Canomodine Bridge
Concept Design
Cabonne Shire Council

Document status

Revision	Date	Document status	Prepared by	Reviewed by
01	24/07/2023	Concept Design	Yuhang Tang	Craig Riley
02	28-07-23	Revised Issue	Yuhang Tang	Craig Riley

Contents

Appendix

1. Introduction

Canomodine Bridge was located on Canomodine Lane, Canowindra, NSW, where the road crosses Canomodine Creek. The location of the site is at coordinates (-33.508037, 148.792126), approximately 52 km southwest of Orange.

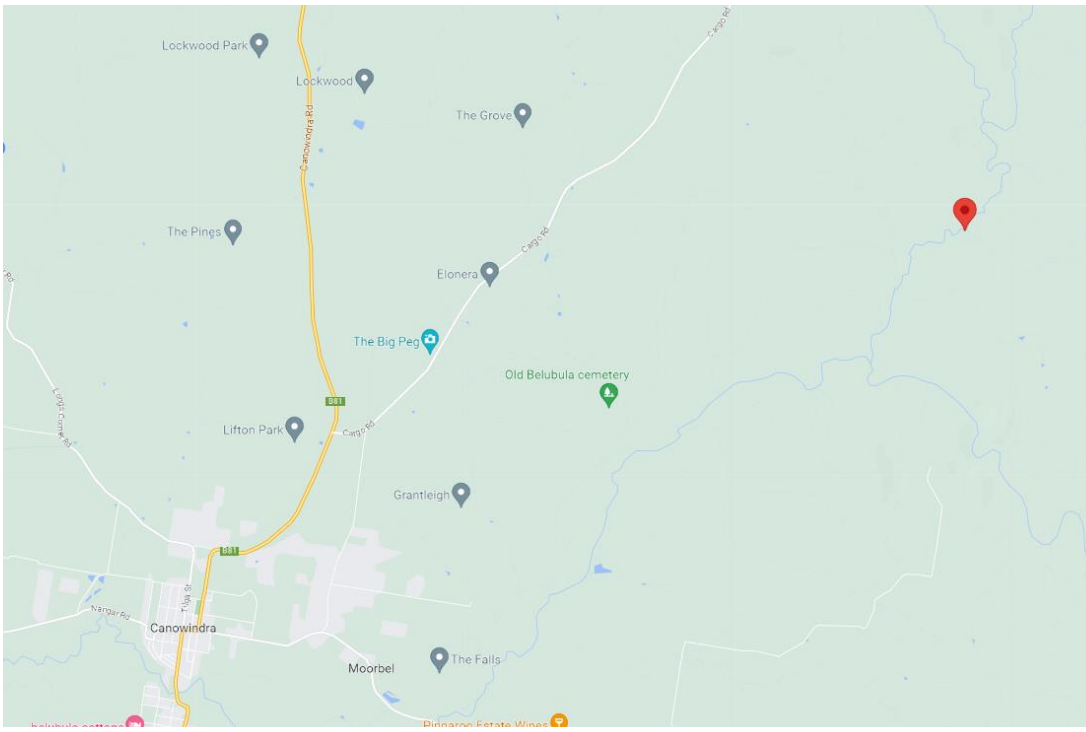


Figure 1 Location of the Bridge Site northwest of Canowindra

The first 2km of Canomodine Lane from the Cargo Road turnoff is sealed (to the Westlime facility) and the remaining 4.5km to the bridge (over a cattle ramp) is unsealed gravel road. In addition to Canomodine Station (which has most of its infrastructure on the west side of the bridge, but a residence and a few paddocks to the east) there is one other farm property served by the bridge.

During major flooding in November 2022 the old bridge was completely washed away leaving only the remains of the southern concrete abutment and a few mass concrete blocks on the northern side. The previous structure was a converted railway carriage on mass concrete footings. The apparent span measured between the abutments was approximately 6m with the height of the structure above the waterway being approximately 2m.

Residents have been using a low level causeway crossing constructed from rocks on the upstream side to access their properties which will need to be maintained during restorative works to the old bridge.

Several Photos of the site are included below for context.

Figure 2 Aerial View of Site. North is vertically up the page. Temporary Causeway being utilised for access currently

Figure 3 Remaining Abutment (looking North)

Figure 4 Temporary Causeway (right) and Remains of Bridge (left) looking North

2. Design Constraints

The following section details the key constraints on the site after discussions with council and following a site visit conducted by Bridge Knowledge on 13 June 2013.

2.1. Funding

Council is eligible for assistance under the *NSW Disaster Assistance Guidelines* to fund the construction of a replacement structure with the same functionality as the one that was damaged in the event to current engineering standards.

The replacement bridge must attempt to replace like-for-like within the constrains of the funding criteria.

Therefore, the funding eligibility will be limited to:

- a single lane bridge
- with the same waterway area as the old structure
- designed in accordance with AS 5100 2017 with a design traffic loading of SM1600 as per AS 5100.2 2017
- built to current Transport for NSW specifications
- guardrail provided to the minimum standard permissible under AS 5100
- restoration of approaches to match to existing (restoration of gravel pavement)

2.2. Existing Structure

The existing bridge was completly washed away in the 2022 flood waters leaving only the remains of the abutments. The existing abutmetns were no fines concrete mass blocks with a mass concrete poured blinding layer and a small concrete upstand as shown in Figure below. The southern abutment remains somewhat in tact, but the northern abutment has been washed away leaving only a few blocks.

The remaining abutment is unsuitable to be compliant with current design standards and will likely suffer damage in future floods if used as structural elements. Therefore it is recommended that the abutment and debris be removed for the new bridge construction with properly designed abutments.

However, the concrete mass blocks may be able to be reused as a scour protection measure in the new bridge abutments which will save some disposal costs.

Images below depict existing abutment condition.

Figure 5 Remains of abutments

Figure 6 Southern Abutment remains somewhat in tact

2.3. Hydraulic Analysis

Bridge Knowledge has conducted a basic concept level hydraulic assessment of the bridge site to help inform the design. The results are summarised in Table 1 below and the full report available in Appendix B.

The proposed deck level of the new bridge is at RL 347.8m achieving an approximate flood immunity to ARI10 which is an event with a probability of exceedance of 10% each year.

Note that the existing bridge would have had a deck level of approximately 347.0m. Calculated from the remaining southern abutment upstand block which sits at 346.6m and assuming a previous structural thickness of about 400mm. The proposed bridge therefore will sit slightly higher to achieve similar waterway area and because the alignment is on a sag curve it fits rather naturally and a small increase in flood immunity is achieved without.

ARI10 has been selected as serviceability event due to the local access nature of this road.

Table 1 Hydraulic assessment results

ARI	Flow (m3/s)	Velocity (m/s)	Water surface level (RL m)
2	29	2.62	346.0
5	68	2.76	346.9
10 (SLS)	108	3.13	347.8
20	159	3.06	348.2
50	248	3.39	348.7
100	334	3.53	349.0
200	420	3.44	349.4
500	534	3.63	349.7
1000	620	3.86	350.0
2000 (ULS)	706	4.02	350.2

2.4. Geotechnical

A geotechnical investigation of the site has been conducted by Macquarie Geotech (Report B21781, issued 28/04/2023). Two boreholes were drilled, one at each abutment, finding silty clays to a depth of about 7m in the north and 4m in the south underlain by moderately waethered mudstone.

Soil aggressivity at the site is rated mild, in accordance with AS2159, due to the presence of groundwater. A geotechnical strength reduction factor of 0.48 has been assigned to the site due to limited investigation, testing, and specialist geotechnical supervision, also in accordance with AS2159.

Based on the geotechnical information provided and summarised in Table 2, it is anticipated that bored piles founded in mudstone would be the most effective solution for the site conditions, due to the low lateral and bearing strength of the overlying strata. 2 x 750 mm diameter piles at each abutment will likely provide adequate lateral and bearing support, with pile length at the Southern abutment (BH1) estimated to be 9 m, and 5 m at the Northern abutment (BH2).

