condition assessment.

The scope included visiting each structure and completing a visual condition assessment by climbing each of structures on Built Section 1664, (STR-0085 to STR-0121) and completing condition assessment report for the following items on each structure:

- Conduct property owner consultation in accordance with the access protocols detailed within the Environmental Work Plans.
  - Provide written notification to the Principal of any detail changes following property owner contact.
- Report on Bolts and Nuts (Elements);
  - Identify the size and quantity of:
    - Defective or missing nuts and bolts,
    - Corrosion Grade 2 and above nuts and bolts (using Procedure AM-PR-0835),
    - Existing step bolts, and
    - Estimated quantity of fall arrest brackets.
- Report on members;
  - Identify the size and quantity of:
    - Defective or missing members,
    - Corrosion Grade 3 members (using Procedure AM-PR-0836),
    - Corrosion Grade 4 members (using Procedure AM-PR-0836),
- Report on foundations and tower leg/stub condition; (non-destructive inspection)
  - Record each leg's Foundation Type (where possible), Column Dia , "K" point height and water shed information on the Lattice steel tower member condition assessment reporting schedule, using the orientation shown on the schedule.
  - Inspect and report each on the tower leg condition. Inspection and reporting is to be done in accordance with Technical Specification 14.1 Appendix 1.Use the template document - Lattice steel tower member condition assessment reporting schedule for reporting, ensuring a clear (cross referenced) photo is taken and recorded in the reporting schedule.
- ACBs
  - Record ACB information (type and condition) on the Lattice steel tower member condition assessment reporting schedule.
- Signage
  - Record Signage condition in the "Lattice Steel Tower Member Condition Assessment Reporting Schedule".
- Structure Earthing
  - Test and record each structure impedance value in accordance with Technical Specification 14.5 - Structure Earthing.
  - Complete all elements of the "Earthing Assessment Reporting Schedule".
- Complete the L.A.M.P. for each structure.

2.1.2 Transmission Lines Refit

Transmission Lines Refit scope as follows:

- Review of the electrical design to confirm with current standards;
- Review the structural design and upgrade as necessary to meet operational maintenance requirements;
- Investigate access track upgrade or improvements required to complete the scope of works, including accessing existing culverts, watercourse crossings etc to meet the QESI code agreement.
- Vegetation clearing and slashing at the tower footprint to enable line of sight to ground level and removal of trip hazards etc.
- Supply of SAHVEA trained and authorised personnel, sufficient to execute the WUC in accordance with the SAHVEA procedures;
- Site Establishment;
- Replacement of nuts and bolts displaying corrosion of **Grade 3 or greater**;
- Replacement of light members displaying corrosion of **Grade 3 or greater**;
- Replacement of members which are mechanically unsound;
- Complete repairs to the Leg/Concrete interface;
- Replacement of
    - All original OPGW hardware (100% on average per tower) and
    - All OPGW down-lead clamps;
- Upgrade climbing attachment points and step bolts to the current standard;
- Upgrade of the existing tower footing earthing system to meet current standards;
- Surface preparation and the application of a sacrificial, zinc rich painting system to the entire surface area of each structure;
- Procurement and replacement signage including new ID plates with new BS number 1664 including aerial identification plates;
- Post construction L.A.M.P. for each structure.
- Update drawing and SAP records accordingly.

2.1.2.1 Previous Painting Trial

In 2013, a surface preparation and paint adhesion trial was undertaken on two of the structures within the built section, the results of the trial have confirmed that abrasive blast media is not required to attain the values for surface cleanliness and surface profile.

Note: The first five structures on the eastern end of the built section (STR-0117 to 0121) have been painted previously to ascetically help blend the structures against the hinterland. Wet abrasive blasting will be required to remove the existing paint as part of the surface preparation process.

2.1.3 Substations

Feeder switching only.

2.1.4 Telecommunications

Not Applicable

2.1.5 Revenue Metering

Not Applicable

2.1.6 Other Project Works

Condition assessment of the 37 structures – 100% completed.

2.2 Exclusions

Exclusions as follow:

- Repair or replacement of any damaged phase conductor or OPGW; and
- Any excessive vegetation clearing or management resulting from a tropical cyclone event.

