Trinacria Consulting

Carnarvon One Mile Jetty

Damage Assessment Post Cyclone Seroja

21st & 22nd April 2021

Department of Transport

Report 2021/0401

28th April 2021

Trinacria Consulting ABN 802 50 103 760
16 Burton Road Darlington. WA 6070
Email: nello@trinacria.com.au
Tel: +61(0) 417 209 626

Report 2021/0401

Document Status – Final

Rev	Description	Author	Reviewer	Approved	Date
A	Draft for Ventia & Client Review	N Siragusa	J Seng	N Siragusa	26/04/21
0	Final	N Siragusa	J Seng	N Siragusa	28/4/2021
1	Date on Figure 2 Corrected	N Siragusa	J Seng	N Siragusa	28/4/2021
2	Client Comments incorporated	N Siragusa	J Seng	N Siragusa	28/4/2021

Contents

Executive Summary

Cyclone Seroja passed to the west of Carnarvon on Sunday 11th April 2021. The seas and swell resulting from the cyclone coupled with the storm surge wreaked havoc on the historic One Mile Jetty which extends approximately 1450 m out to sea from Babbage Island. The maximum wind gust recorded at Carnarvon was 107 km/hr at 1246 on Sunday 11th April 2021.

The jetty, which is under the custodianship of the Carnarvon Heritage Group, has been closed to the public since 2017 following a condition assessment and recommendations by consultant's MP Rogers and Associates (MPR).

Cyclone Seroja also caused damage to the old disused Prawning Jetty located approximately 900m SE of the One Mile Jetty.

The Department of Transport, who is responsible for marine safety, engaged Ventia and Trinacria Consulting (subconsultant to Searle Consulting) to undertake an inspection of the jetty and report on the level of damage. The inspection was undertaken on 21st and 22nd April 2021 by Nello Siragusa (Trinacria Consulting), Jimmy Seng and Gabriel Jackson (Ventia).

The portion of jetty in the deep water (> 2m) section suffered extensive damage and was essentially totally destroyed. The timber (piles, stringers, crossheads etc) from destroyed sections have been carried south by prevailing currents with some sections being washed into the boat harbour. The destroyed section extends from Pier 186 to Pier 245 or a length of approximately 360m.

The section of jetty west of the beach (Piers 117 to 186) while largely intact has suffered considerable damage in the form of missing or collapsed piles and at risk of collapsing if subject to another extreme event.

The intertidal section of jetty between the end of the mangroves and the beach (Piers 70 to 117) has fared better but is in poor condition as previously highlighted in the MPR report.

The first 420m section of jetty (Piers 1 to 70) is in the mangroves and suffered little impacted from the cyclonic waves.

The principal failure mode appears to be wave uplift removing the timber decking, weakened timber piles snapping at mid tide level due to rot and marine borer attack and split timber corbels rendering the bolts securing the stringers to the corbels ineffective.

It is recommended that the section of jetty between Pier 70 and Pier 245 (Jetty head) is demolished to prevent risks to safe navigation.

Marker buoys should be placed around the entire length of the jetty to prohibit boating given the likely presence of submerged pile stumps and the possibility of falling debris.

Background

Cyclone Seroja passed to the west of Carnarvon on Sunday 11th April 2021. The cyclone path is shown on Figure 1. (Courtesy Zoom Earth). While there were no destructive winds at Carnarvon the seas and swell resulting from the cyclone coupled with the storm surge wreaked havoc on the historic One Mile Jetty which extends approximately 1450 m out to sea from Babbage Island.