Table 2 Geotechnical Design Values-Bored Pile Footings

Location and Depth (m)		Material Description	Ultimate Bearing Capacity (kPa)	Serviceability Bearing Capacity (kPa)	Ultimate Skin Friction (kPa)	Modulus of Subgrade Reaction (MN/m^3)	SPT (N)
BH1	BH2						
-	0.00-0.10	Topsoil	-	-	25	-	-
0.00-1.95	-	Gravelly Sand	-	-	-	8	6
1.95-6.50	0.10-1.00	Sandy Silty Clay	-	-	4	4	3
-	1.00-3.00	Silty Clay	-	-	4	4	3
6.50-7.20	3.00-3.27	Gravelly Clay	1800	600	60	140	14
7.20-7.90	-	Mudstone (XW)	3000	700	75	240	-
-	3.27-8.27	Mudstone (HW-MW)	3000	1000	150	240	-
7.90-8.45	-	Mudstone (MW)	9000	3000	350	480	-
8.45-13.34	8.27-12.32	Mudstone (SW)	30,000	6000	600	2400	-

2.5. Utilities

An exploratory Before You Dig Australia (BYDA) enquiry has found that underground electricity and communications services are present at the site or within the immediate vicinity. In addition, the provided survey notes the presence of overhead and underground Telstra utilities to the South-West of the site.

Utility locations will need to be located and identified prior to the commencement of any works, and relocated if necessary.

Contractors should conduct their own site investigations prior to any excavation or earthmoving activities.

BYDA enquiry results are attached to this document in Appendix C.

2.6. Road Geometry

Residents have noted that the site is difficult for larger vehicles or farm machinery to negotiate. This project does not intend on impacting any property boundaries and so the road and bridge must fit within the existing road reserve and road works are not funded as part of the replacement so realignment must be minimized. This does not leave many options available to improve the road alignment along this section.

The existing approach radius was about 30m on an unsealed road. The proposed alignment has been able to increase this to 35m by shifting the alignment slightly north, but still away from the fenceline. This is a marginal improvement to the existing, but it will still remain a low design speed area unless substantial investment is made in an upgrade.

2.1. Environmental

A environmental consultant must be engaged to comment on the impact of the proposed works and the recommendations in the REF should be followed. However based on the initial site scoping inspection it would appear that this site has no major environmental concern that would otherwise preclude the construction of the proposed bridge works.

Following the guidelines given in the DPI guide for stream order and waterway classification, Canomodine creek would be likely classified as a class 2 waterway. This represents a named waterway with permanent to intermittent flow, defined bed and banks with semi-permanent waters in pools. Marine or freshwater aquatic vegetation is present and fish habitat is observed. A waterway of this type would typically require a bridge as opposed to a culvert and minimized impact on fish passage during construction. The proposed single span bridge would meet this criteria. Prior to construction a fisheries permit may be required.

A sediment and erosion control plan will need to be developed for the construction works to minimize the impact to the waterway.

3. Design Considerations

Having considered the identified constraints for the project, the following section explores the proposed concept design of the bridge replacement.

3.1. Design Criteria

The criteria used in the design has been compiled from applicable standards and information provided by Council and is outlined in Table 3. Applicable Australian standards and design guides used during design include:

- AS1170.1:2002 – Structural Design Actions
- AS2159:2009 – Piling
- AS5100:2017 – Bridge Design Suite
- Austroads Guide to Road Design Part 3: Geometric Design (2016)
- Austroads Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures (2018)

The design criteria have been provided to inform the subsequent detail design phase of the project.

Table 3 Joyces Bridge design criteria

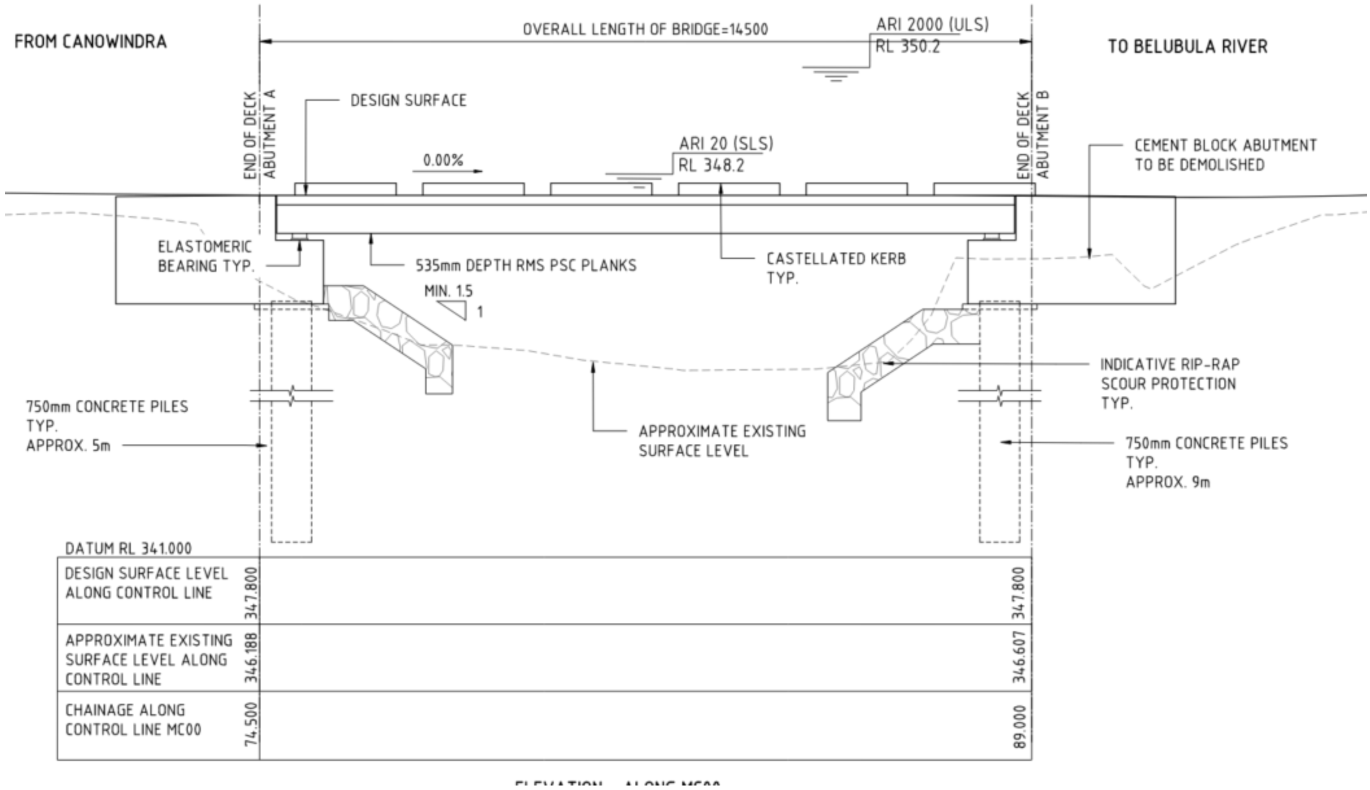
Element	Key Bridge Criteria	Reference
Design Life	100 Years	AS5100.1 Clause 8.2
AADT	<100 15% heavy vehicles	Assumed, low usage regional road
Design Speed	40 km/hr	Concept Design
Crossfall	3% one-way upstream side raise	Concept Design
Longitudinal grade	None	Concept Design
Minimum Length	14m. Existing abutment to existing abutment	Concept Design
Alignment	Inline – use current causeway for temporary access.	Concept Design
Design Lanes	Single lane bridge	Council
Bridge carriageway width	4200 mm minimum or as otherwise approved by the authority	AS5100.1 Clause 13.4
Design Vehicle	SM1600	AS1597.2 Clause 3.3.5
Traffic Barriers Performance Level	No barrier - Kerb only	Council
Materials	Superstructure to be concrete Substructure to be concrete	N/A
Wearing surface	Concrete with a broomed finish	N/A
Durability	Minimum exposure classifications: Concrete elements – B1	AS5100.5 Table 4.3
Hydraulics	Serviceability (scour protection) - 20 yr ARI (refer drawings) Ultimate (bridge design) - up to 2000 yr ARI (refer drawings)	AS5100.1 Clause 11.1

3.2. Bridge Geometry

The proposed structure is a single lane concrete girder bridge spanning 14.5m, with 535 deep prestressed TfNSW plank girders and a 200 thick insitu concrete deck. The bridge width is approximately 4.8 m, to tie into existing approaches, and has a carriageway width of 4.3 m, noting that the minimum single lane bridge carriageway width to AS5100 is 4.2m. The span between abutments of the destroyed bridge was approximately 13m (measured from survey).