2.3 Assumptions

Assumptions as follow:

- It is assumed that for the majority of the surface area on the structures, high pressure water blasting will be sufficient to obtain the level of cleanliness and surface profile required for the application of the painting system. Wet abrasive blasting will only be required on the members and fittings with Grade 2 corrosion and the previously painted structures described in section 2.1.2.1;
- The scope of work detailed are permitted to be undertaken in accordance with the Wet Tropics Permit No: WTMA18010 – Maintenance of Infrastructure within the Wet Tropics World Heritage Area.
- It is assumed that the works will be tendered in accordance with the current Panel Agreement for the Refit of Transmission Lines and that the successful tenderer will have the required level of trained and authorised personnel, approved process, project documentation, plant and equipment to complete the scope in line with the panel agreement;
- It is assumed that the Principal will have sufficient internal resources such as access permit recipient and site facilitators to meet the scope of work in line with the programme;
- It is assumed that the OPGW hardware replacement works will be completed by Energy Queensland transmission lines and there will be sufficient resources available to complete the scope in line with the schedule.
- There are no Cultural Heritage issues anticipated as the only ground disturbance works will be upgrades to the existing access track system (no new tracks required) and the upgrading of existing structure earthing.

2.4 The Site

2.4.1 Location

The site of the works is located in Far North Queensland, and extends from the transition site at Bayview Heights (Cairns) – H044, running southwest through the Wet Tropics to the final structure 0085 near Davies Creek, East of Mareeba.

The region experiences extremes in climatic conditions including, high ambient temperatures, high relative humidity and regular rainfall outside of the wet season, and this coupled with the large travel times to some structures (up to two hours travel time) will require a high level of fatigue management for site based personnel.

2.4.2 Access

Access to the easement in the Wet Tropics Section (37 structures) is available from a single access track with egress points from the east and west.

- The Eastern entry point to the line (STR – 0117) is via Lake Morris Road, approximately 1 hour drive from Cairns. Lake Morris Road is a sealed tourist drive however it is very narrow, windy and has many switch-backs. In heavy rain, the road is frequently closed due to land slips and falling rock / debris.
- Access to the Western entry point to the line (STR 0085) is from Davis Creek Road, approximately 7.0 km from the Kennedy Highway. The entry to Davis Creek Road is approximately 14.5 km from the township of Mareeba. Mareeba is 65km West of Cairns, via the Kuranda Range.
- Structures 0118 to 0121 (4 structures) are situated on the eastern flank of the range in the suburb of Bayview Heights and are accessible via spur tracks off established roads. The spur tracks are located on

private property and will require considerable management as they pass within close proximity to private residences' and are controlled via electric gates. Structures 0118 to 0120 are not accessible in wet weather.

- Structures 0102 to 0117 (15 structures) are located in the Copperlode Falls Dam (Cairns City Water Supply) catchment envelope administered by the Cairns Regional Council and the Wet Tropics Management Authority. All of these structures are accessible via spur tracks off established roads.
- There is an observation deck viewing the Copperlode Falls (Spillway) located beneath structure 0107. Pedestrian access to the observation platform and sections of the car park will need to be closed during construction works. An alternate temporary viewing area may need to be established depending on the discussions to be held with the Cairns Regional Council.
- The remaining structures 0102 to 0117 (17 structures) are located in the Wet Tropics Management Authority region and the Barron Gorge National Park. All are accessible from established, unsealed access tracks and spur tracks.
- All of the structures require a four wheel drive vehicle to gain access and the majority of structures within the Wet Tropics Management Authority region and the Barron Gorge National Park take 1.5 – 2.0 hours' drive time.
- There are 3 formed creek crossings (2 - concrete culverts and a bridge) and numerous unformed crossings of creeks and streams which will require repairs for construction traffic. The bridge located near STR 0099 will require proof loading, which may result in carrying out of structural repairs or applying load limit restrictions.

2.4.3 Communication

Due to the rugged terrain and the dense cover of the rainforest canopy, mobile phone reception and Global Positioning Satellite triangulation is not available at ground level on some access tracks and at structure locations. A collaborative safety management philosophy and system will need to be developed and implemented between the Principal Contractor and the Principal to ensure that all personnel entering the easement are registered on a daily basis ("tag in – tag out" system) and where passable there should be a buddy system so individuals are not driving unaccompanied.

2.4.4 Unexploded Ordnance

Unexploded Ordnance (UXO) mapping indicates that the area on the Western end of the line (Bare Hill Conservation Park) may contain UXO with a risk rating of slight.

UXO inductions will be incorporated in the Project Management Plan.

2.4.5 Ground Conditions

The majority of the structures will require some degree of vegetation clearing due to the WTMA policy of allowing natural revegetation following the original construction of the line.

In order for the Refit Contractor to meet the environmental conditions specified in the contract and to allow for the installation of drop sheets and to establish visual contact with the ground line, a minimum clearing regime of that below will be required;

- Vegetation clearing and slashing of the tower base footprint
- Vegetation clearing and slashing a 3 meter perimeter around the tower base
- Vegetation clearing and slashing of the existing lay-dawn pads and
- Removal of tree's and branches growing toward the open space created by the structure.

All major access tracks and spur tracks will require trimming and or clearing of overhanging vegetation to facilitate the movement of larger construction equipment.