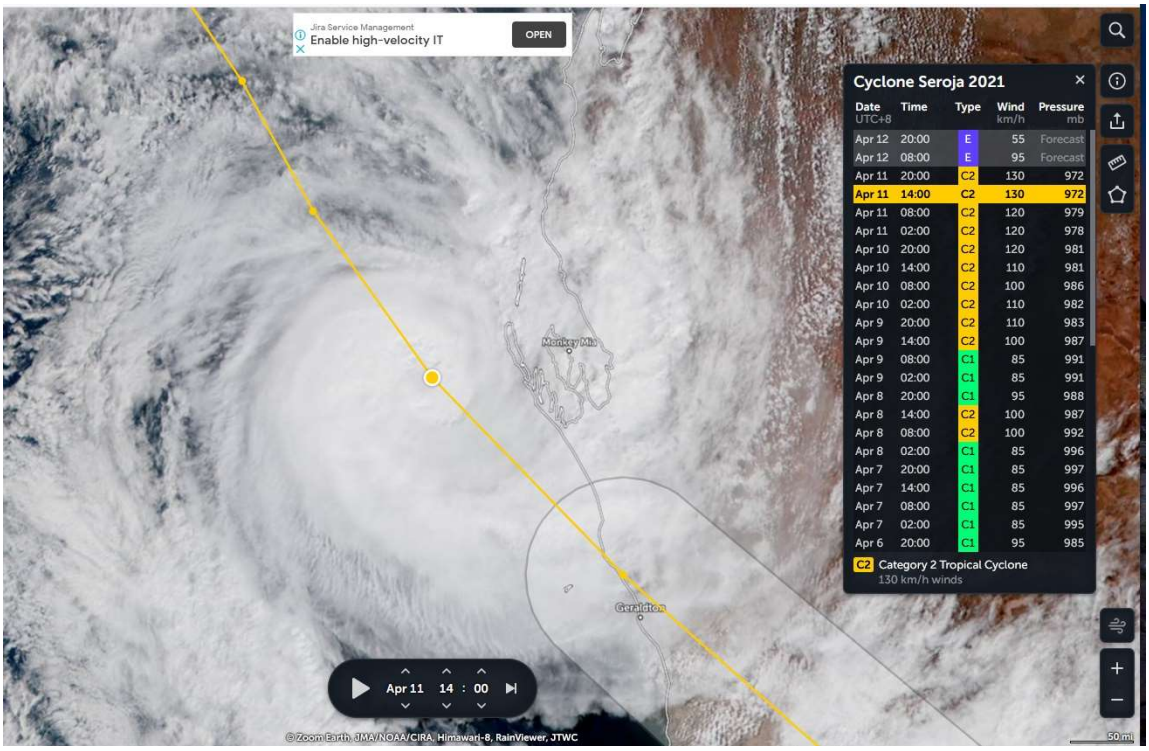

Figure 1: Path of Cyclone Seroja (Courtesy Zoom Earth 2021)

The maximum wind gust recorded at Carnarvon was 107 km/hr at 1246 on Sunday 11th April 2021. (Reference BOM - http://www.bom.gov.au/climate/dwo/IDCJDW6024.latest.shtml)

Predicted astronomical tides for Sunday 11th April were high tide – 1.66m at 1040 Hrs and low tide 0.82 at 1648 Hrs. The maximum tidal residual (storm surge) measured at the Department of Transport tide gauge was 1.03m at 1635 Hrs, fortunately this coincided with the low tide. The maximum observed water level was 2.25m at 1230 Hrs. A plot of the observed and predicted tides as well as the residual (storm surge) is shown in Figure 2.

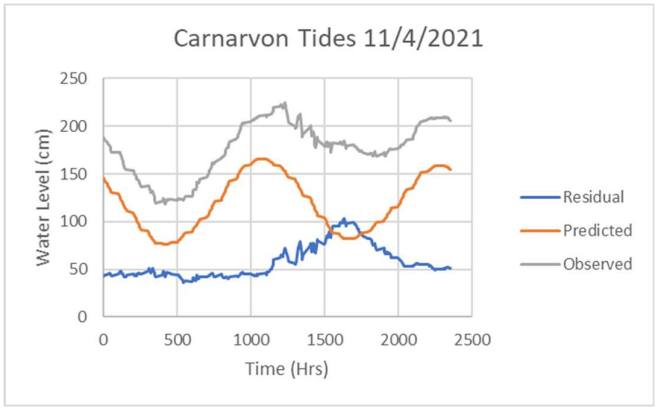

Figure 2: Carnarvon tides on the day of Cyclone Seroja

The deck level of the One Mile Jetty is given as 15.5 ft (4.72 m) above Low Water Mark (LWM) Carnarvon (Refer PWD WA Drawing 3663-2-1 A). LWM on that 1971 Drawing was defined as 2.22 ft (0.68m) below SMSL (which may mean State Mean Sea Level or AHD). The Submergence curve published by DoT in 2011 provides the following information in relation to tides.

