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Shoalhaven City Council
Attention: My Wayne Brighton
Bridge Road
NOWRA

1014-L-02

24 June 2010

North Nowra Link Road - Route Comparison - Bomaderry Creek Bridge

In our previous report we gave an assessment of the bridge options available for the central route (Option 1) for the North Nowra Link Road. This report is expanded and now includes an examination of the southern (Option 2) and northern (Option 3) routes and a comparison of the bridge requirements for each.

Horizontal Road Alignments

The corridor selected for Option 1 entails a crossing of Bomaderry Creek on a curve of radius approximately 280m. This alignment requires a one way cross fall on the road with a minimum value of 2.0%. For increased safety higher values of cross fall are normally used for this curve radius, and standard highway design uses 7% cross fall. However, given the urban environment 7% cross fall may be uncomfortable for queued traffic and a slightly lower cross fall of 5% has been selected.

The corridor selected for Option 2 entails a crossing of Bomaderry Creek approximately 120m long. The western 40m is curved at a radius of 500m and the remaining 80m are straight. The curve would require a one way cross fall of about 3% transitioning to a two way cross fall on the straight end of the bridge.

The corridor selected for option 3 requires a crossing approximately 75 m long. The western 45m will be straight and the remaining 85m on a 240m radius curve. This curve will require a 5% cross fall as for option 1, transitioning from a two way cross fall at the western end.

The horizontal alignment requirements for each of the options are similar and no alignment has preference on this account.

Vertical Alignments

The approaches to the bridge for option 1 are likely to grade towards the bridge at between 5% and 6%. It was proposed initially that the bridge surface should have an arched profile (over vertical curve) to drain water off the bridge. This required a grade at the ends of the bridge of about –0.8%.

The vertical curve required to join the approaches would be 120m in length. Without an arch in the bridge the centre of the crossing would have an elevation of about 35.1m, 14.1m above the creek bed. A three span arrangement, with spans of 20m, 35m and 20m would give abutments of about 3m height.

Introducing an arch into the bridge considerably increases the height of the bridge. The centre of the bridge increases in height to RL39.4m, 18.4m above the bed, and with the same span arrangement abutment heights increase to 7m. Elevated approaches to the bridge would extend 75m on the western side and 50m on the eastern side of the bridge.

The introduction of an over vertical curve within a sag vertical curve and a horizontal curve would be poor road design. It would be visually uncomfortable for motorists if not uncomfortable in sensation. The raised abutment height would require extensive earthworks or retaining to protect the corridor. The water draining off the bridge would be added to by water draining from the elevated approaches.

The bridge drainage issue is not unique to this site. Drainage from bridges is often captured in underbridge drainage systems. It is understood that, subject to final design, all bridge discharge will have to be treated, and that the low bank areas are not generally sensitive. It is therefore proposed, in accordance with the Soil and Water investigation and recommendations, that either one or both piers should have gross pollutant traps installed at their bases and all drainage be directed to these. If there is the need for further treatment, sand filtration can be addressed by beds adjacent to the pier bases.

For the option 2 crossing western approaches grading down to the bridge at about –2.5% and the eastern approach would be level. The intersection of the approaches is at ch 1484 on the proposed alignment, 37m before the bridge. With street lighting a short vertical curve of 50m would be required, but this would be in the middle of a horizontal curve. A better choice in this case is a vertical curve of 160m, which ends at the tangent of the horizontal curve at ch1544.773m. The bridge level would be about RL 38.30 at its lowest, well above the 100 year flood level of approximately RL 10.

The plateau on the eastern side of the gorge dips down in the last 25m by about 3m. The 30m road reserve will permit battered construction in this area and allow the bridge to be limited to 110m in length.

The approaches for option 3 are about –2% on the west and +6% on the east, requiring a change of grade of 8%. The intersection of the grades is about ch1367. This is located within the horizontal curve beginning at ch 1306 and the combination of these would allow a 120m curve. The low point of this curve would be at RL 33.65m. The 1% flood level of about 31.3m would only provide 2.35m for frreboard and structure depth, but this is achievable.