A plank bridge is proposed as an economical and readily available standard bridge design. However there are also a few modular bridge options on the market which may be considered.

Typical reinforced concrete abutments and pile foundations have been assumed for concept stage. Shallow footings are not considered suitable for a bridge subject to the large lateral loads imposed by flooding and inundation. A typical elevation of bridge concept design is provided in figure below. Concept drawings also provided at in Appendix A



3.3. Road Geometry

The proposed bridge will be constructed on the existing road alignment. The design speed is 40km/h considering the road's frequent vertical and horizontal curves. The proposed alignment slightly improves the radius of the Northern approach from 30m to 35m, without interfering with the existing property access gate and fence line.

Although the road is far from being compliant with Austroads standards, as the radii are tight, gradients are large and widths are narrow. The proposed alignment mostly follows the existing natural gradients and radii.

3.4. Barriers

The proposed new bridge replacement would typically require low performance barriers when using the procedure given in AS5100.1 - Appendix A. However , clause 14.5.1 (b) permits the performance level to be nominated by the ‘relevant authority’ following a risk assessment.

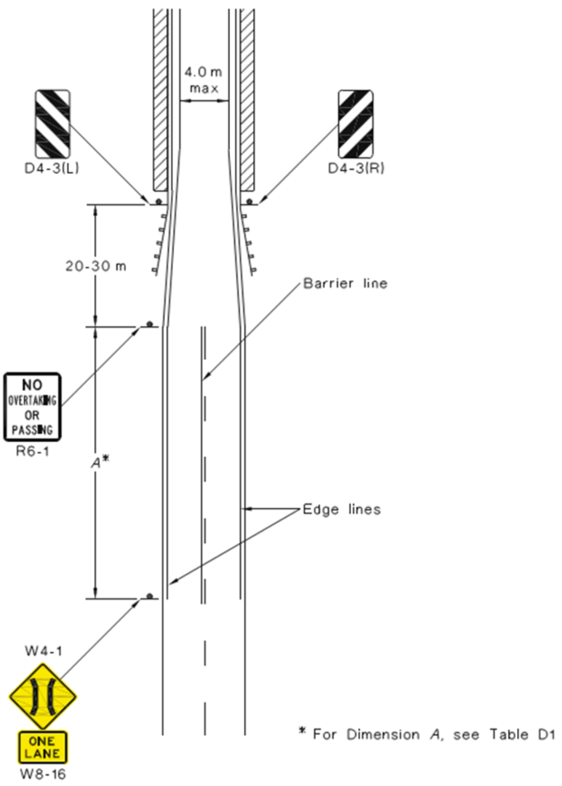
It is recommended that a risk assessment be conducted and approved by Council, but the preliminary assumption at this point is that ‘no barrier’ is an appropriate selection at this site.

This is because the bridge is very low use with low traffic speed and good visibility and the likelihood of an errant vehicle leaving the bridge deck is very low. On the other hand, barriers would create a waterway barrier as the bridge is frequently inundated. Traffic barriers would require frequent maintenance and repair as a result of damage caused by debris impacting and becoming snagged against the barriers. Therefore, it can be said that the frequency of the risks and subsequent consequences of having barriers appear to outweigh the very unlikely event of an errant vehicle driving off the bridge without barriers.

However, to further manage the risk of an errant vehicle departing the bridge, the following controls are recommended:

- Signage according to AS1742.2 Figure 4.11 including ‘one lane’ bridge sign, ‘no overtaking or passing sign’ and black and white striped delineation signs. (Included in appendix B)
- Solid or castellated kerbs with a height of at least 250 mm above finished shoulder level to redirect wheels in low angle impact
- Include a “yellow” speed advisory sign in the vicinity of the bridge to suggest a lower speed and warn users of upcoming hazard.

85 AS 1742.2—2009



NOTE: A one-lane bridge is one that meets the width limitations specified in Clause 4.6.2.2. The maximum width between edge lines is 4.0 m.

FIGURE 4.11 ONE-LANE BRIDGE

Figure 7 Excerpt from AS1742.2

3.5. Design Loads

Traffic loading for the structure is SM1600 loading as per AS5100.2. Per the standard, the SM1600 load consists of concentrated wheel loads, a uniformly distributed load applied over a standard 3.2 m design lane, and braking loads, applied parallel to the centreline of the bridge deck. These loads are positioned within the design lane to produce the most severe effects and identify the critical cases.

Concrete prestress, shrinkage, and thermal loads will be applied in accordance with AS5100, to determine the expected strain along the length of the bridge.

In accordance with AS5100.2, §15.4.1, the bridge earthquake design category of the proposed structure is *BEDC-1: Minor single span bridges carrying infrequent traffic*. Earthquake loads are not required to be considered for bridges with BEDC-1 classification.

Flood loading shall be determined in accordance with AS5100.2, Section 16, using the results of the hydraulic assessment conducted by Bridge Knowledge. Flood loading typically includes relevant combinations of drag, uplift, downthrust, overturning, debris accumulation, and log impact, depending on the velocities and depths of flood flows and extent of inundation of the structure.

4. Quantities

The following Bill of Quantities (BOQ) is provided as an approximate guide to assist Council in tracking project costs. This information cannot be relied on for tendering purposes and contractors must perform independent calculations for cost estimates.

Canomodine Creek Bridge Quantities		
Number	**Quantity**	**Unit**
Deck Section		
180 mm nominal thickness insitu, 40 Mpa	70	m^2
Concrete Volume	14	m^3
Steel Weight	3500	kg
Girders		
TfNSW 535 mm plank, 14.5 m length	5	Number
Total length of girders	72.5	m
Abutments		
1.2 x 1.2 m section, 5.4 m length	2	Number
Concrete Volume	16	m^3
Steel Weight	3200	kg
Curtain/Wing Walls		
2.7 m long 0.3 m thick wing walls, 0.3 m thick curtain wall	25	m^2
Concrete Volume	6	m^3
Steel Weight	1100	kg
Piles		
750 mm bored RC pile, 2 per abutment, 6 m length	4	Number
Total length	24	m
Concrete Volume	11	m^3
Steel Weight	1800	kg
Scour Protection Rip Rap		
d_{50} = 500 mm, section thickness 1 m	50	m^3
Drainage		
Sub-soil drains - granular	20	m
Sub-soil drains - NFC	20	m
Table drains	120	m
Table drain scour protection - d_{50} = 300 mm	30	m^3
Earthworks		
Stripping	15	m^3
Earthworks - Excavation, haul and stockpile	300	m^3

Earthworks - profile/excavate pavement haul and stockpile for reuse	50	m^3
Reuse of suitable excavated/profiled material as selected - load & haul	50	m^3
Supply & Haul imported Selected	50	m^3
Street Furniture		
Signs	4	Number
Longitudinal line marking	0	m
Low performance barrier	0	m
Site Reinstate		
Top dressing	65	m^3
Turf or jute matting	240	m^2
Grass seed/hydromulch	300	m^2