Highest Recorded tide (Cyclone Hazel 1979)	2.7m
HAT	2.0m
MHWS	1.5m
MSL	1.0m
AHD	0.95m
MLWS	0.6m
LAT	0.0m

Table 1: Tidal Planes for Carnarvon 2011

There has been at least one datum change since 1971. Prior to 2009 Chart Datum (CD) was 3.739m below BM A876. In 2009 CD was amended to LAT or 3.879m below BM A876, a difference of 0.14m. The relationship between LWM Carnarvon in 1971 and LAT is not known however based on the 2009 change in datum the deck level for the One Mile Jetty is possibly closer to 5m above current datum.

(Note DoT Chart 982 appears to use the pre-2009 datum where LAT = -0.14m CD)

The One Mile Jetty is located off Babbage Island on the southern side of the Gascoyne River mouth. The jetty licence is held by the current custodians the Carnarvon Heritage Group. The jetty was constructed over various periods with the oldest sections being in excess of 120 years old – well beyond the life of a typical timber jetty. Commercial operations on the jetty ceased in the mid 1980's. Since that time, it has become a tourist attraction. The location of the jetty is shown on Figure 2.

The head of the jetty was closed in 1993 due to damage by a fire. Following an inspection by consultant's MP Rogers in 2017 (MPR Report R886 August 2017) the remainder of the jetty was deemed unsafe and closed to the public. Fund raising efforts by the Carnarvon Heritage Group has met with limited success however there was a recent commitment by the WA government to commit $4m toward the restoration efforts. Attempts to obtain additional Commonwealth funding are ongoing.

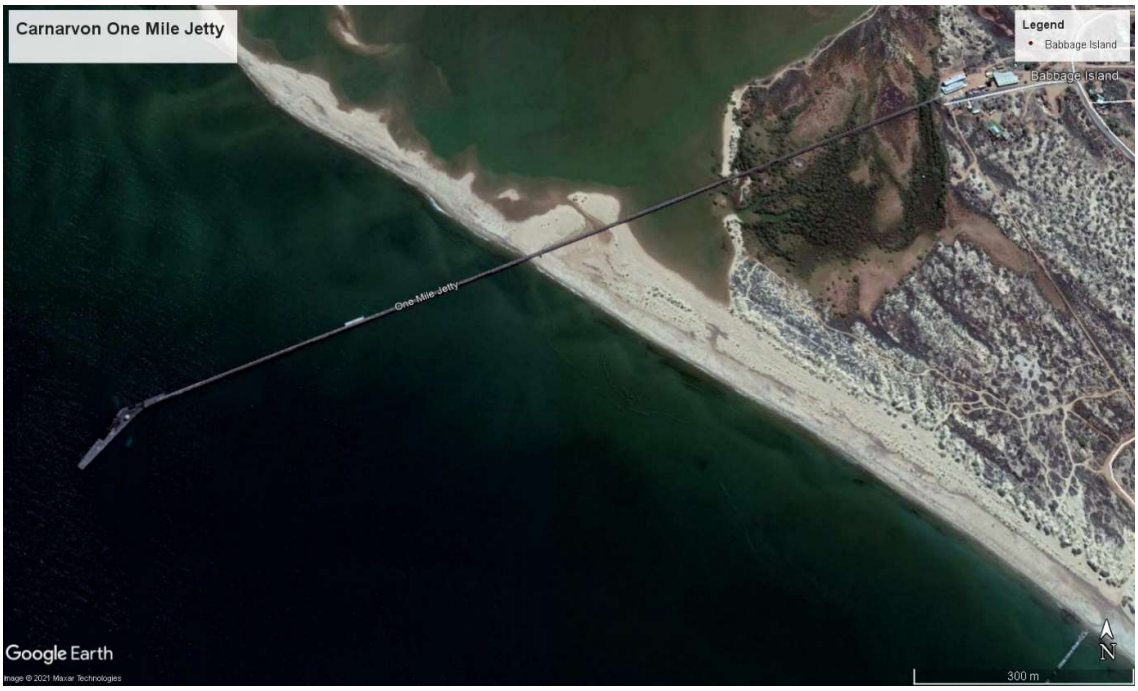

Figure 3: Carnarvon One Mile Jetty. Old Prawning Jetty can be seen on bottom right corner (Google Earth 2017)

Cyclone Seroja also caused damage to the old disused Prawning Jetty located approximately 900m SE of the One Mile Jetty.