Bridge Lengths

The overall length required for option 1 is 75m. This will place abutments just clear of the top of the gorge, and allow room beneath the eastern abutment for fauna movement and retention of the footpath system operating there.

The overall length required for option 2 is 120m. This also allows for abutments to be set back slightly from the top of the gorge on the western side. The crossing is at a skew of about 15 degrees to the stream and tops of banks and the bridge would best be constructed with abutments and piers skewed at this same angle.

Where option 3 crosses the creek the valley it is a broader shape with a relief of about 5m at the creek. Assuming an economical abutment height of about two metres, the bridge at this crossing would not need to be longer than 75m, which will also locate the abutments at about the 1% flood level.

Bridge Structures

The central and southern options require medium length spans to minimise the environmental impact of the structures. At the both these crossings the gorge is deep and steep sided and the only practical configuration is construction of piers in the base of the gorge on either side of the creek.

Option 1 requires a central 35m span to cross the creek clearly. Two 20m end spans would make up the total 75m length. The unequal spans give a more open centre portion of the span and will keep the bottom of the gorge clear of structure. The longer central span will have a small cost penalty, but would not require a change to the type of construction.

For this span typical construction is precast super tee beams. There may be crane issues, but the alternatives of insitu construction or launched construction are not feasible. Insitu construction would require extensive and expensive falsework 15m above the creek that would have to address environmental constraints. Self launched construction is not economic for this comparatively short bridge and the area required for a casting bed would probably not be available within the corridor. The curved bridge edge can be achieved by varying the flange width of the outer beams.

We have carried out preliminary design of the main span for this option and confirmed the feasibility of using 7x1500 deep super tee beams. This may be improved on by more refined design, and by detailed study of crane requirements and other issues.

A concept drawing for this option as well as the other options, is attached in appendix A.

Option 2 would require spans of up to 45m. This is at the upper limit of super tee construction and without access truck access to the base of the gorge the long and heavy beams may present erection difficulties. The only acceptable and practical method of erection may be by gantry.

We have carried out preliminary design of the main span for this option and confirmed the feasibility of using 8x1800 deep super tee beams. As for option 1, this may be improved on, subject to detailed study of crane requirements and other issues that may affect the final design.

Piers for this option are very tall, with pier 2 reaching 26m above ground level. Although not technically difficult to build the extent of scaffolding required would be extensive and the costs significantly higher than normal.

At the northern crossing shorter spans could be used and both three and five span alternatives are feasible. There is no particular length requirement for the central span, but a slightly longer central span may be considered for both three and five span alternatives.

The three span alternative would again be a super tee type of construction, and at present is suggested as three equal spans of super tee girders 1200 deep. The overall depth of this structure would be about 1.5m, which would meet the flood clearance required.

The five span alternative would allow the use of spaced plank construction, with approximately 500 deep beams at 1.2m centres. A longer 20m central span could be built with 600 deep girders. The plank beams, which are 600 wide rectangular shaped beams are inexpensive compared to the super tee beams.

Where schemes involve shorter end spans they would not require beams of the same depth as the centre span. In the case of option 1 the clearance near the abutments would be reduced to about 1.3m affecting fauna movement, and similar considerations apply to the other options. It is therefore proposed to use shallower, beams for option 2 end spans.

Other Considerations

Council has advised that the visual impact of the structure is of very high importance. In consideration of this some architectural treatment if piers and abutments in shape and possibly texturing may be desirable. Pier shapes for options 1 and 2 have been drawn to indicate this consideration, but the low piers of option 3 give little chance of this and are shown as basic column and trestle type piers.

The change in deck depth at the piers will detract from the appearance of the bridge. This may be accepted in consideration of the environmental and economic benefit, or may be addressed with cosmetic treatment, such as introducing tapered skirting along part of the end spans.

The depth of fill in the approaches for all options entails a reasonable risk of settlement and suggests the use of the longer, 6m approach slabs at each end of the bridge.