5. Conclusion

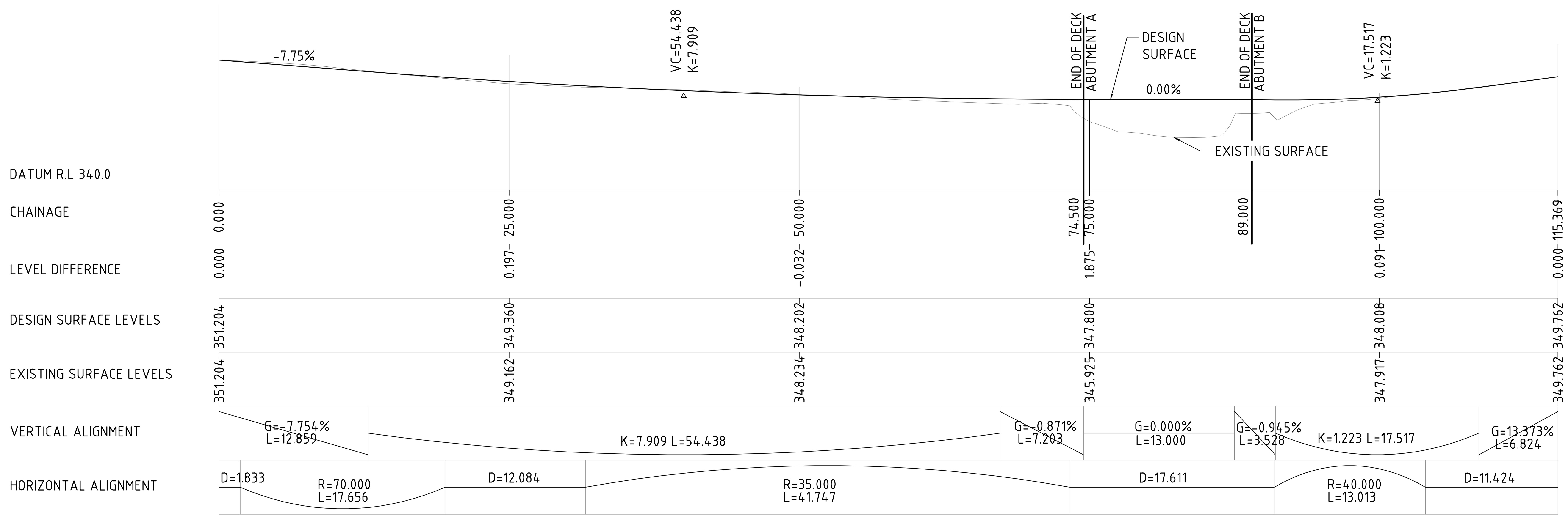
Canomodine bridge crosses Canomodine Creek on Canomodine Ln, Canowindra NSW, and provides local access for the rural regional community. Council intends to replace the previous bridge, which was destroyed during a flood event in 2022.

The proposed replacement structure is a single-span, single-lane concrete structure, incorporating bored concrete piles, cast insitu concrete abutments, prestressed concrete TfNSW plank type girders and a cast insitu concrete bridge deck with a deck level of 347.8 m.

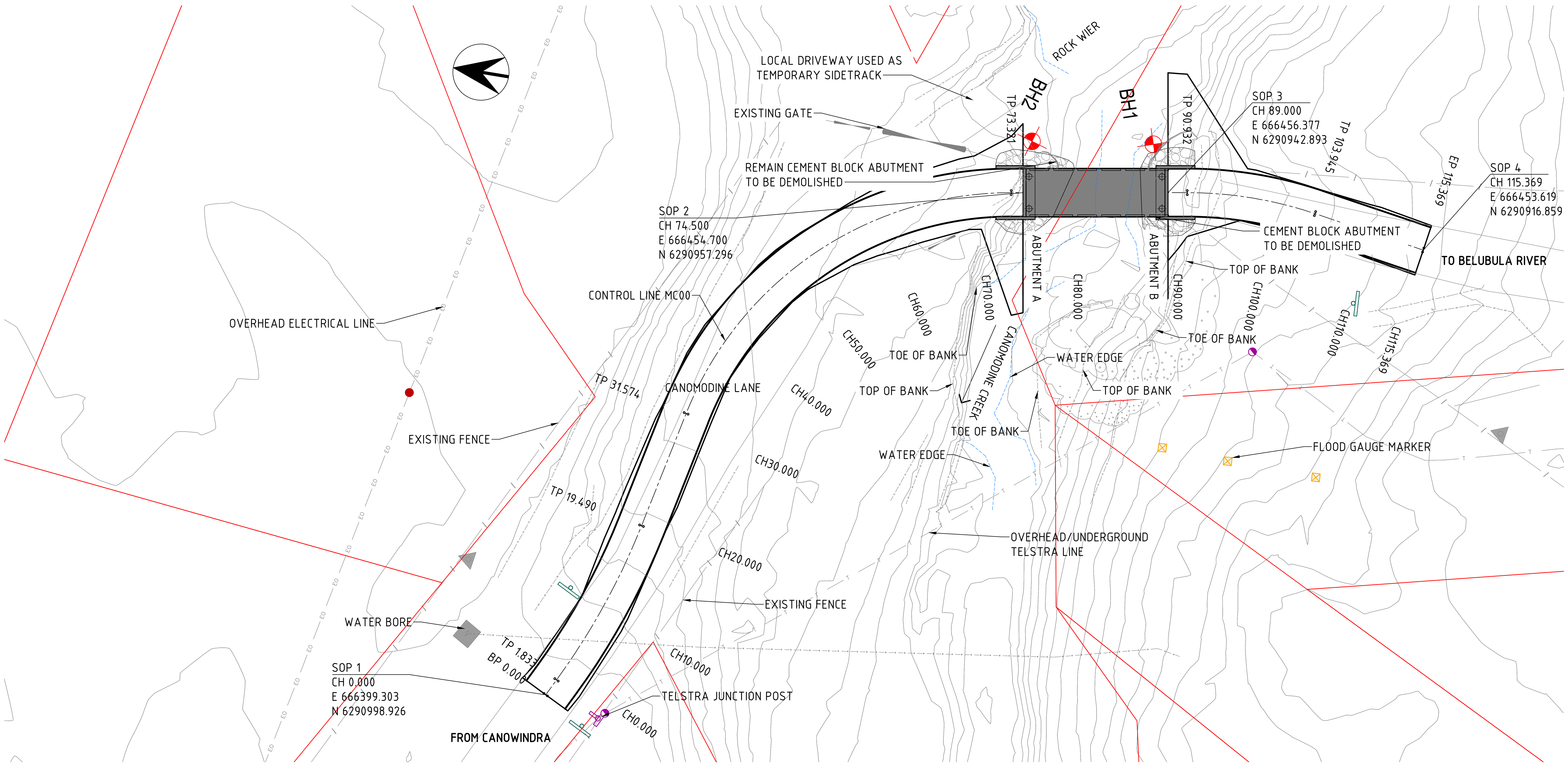
Draft concept drawings have been supplied for Council review.

Appendix A

Concept Drawings



LONG SECTION ALONG MC00



PLAN

GENERAL NOTES

SCALE 2500 0 5000 10000mm SCALE 1:250mm OR AS SHOWN.

DIMENSION IN MILLIMETRES.
CHAINAGES AND REDUCED LEVELS ARE IN METRES.
REDUCED LEVELS ARE TO THE AUSTRALIAN HEIGHT DATUM.
CO-ORDINATES ARE TO MGA ZONE 55.