The Department of Transport engaged Ventia and Trinacria Consulting (subconsultant to Searle Consulting) to undertake an inspection of the One Mile Jetty following cyclone Seroja to ascertain the extent of the damage. This was important as debris from the jetty was posing a hazard to commercial shipping and recreational boating.

The inspection was undertaken over a two-day period on 21st and 22nd April 2021. The inspection was undertaken by vessel for the major part. Sections of the deck were inspected by accessing the deck from the beach near the 800m mark (Pier 117). It was not possible to conduct a dive inspection as turbidity levels were still quite high resulting in poor visibility.

Jetty Layout

The jetty approach comprises Piers 1 to 220, it is approximately 1335m long and 4m wide with pile bents at 6.1m (20 ft) centres. The jetty approach is on an alignment of 247 degrees. The original construction comprised two (2) raked piles per bent however over the years additional piles were driven alongside existing piles as piles succumbed to rot or loss of section due to attack by marine organisms. Redundant piles were generally left in place. The approach jetty has double timber crossheads supporting 5 timber stringers on timber corbels, timber decking, lower waler beam and cross braces. Timber sections were generally 12 inch x 12 inch jarrah or 12 inch x 6 inch jarrah. Pile penetration was in the order of 4 – 6 m.

The jetty head comprises bents 220 to 248 and is approximately 165m long on an alignment of 211 degrees. The width of the Jetty head varied from 9m to 22m. Jetty head piers are at 6.1m centres and piles are at 2m centres within each pier. As with the approach jetty piling was augmented with either steel or timber piles as the original piles became unserviceable. Jetty head piles were generally vertical piles with cross bracing and other details similar to those on the approach jetty.

There is a light gauge rail line running the full length of the jetty.

Maintenance undertaken over the years included addition of supplementary piles, corbels and stringers, renewed halfcaps and renewal of a section destroyed by fire between Piers 167 and 177.

There is a low-level landing between piers 168 and 173.

The Gascoyne river mouth is very dynamic therefore at times some sections of the approach jetty will be on a sandy beach covering piles which would have previously been in an intertidal area and therefore subject to attack by waves and marine organisms. The first 400m of the approach jetty (Piers 1 to 70 inclusive) is within the mangrove wetland and is therefore protected from heavy seas and swells.

Water depth at the head of the jetty is approximately 5m. Most of the jetty (1165m) is in water depths less than 2m CD. The 0m contour is approximately 950m from the abutment.

Inspection Results

General

The portions of jetty in the deep water (> 2m) section suffered extensive damage and was essentially totally destroyed. The timber (piles, stringers, crossheads etc) from destroyed sections have been carried south by prevailing currents with some sections being washed into the harbour. The destroyed section extends from Pier 186 to Pier 245 or a length of approximately 360m.

The section of jetty west of the beach (Piers 117 to 186) while largely intact has suffered considerable damage in the form of missing or collapsed piles and at risk of collapsing if subject to another extreme event.

The intertidal section of jetty between the end of the mangroves and the beach (Piers 70 to 117) has fared better but is in poor condition as previously highlighted in the MPR report.

The first 420m section of jetty (Piers 1 to 70) is in the mangroves and suffered little impacted from the cyclonic waves.

Jetty Head – Piers 218 to 245

The jetty head was essentially destroyed with 5 bays (Piers 239 to 245) still standing at the very end and a further two bays still standing further east. It is worth noting that in sections totally destroyed only steel piles remain. Inspection of the few pile sections washed ashore or retrieved from the beach indicate that the timber piles snapped at the waterline. These piles showed evidence of excessive section loss due to a combination of rot and attack by marine organisms including Limnoria and possibly Teredo.