2.5 Project Interaction

Interactions with other projects and Engineering Task Request (ETRs) as follow:

There are no identified Interactions with other projects and Engineering Task Request.

2.6 Project Risk

Project risks identified during Project Proposal phase are as follows;

- Estimate Allowance (contained within the released budget): $850,000
- Contingency (contained within the approved budget): [redacted]
- Mitigated (contained within the approved budget):

3. Project Financials

3.1 Project Estimate Summary (for Sponsor)

Estimate Components			Base Cost $	Escalated $
Base Estimate (A)	Cost Estimate		38,366,545	40,746,921
	Estimate Allowance		850,000	902,737
Contingency (Unknown Risk) (B)		[redacted]	[redacted]	[redacted]
Mitigated Risk (Known Risk) (C)		[redacted]	[redacted]	[redacted]
Total Proposed (B+C)		[redacted]	[redacted]	[redacted]
Total Proposed Approval (A+B+C)			[redacted]	[redacted]

Cash Flow Total Estimate (exc Allowance)	Base Date July 2020	Completion
To June 2021	1,534,662	1,629,877
To June 2022	18,032,276	19,151,053
To June 2023	17,264,945	18,336,114
To June 2024	1,534,662	1,629,877
Total	**38,366,545**	**40,746,921**

3.2 Un-escalated Base Estimate Summary (for Business Development)

	Prescribed $,000	Negotiated / Non-Regulated $,000	Total $,000
Line Works	34,784,219	0	34,784,219
Primary Plant	0	0	0
Secondary Systems	0	0	0
Communications	0	0	0
Management & Overheads	2,732,327	0	2,732,327
Total	$38,366,545		$38,366,545

Table 2-2 - Project Estimate – Elemental

3.3 Quotation Summary

3.3.1 Asset Write-Off Table

TBA

3.4 Approved Released Budget

The approved release budget to execute the project is as follows:

	Total $Esc	Control Management
Project Estimate	40,746,921	Project Manager
Project Allowance	902,737	Project Manager
Project Release Budget	41,649,658	Project Manager

3.5 Planned Costs (Forecasted Cash Flow)

During Project Execution, project planned cost are managed in SAP.

4. Connection and Access Agreement Tables

Not applicable.

4.1 Table 1 – Works

Not applicable.

4.2 Table 2 - Progress Schedule

Not applicable.

4.3 Project Schedule

Project timing shall be managed using a Project Schedule. Refer to the Project Schedule in PWA Server.

4.4 Network Impacts and Outage Planning

An Outage Plan was derived as part of the project proposal on the likelihood of the outages required for this project. This outage has been submitted to Network Operations.

4.4.1 Feeder Outages;

Single circuit feeder outages will be required for extended durations within the “shoulder period” between April and October.

275kV Feeders Outages;

- 877 - April to October 2022, and
- 8902 - April to October 2023.

4.4.2 Return to Service Times (RTS);

Due to the remote locations of the substations and structures where working earths are installed, the following RTS times are proposed:

- During Business Hours – 10 hours, and
- Out of Business Hours – 24hours.

4.4.3 Contractor Rest and Recreation Breaks (R&R);

As each Refit Contractor operate under differing enterprise bargaining arrangements, it is not practical to schedule R&R breaks into the construction programme or outage plan.

Feeders will return to service during scheduled Contractor breaks, which should account for 7 RTS events per calendar year.

4.4.4 Network Constraints;

Network Operations have advised of the following known outage restrictions:

- 132KV network from H011 Ross will need to be intact, including the Ross Transformers.
- Maintenance activities on this network will need to be moved to gaps in the project roster.
- Load in Cairns to be <200MW which means April to September Access only.
- H039 Woree SVC Must Be in Service.
- Inverter Generators constrained for the duration of your outages.
- CP work planned at Woree and Ross at the same time period.

The Project Team is investigating the above restrictions.

5. References

The following documents are applicable to this Project Management Plan.

Document name and hyperlink	Version	Date
Project Scope Report	V5	27/12/2019
Project Proposal	V1	24/09/2020
Condition Assessment Schedules		March 2020
Project Change Request Register	Server	
Project Outage Plan	TBA	
Project Schedule	Server	
Budget/Plan/Actual - SAP		
Transmission Lines Design Advice	V1	24/06/2020
Safety in Design	Server	
Risk Register	Server	
Risk Spreadsheet	V.1	08/06/2020
Issues Register	Server	
Defects Register	Server	
Project Team and External Contacts	Server	
HIC	TBA	
Project HSE Risk Assessment		
Finalisation		
Milestone Checklist	Server	
Project As-Built SAP Data Collection Template - Lines	TBA	