CONCEPT DESIGN

NOT FOR CONSTRUCTION

ISSUE	DATE	AMENDMENT DESCRIPTION	PREP	CHECK	AUTH
1	24/07/2023	CONCEPT DESIGN	YT	CR	DM

THIS DRAWING IS CONFIDENTIAL AND SHALL ONLY BE USED FOR THE PURPOSE OF THE NOMINATED PROJECT

	PREPARED	CHECKED
DESIGN	YH. TANG	C. RILEY
DRAWING	YH.TANG	C.RILEY

PREPARED BY bk. bridge knowledge. ENGINEERING CONSULTING SERVICES

YH. TANG
BRIDGE ENGINEER

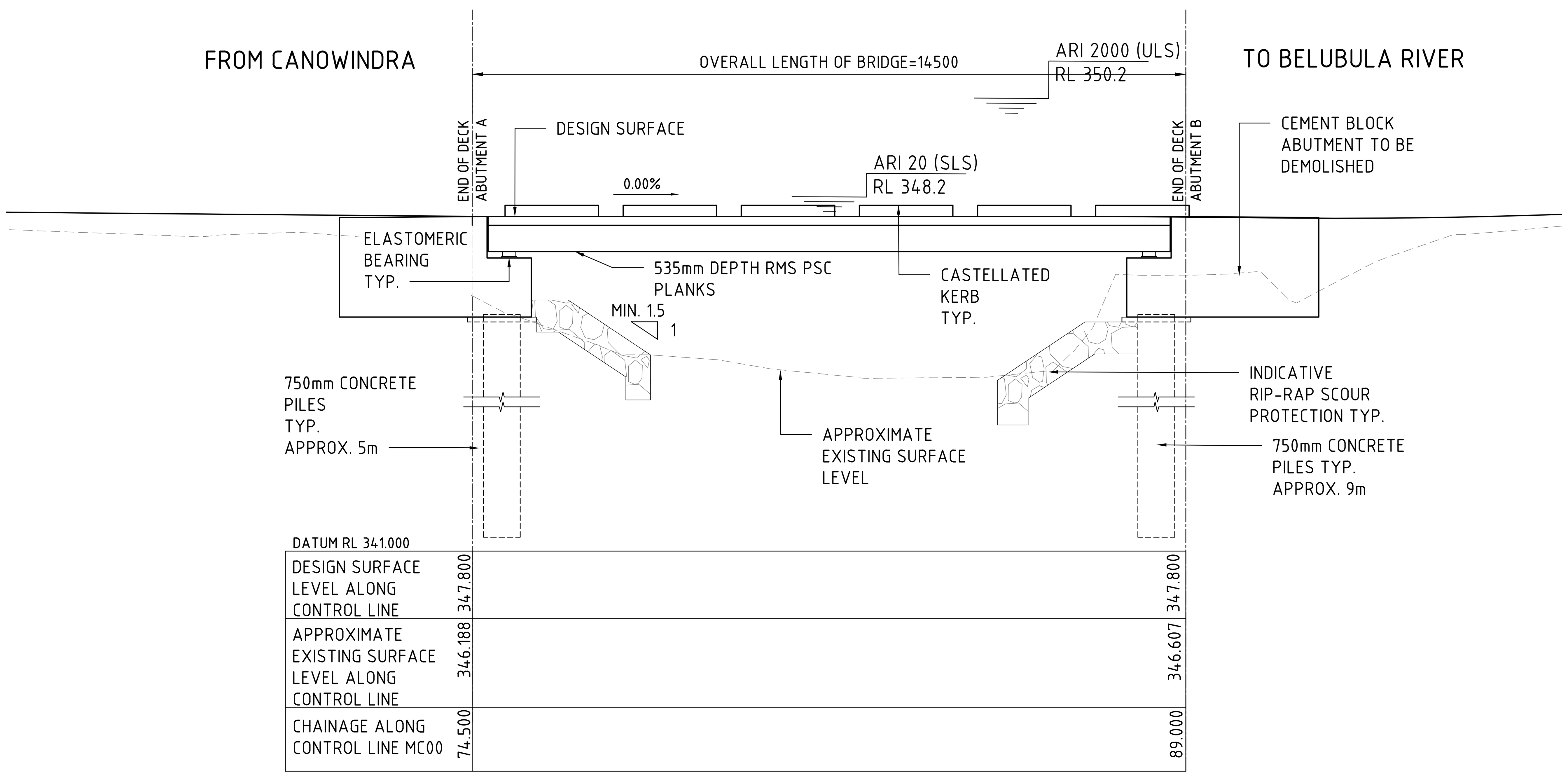
CABONNE COUNCIL

CANOMODINE LN — CABONNE COUNCIL

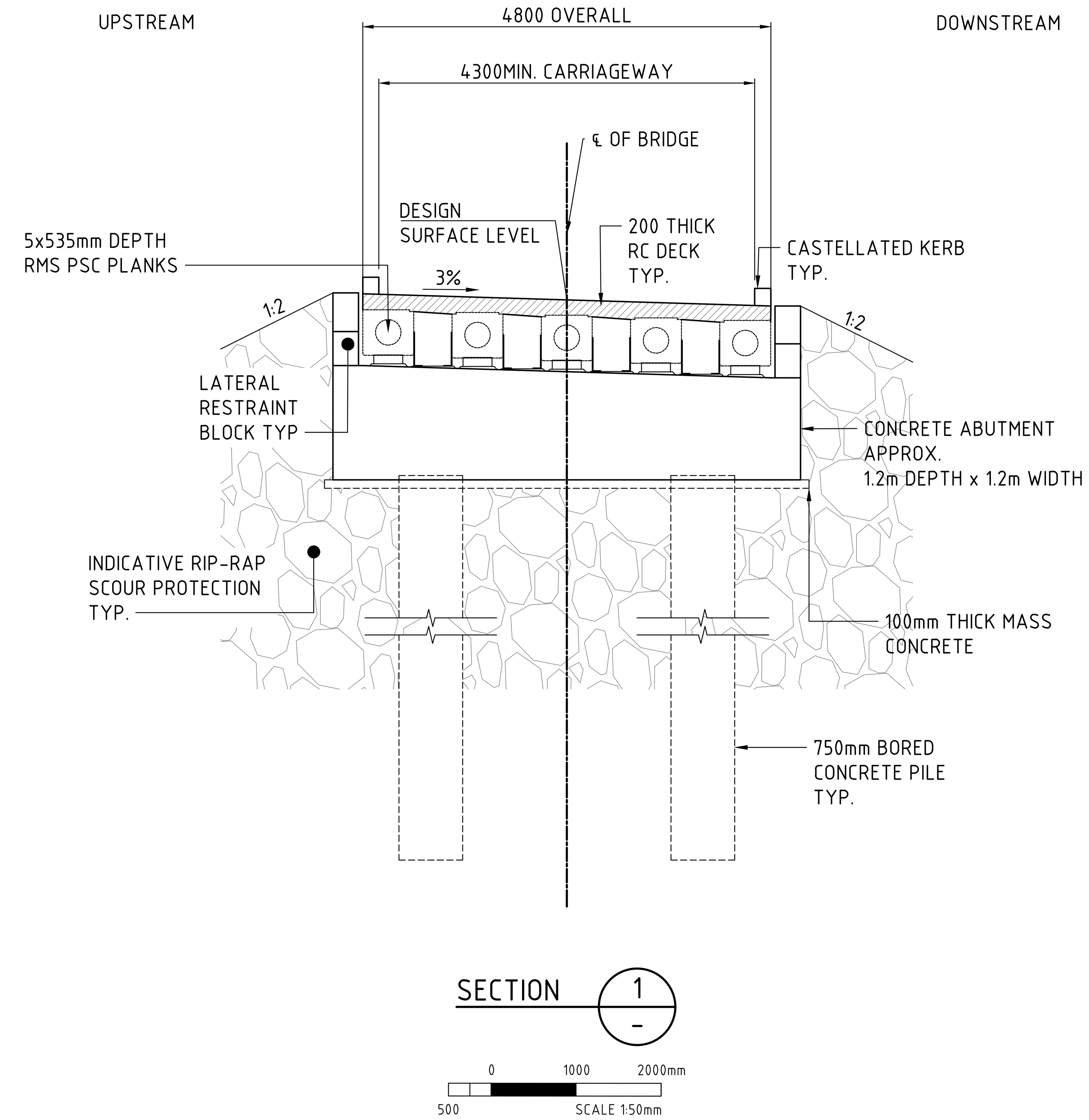
CANOMODINE BRIDGE REPLACEMENT
CONCEPT DESIGN