It is therefore likely that remaining piles are similarly affected and therefore unlikely to withstand another extreme event. Crossheads that were washed ashore or still in remaining in destroyed sections revealed that bolts securing the corbels were still in place and showing various degrees of corrosion. However, the splitting evidenced in the corbels (Refer Photo 24) would indicate that the corbels and stringers would have been separated from the crossheads due to the split timbers and not due to failure of corroded bolts.

The mode of failure would likely been as follows:

- Decking lifted off by wave impact.
- Timber Piles snap at intertidal zone where section loss caused by rot and marine organisms.
- Stringers and corbels separated from crossheads.
- Crossheads separated from piles (recovered crossheads showed that these remained bolted together).

Photo 1 to Photo 5 show the extent of damage to the head section of the jetty.

Jetty Approach – Piers 186 to 218

The section of the approach jetty between Piers 186 and 218 (approximately 190m) was effectively totally destroyed with only two small sections left standing see Photo 8 and Photo 9. This section of jetty is in an average depth of RL -2m CD. Given the tide and storm surge at the time (Refer Figure 2), the total still water level (SWL) would have been in the order of 4 to 4.5m CD in this location and therefore capable of sustaining a wave of up to 4m in height. The crest height of a breaking wave in this location could be as high as 5.4m (SWL +80% wave height). Photo 6 and Photo 7 taken by Eddie Smith (Carnarvon Shire) show waves breaking over the jetty at this location.

It is likely that there are stumps of broken timber piles located at or just above seabed which could pose a danger to boating.

Jetty Approach Piers 70 to 186 – Intertidal and Beach Section

This section was spared to some degree as the approaching waves from the north were broken by the shallows at the mouth of the Gascoyne River. The broken waves can be seen in Photo 7. Damage was still evident in the form of snapped or missing piles, missing cross bracing, broken stringers and broken handrailing. Typical damage is shown in Photo 10 to Photo 15.

Jetty Approach – Piers 1 – 70

As previously mentioned, this section of the jetty is within the mangrove wetland which is only inundated during higher tides. The mangroves prevent wave action from impacting the structure even during periods of high tide and storm surges. Deterioration in this section is due to age, termite attack and a high likelihood of marine borers near the mud line – Refer Photo 16 to Photo 23.

Decking

Generally, the decking planks are well weathered and require replacement. Some boards have been replaced over the years. Refer Photo 20 to Photo 23

Inspection of salvaged timber

Salvaged timber members shown in Photo 25 to Photo 30 were inspected to ascertain weaknesses and likely modes of failure. Salvaged piles consistently showed evidence of Limnoria attack at the waterline with resultant rot inside the pile. Piles were snapped at this location. It is likely that many existing piles are similarly affected. There was little evidence of Teredo infestation in salvaged piles.

Salvaged Crossheads showed that corbels were broken away by a combination of split corbels leaving the bolts in place as well as failed bolts due to corrosion.

Conclusions and Recommendations

The One Mile Jetty suffered irreparable damage from Pier 186 to 245 – a length of approximately 360m - because of Cyclone Seroja which impacted the jetty on 11th April 2021. A further section between Pier 70 and Pier 186 suffered varying degree of damage and would likely fall into further disrepair should another extreme event impact the jetty. The 400m section of the jetty between the abutment and pier 70 escaped relatively unscathed as this section is protected by the mangroves.

There is a large quantity of timber in the waters to the south of the jetty which pose a danger to navigation. A further extreme event will likely result in further damage more flotsam creating hazards to navigation. Marker buoys should be placed around the entire length of the jetty to prohibit boating given the likely presence of submerged pile stumps and the possibility of falling debris.

It is recommended that the section of jetty between Pier 70 and Pier 245 (Jetty head) is demolished to prevent risks to safe navigation.

Photo 1 Jetty Head - 5 bays remaining.

Photo 2: Portion of jetty head - note steel piles remaining.