Extensive exposed areas of sandstone indicate the use of spread footing structures for the bridges. Depending on accessability these may have to be prepared using hand equipment. The use of bored foundations is not considered necessary or feasible at this stage. Abumtents will most likely be cast insitu concrete gravity walls. Pier structures are about 8m high and will be cast insitu.

A picnic ground is located to the southeast of the proposed bridge for option 1. It will be possible to design and construct a stepped foot access from the ground level enabling foot traffic access to the pedestrian walkway on the bridge for public benefit if this is ultimately considered a desirable feature. Where the proposed road / bridge will sever the walking trail at the east side of the creek, the clearance under the bridge will allow convenient redirection of the walking trail (which it is envisaged will be undertaken by Council).

Anticipated traffic volumes indicate the need for regular protection level barriers. High bicycle volumes in urban areas will require 1.3m barriers at the edges of the bridge and a matching 1.3m barrier between the traffic and the walkway has been shown. This could be reduced in height to 1.0m to reduce the sense of confinement in the walkway and provide viewing opportunities.

Comparative costing

The benchmark cost for super tee construction at around 30m spans is approximately $3,250 per square metre, although restrictions on erection may make this project more expensive. Taking this as indicating a cost for option 1 of $3.7 million gives the following approximate construction costs:

Option no	Location	Total length	Construction details	Rate/m²	Cost
1	Central route	75m	20/35/20m long, super tee 1500 deep	$3,250	$3.7 million
2	Southern route	120m	37.5/45/37.5m long, 1800 deep super tee	$4,100	$7.4 million
3	Northern route, alternative 1	75m	22.5m/30m/22.5m	$3,200	$3.6 million
3	Northern route, alternative 2	75m	14/14/20/14/14m spaced plank	$2,800	$3.2 million

It is emphasized that these figures are approximate construction cost only, and may change significantly once all environmental constraints are considered. The difference between schemes is probably accurate within 20%, although the costs of option 2 may be higher still if the constraints of the site severely affect construction.