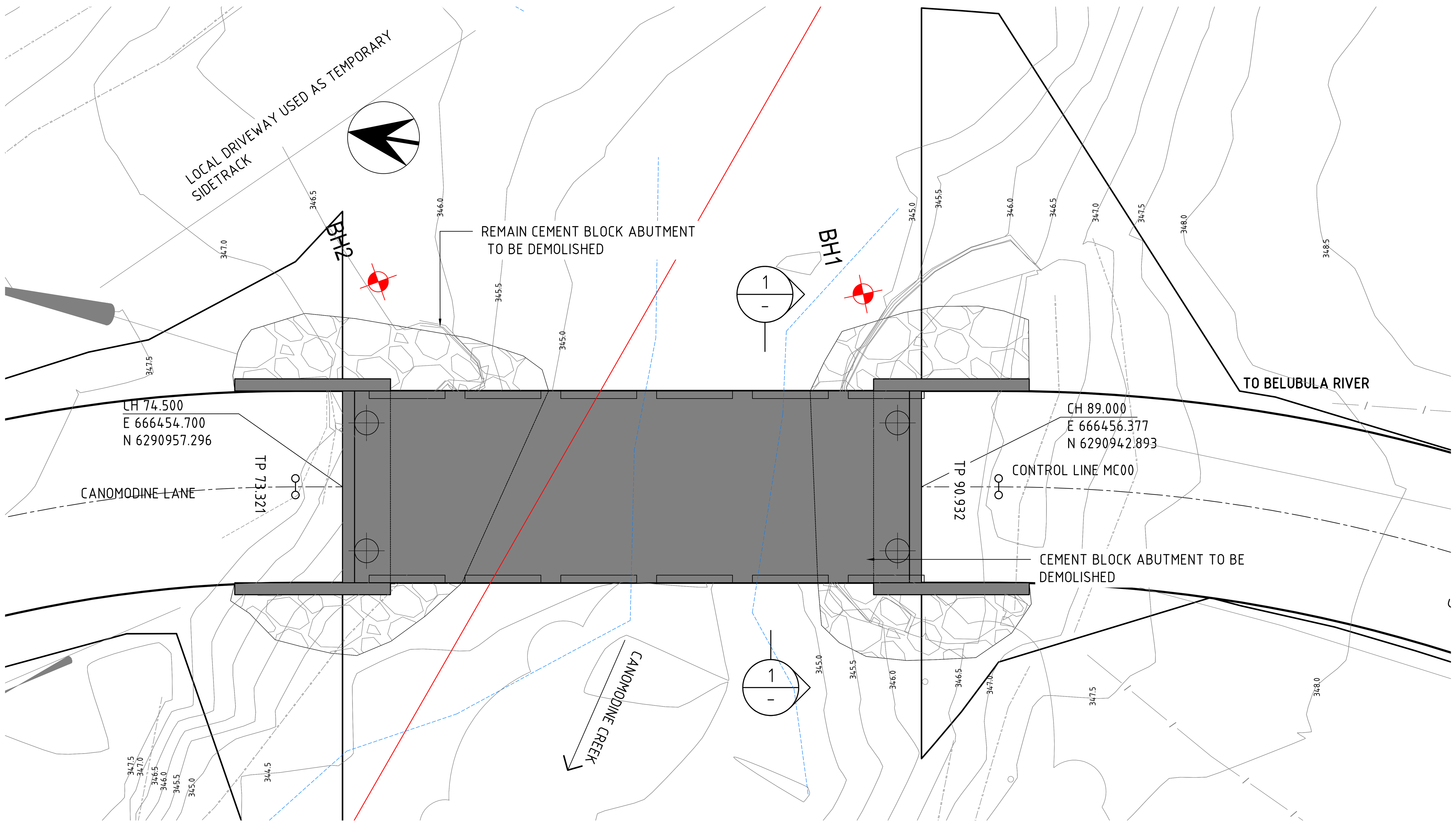
ROAD DESIGN-LONG SECTION AND PLAN

DRAWING SET No: BKP406-CC-BR001
DRAWING No: BR001-DRG-01
ISSUE STATUS: CONCEPT DESIGN
ISSUE: 1 | No SHEETS: 2 | SHEET No: 01



ELEVATION - ALONG MC00





PLAN

GENERAL NOTES

SCALE 0 1000 2000 3000 4000 5000mm 1000 500 OR AS SHOWN.

DIMENSION IN MILLIMETRES.
CHAINAGES AND REDUCED LEVELS ARE IN METRES.
REDUCED LEVELS ARE TO THE AUSTRALIAN HEIGHT DATUM.
CO-ORDINATES ARE TO MGA ZONE 55.

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ISSUE	DATE	AMENDMENT DESCRIPTION	PREP	CHECK	AUTH
1	24/07/2023	CONCEPT DESIGN	YT	CR	DM

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	PREPARED	CHECKED
DESIGN	YH. TANG	C. RILEY
DRAWING	YH.TANG	C.RILEY

PREPARED BY: bk. bridge knowledge. ENGINEERING CONSULTING SERVICES
YH. TANG
BRIDGE ENGINEER

CABONNE COUNCIL

CANOMODINE LN — CABONNE COUNCIL

CANOMODINE BRIDGE REPLACEMENT
CONCEPT DESIGN

GENERAL ARRANGEMENT

DRAWING SET No	BKP406-CC-BR001
DRAWING No	BR001-DRG-02
ISSUE STATUS	CONCEPT DESIGN
ISSUE	1
No SHEETS	2
SHEET No	02

Appendix B

Hydraulic Assessment Report

Our Ref: BKP406-CC-RPT-FL-01-01

Ben Lawson
Project Manager
Cabonne Council
PO Box 17
MOLONG NSW 2866

15 June 2023

Canomodine Bridge- Hydraulic Assessment

Introduction

The Canomodine Bridge was lost during a storm event in 2022. The bridge deck and one abutment were washed away, while another abutment remained but with some damage. The proposed replacement structure is a single-lane bridge designed as per AS5100 with SM1600 traffic load. The span is expected to be 14.5m and a width of 4.8m

A hydraulic assessment has been carried out of the site in relation to the ARI events up to the 2000-year flood. The assessment determined the flood levels and velocities for each ARI event. These flood levels and velocities are appropriate for calculating the flood loads on the bridge as per AS5100. A 1D HEC-RAS model was used with hydrology data sourced from ARR's Regional Flood Frequency Estimation (RFFE) Model 2015.

Model Development

Flows for a range of events up to the 100-year ARI event were obtained from the RFFE Model 2015. The 50 and 100-year ARI events were then used to linearly extrapolate the flows up to the 2000-year ARI event. The flows are summarised in Table 1 and are also illustrated in Figure 1.

Table 1: Catchment flows

ARI	Flow (m3/s)
2	29
5	68
10	108
20	159
50	248
100	334
200	420
500	534
1000	620
2000	706

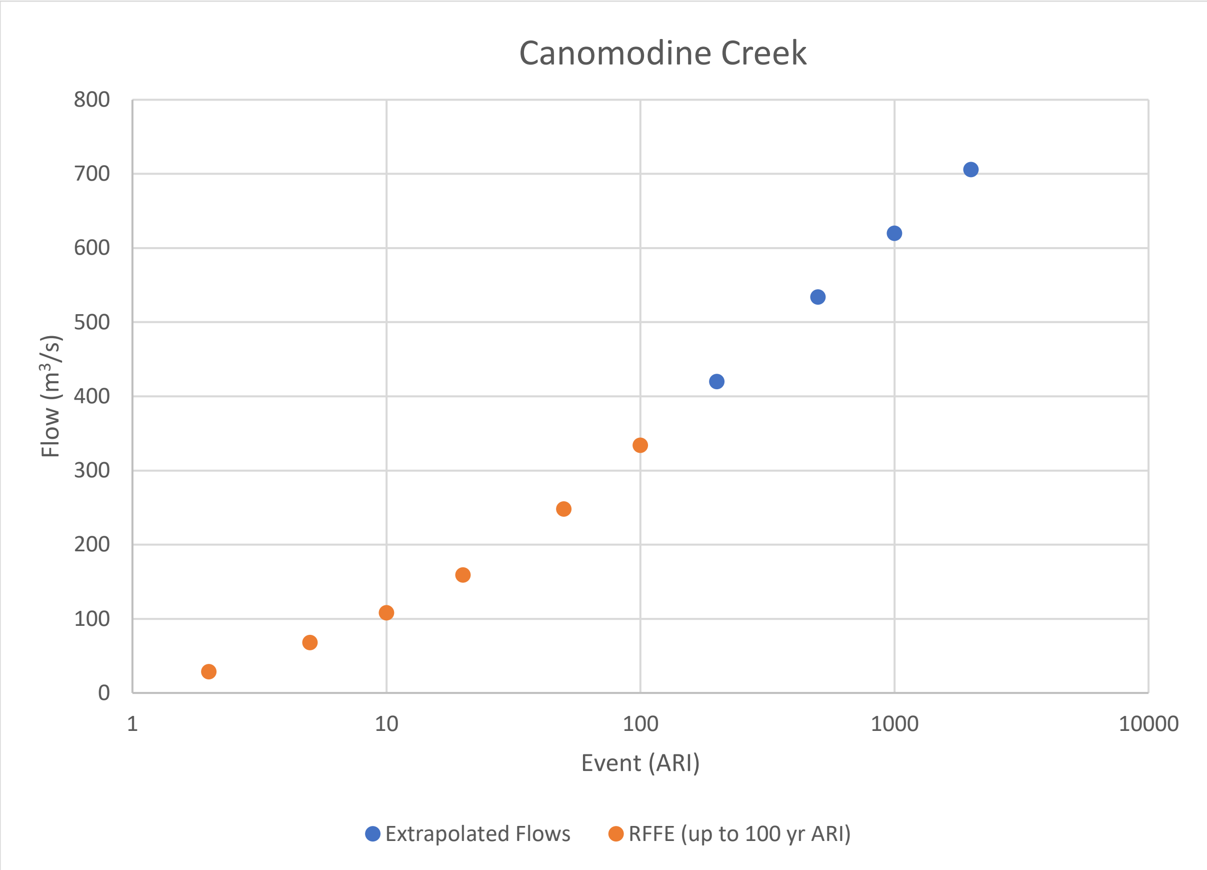


Figure 1: Flows up to 100-year ARI and extrapolated flows up to 2000-year ARI

The terrain data used in this analysis was sourced directly from the survey provided by council in AHD datum.