Photo 3: Panoramic view of jetty head and end of approach jetty showing missing sections

Photo 4: Underside of jetty head showing timber piles completely rotted at water line

Photo 5: Broken Pier showing broken timber pile with crosshead still attached to steel pile

Typical State of Jetty Head

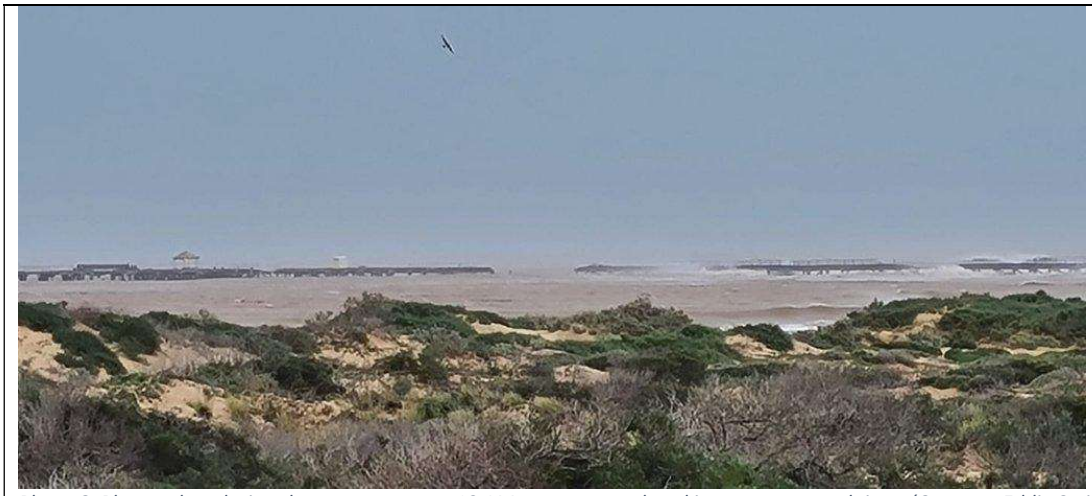

Photo 6: Photo taken during the storm - approx 10 AM - note waves breaking over approach jetty (Courtesy Eddie Smith)

Photo 7: Photo taken short time later showing demolished section of the approach and breaking waves in shallow beach area (Courtesy Eddie Smith)

Photo 8: Jetty Approach between Piers 186 and 218

Photo 9: Jetty Approach - Pier 186 is the end of the complete section

Jetty Approach – Piers 186 to 220

Photo 10: Approach jetty Shallow area - Piers 70 to 186

Photo 11: Broken pile causing jetty to collapse

Photo 12: Broken Stringer and missing braces

Photo 13: Missing pile and cross braces

Photo 14: Missing Pier

Photo 15: Broken Stringer and missing handrail

Jetty Approach Piers 70 to 186

Photo 16: View of approach jetty from abutment to end of mangroves - no storm damage evident

Photo 17: Evidence of termite on stringers near abutment

Photo 18; Pile near abutment showing evidence of rot. Likelihood of necking below the mudline when mud level was lower.

Photo 19: Abutment pile showing evidence of previous fire. Note also split corbel which is prevalent throughout.

Jetty Abutment and Approach Piers 1 to 70

Photo 20: Typical condition of deck planks

Photo 21: Split and worn deck planks

Photo 22: Unsafe deck planks - replaced deck planks can be seen in the background

Photo 23: General deterioration of decking and rail line

Photo 24: Typical detail of split corbels resulting in separation of corbels and stringers from the crossheads

Typical Condition of Jetty Decking and Corbels

Photo 25: Typical pile showing break at waterline due to rot and Limnoria attack.

Photo 26: View inside snapped pile

Photo 27: Salvaged pile cut just above necked area where pile snapped showing internal rot

Photo 28: Further section above rot area confirming that Teredo not present

Photo 29: Salvaged pile cut just above necked area (MSL) – no evidence of Teredo

Photo 30: Salvaged Crosshead showing bolts in place where corbels were secured

Photos of Salvaged timber sections

Photo 31: Salvaged timber piles still attached to broken crossheads. Pile at top of photo has rotated. Both piles snapped at mid tide level due to rot and attack by marine organisms - predominantly Limnoria.

Photo 32: End view of pile at top of photo (Photo 31)

Photo 33: Same Pile with rotted section cut off to determine extent of Teredo Infestation.

Photo 34: End view showing minimal Teredo activity.

Salvaged timber piles

While the above photos show minimal Teredo damage it is likely that teredo would have been more active closer to the mud line.