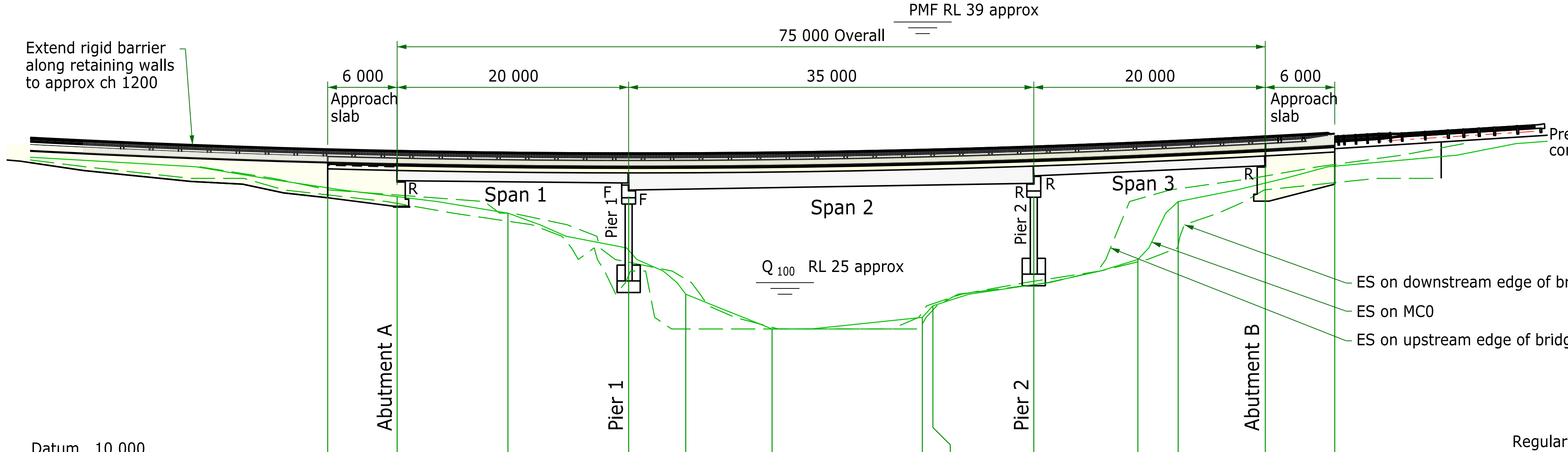
Yours faithfully

Jim Alexander

APPENDIX A

PROPOSAL DRAWINGS

1012-DSK01	PROPOSED GENERAL ARRANGEMENT - OPTION 1 – CENTRAL ROUTE
1012-DSK02	PROPOSED GENERAL ARRANGEMENT - OPTION 2 – SOUTHERN ROUTE – SHEET A
1012-DSK03	PROPOSED GENERAL ARRANGEMENT - OPTION 2 – SOUTHERN ROUTE – SHEET B
1012-DSK04	PROPOSED GENERAL ARRANGEMENT - OPTION 3 – NORTHEN ROUTE – ALTERNATIVE 2



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Chainage on Control line MC0	1218.971	1224.971	1234.5	1244.971	1249.9	1257.3	1270.3	1271.3	1279.971	1288.9	1292.4	1299.971	1305.971

DEVELOPED ELEVATION
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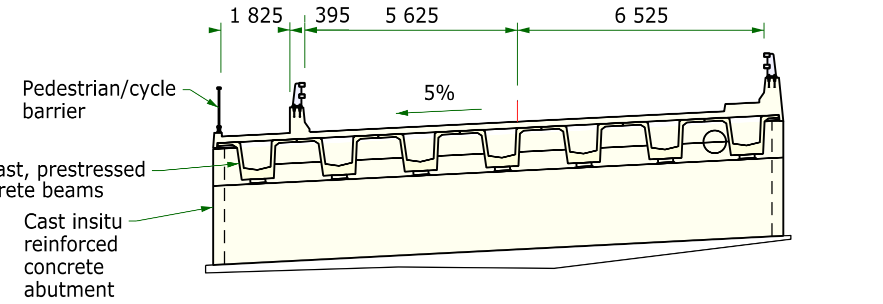