The bridge was modelled by assuming the following dimensions:

- 4.8m width
- 14.5m single span
- Structural depth of 0.7m

The bridge deck level was modelled at 347.8m (AHD), and the soffit of the superstructure is 347.1m, achieving slightly greater waterway area from the existing bridge.

Manning's n value is utilised in HEC-RAS to define the stream roughness. Manning's n values for the stream have been adopted from the Austroads Guide to Bridge Technology Part 8: Hydraulic Design of Waterway Structures – 2019 (AGBT Part 8), Table A2 as summarised in Table 2.

Table 2: Manning's n values

Location	Description	Value
Main channel	Some weed, light brush on banks.	0.035
Overbanks	Short grass.	0.03

Design Flood Results

The cross-section at the bridge location is shown in Figure 2 which shows the flood levels for the modelled events and the long section of the bridge location is shown in Figure 3.

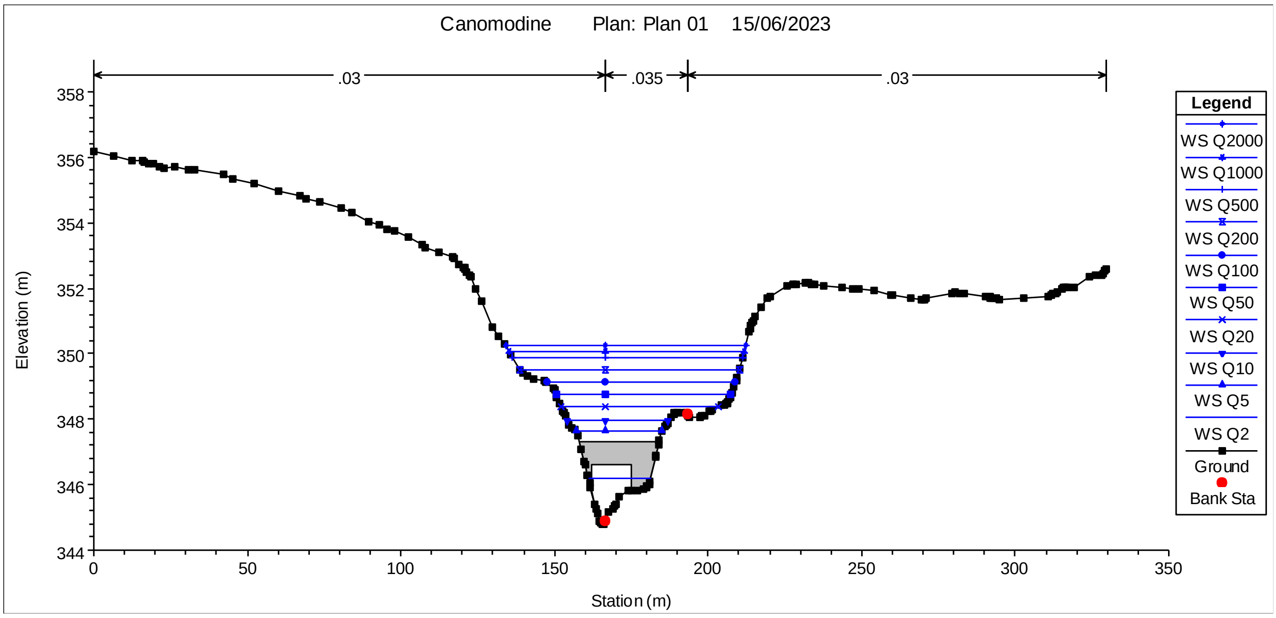


Figure 2: Cross-section showing flood levels

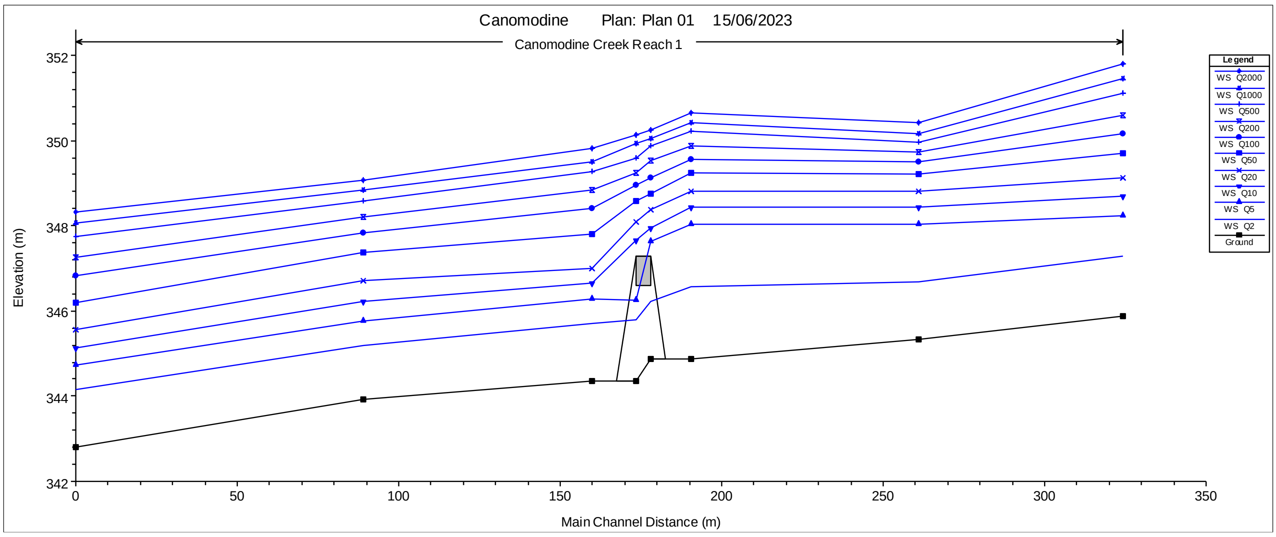


Figure 3: Long section showing flood levels

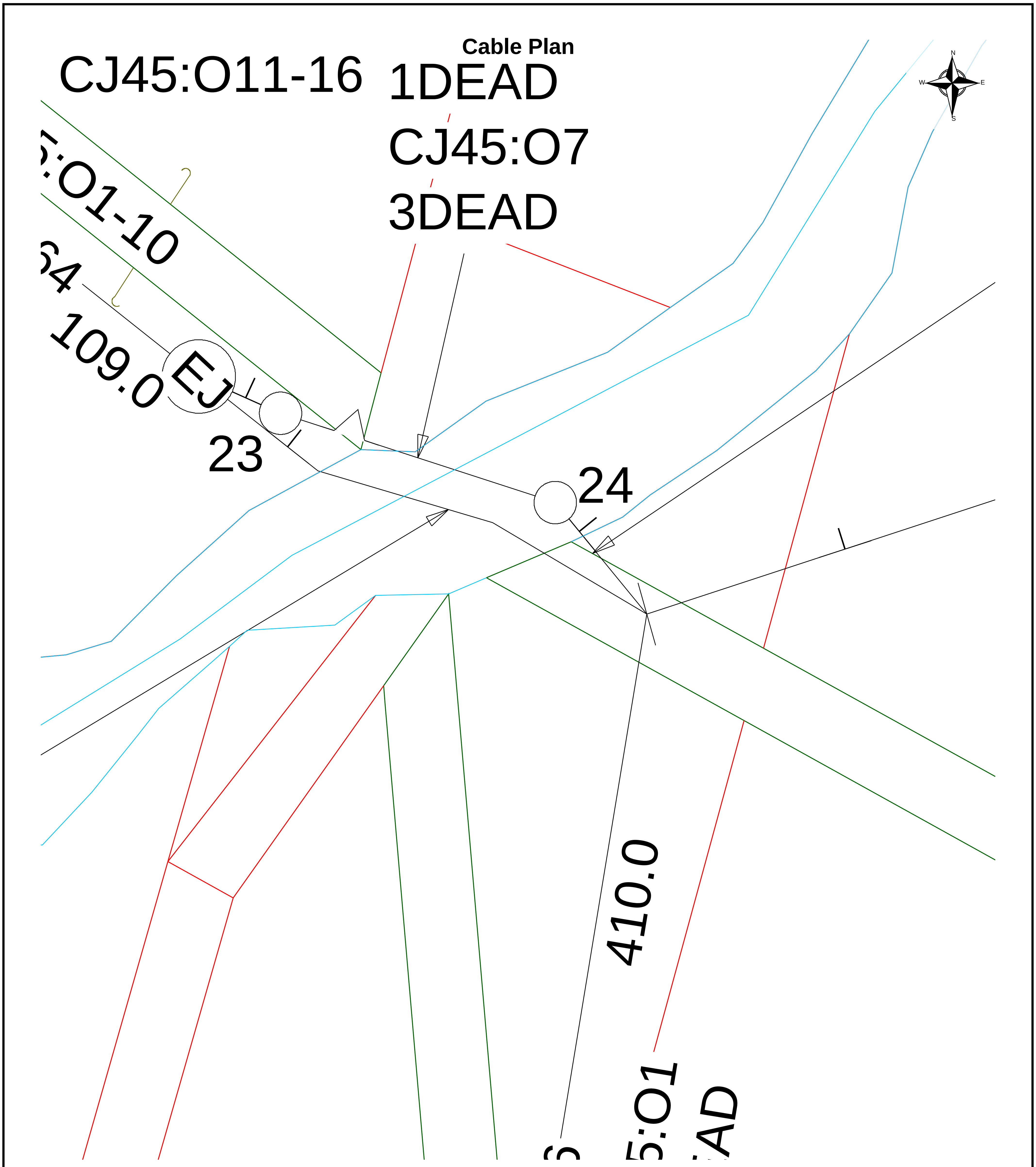
The velocities and flood levels are summarised in Table 3 for the events to be used in the design of the new bridge.

Table 3: Summary of flood assessment results

ARI	Flow (m3/s)	Velocity (m/s)	Flood Level (m AHD)
2	29	2.62	346.0
5	68	2.76	346.9
10	108	3.13	347.8
20	159	3.06	348.2
50	248	3.39	348.7
100	334	3.53	349.0
200	420	3.44	349.4
500	534	3.63	349.7
1000	620	3.86	350.0
2000	706	4.02	350.2

This hydraulic assessment has used a basic 1D HEC-RAS model and non-time-dependent RFFE flows to output velocities and flood levels that are appropriate for calculating flood loads on a bridge for the various ARI flood events. This assessment does not determine the extent of inundation, afflux changes or flood duration. If this information is required a two-dimensional model with time-dependent flows may be more appropriate.

Appendix C
Before You Dig Australia Enquiry Results



	Report Damage: https://service.telstra.com.au/customer/general/forms/report-damage-to-telstra-equipment Ph - 13 22 03 Email - Telstra.Plans@team.telstra.com Planned Services - ph 1800 653 935 (AEST bus hrs only) General Enquiries	Sequence Number: 226223607
TELSTRA LIMITED A.C.N. 086 174 781		Please read Duty of Care prior to any excavating
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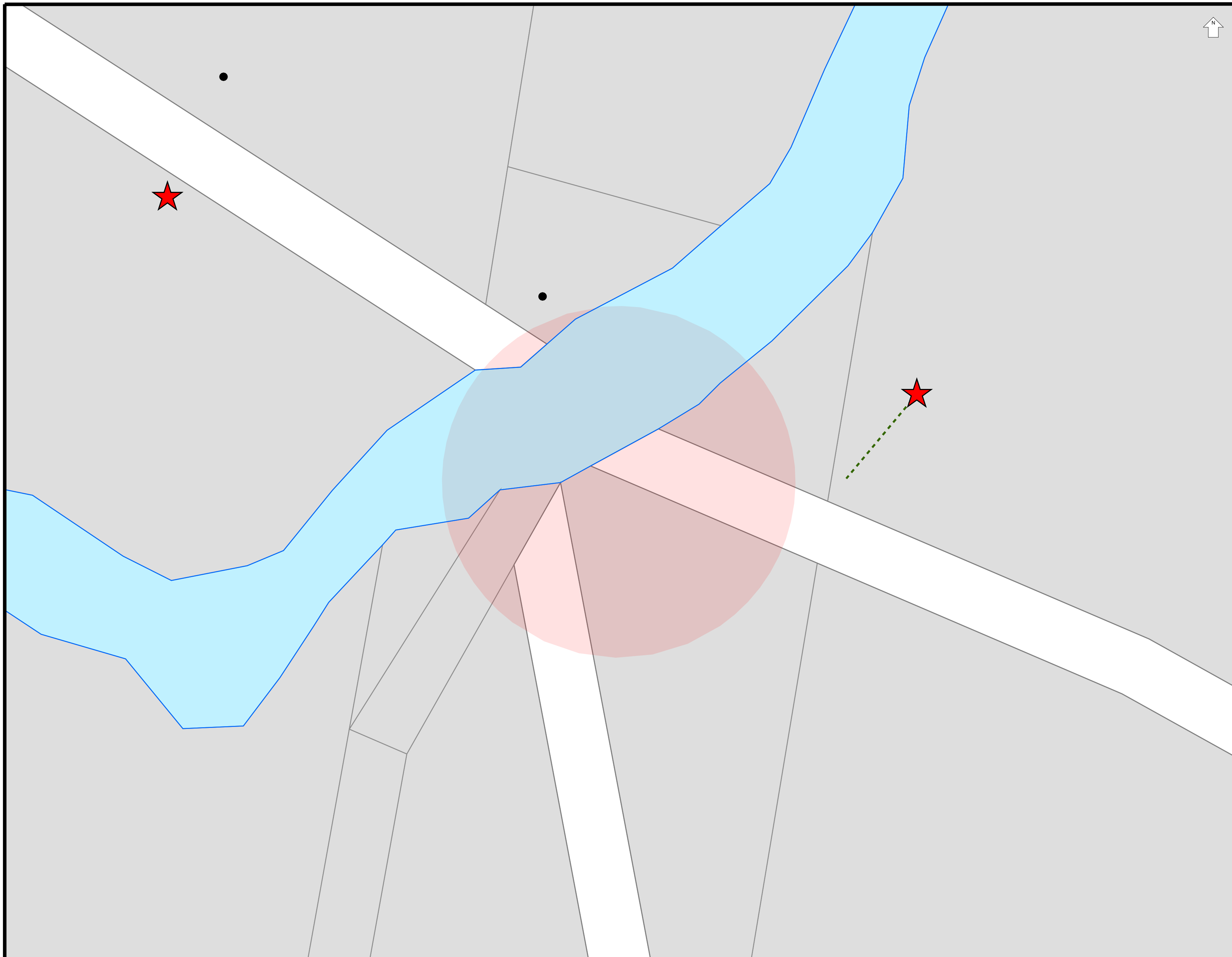
WARNING
Telstra plans and location information conform to Quality Level "D" of the Australian Standard AS 5488-Classification of Subsurface Utility Information.
As such,Telstra supplied location information is indicative only.Spatial accuracy is not applicable to Quality Level D.
Refer to AS 5488 for further details. The exact position of Telstra assets can only be validated by physically exposing it.
Telstra does not warrant or hold out that its plans are accurate and accepts no responsibility for any inaccuracy.
Further on site investigation is required to validate the exact location of Telstra plant prior to commencing construction work.
A Certified Locating Organisation is an essential part of the process to validate the exact location of Telstra assets and to ensure the asset is protected during construction works.

See the Steps- Telstra Duty of Care that was provided in the email response.



Overhead wires not shown
LOOK UP & LIVE!

LEGEND

- LV Underground Cable
- HV Underground Cable
- Underground Pipe
- Underground Earth or Wires
- Ground Substation
- Pole
- Cubicle
- Pit
- Area of Interest

Critical Assets

Contact Essential Energy on 13 23 91

- Zone Substation
- Underground Cable
- Underground Fibre

Proposed Works

- Area of proposed works

Proposed assets are shown as orange symbols

THE INFORMATION ON THIS MAP MAY NOT BE ACCURATE.
If details are incorrect, please notify Essential Energy on 13 23 91 (or fax 1800 354 636)

ISSUE DATE: 23/06/2023

You must resubmit your request if you have not started work within 4 weeks of the 'Issue Date' above

A4 SCALE: 1:1667

Job Number: 34476271 Sequence number: 226223606 Job location: 479 Canomodine Lane, Canowindra Map Centre: 148° 47' 31.5", -33° 30' 28.9"