SECTION 1
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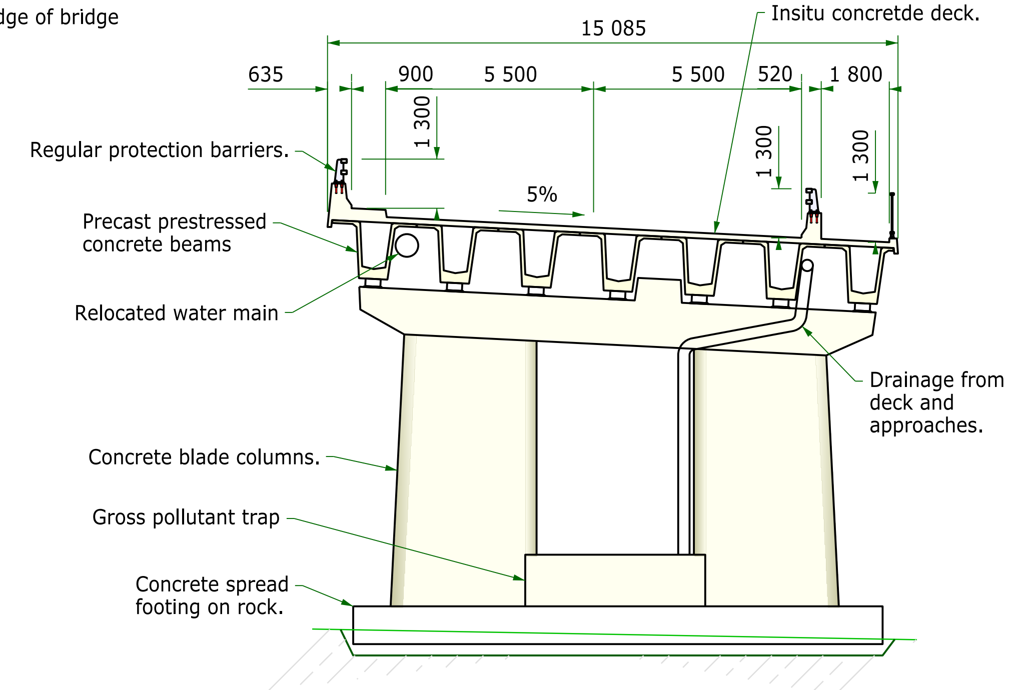
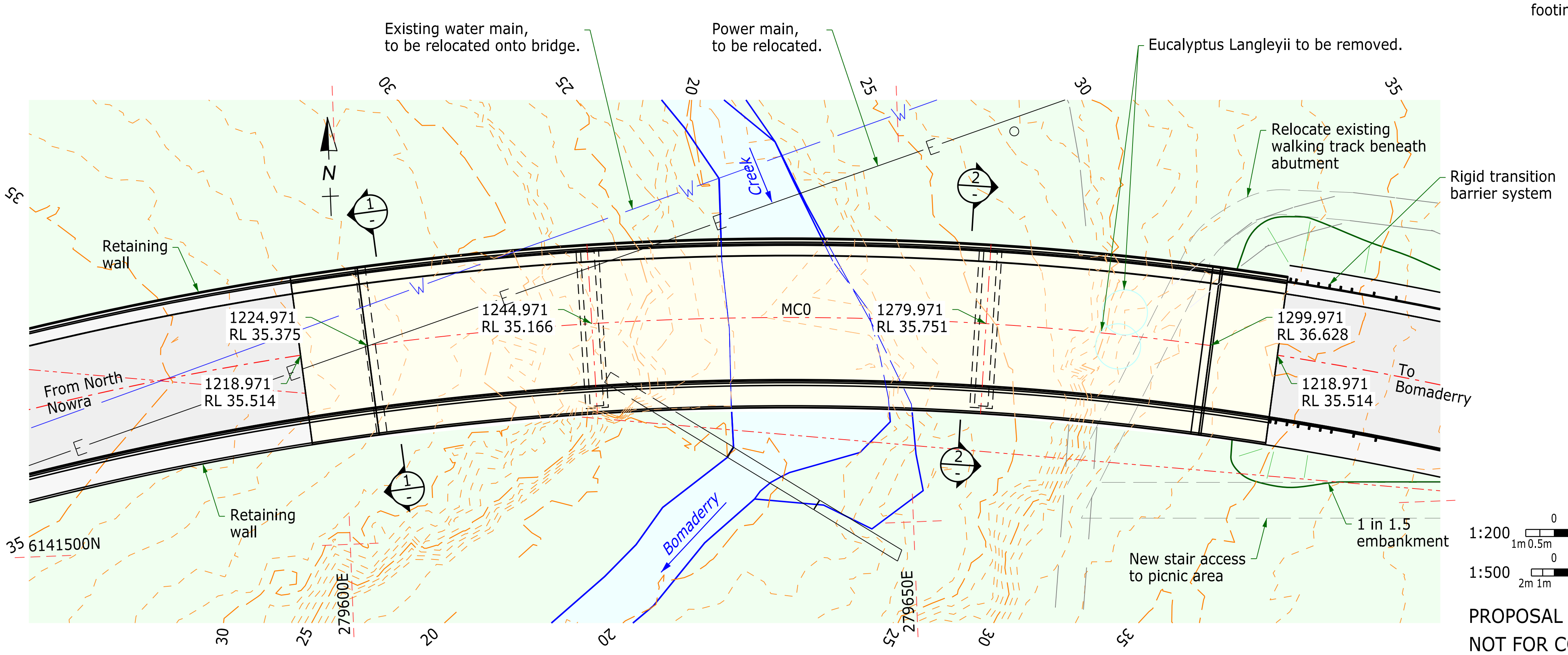


SECTION 2
1:200

General Notes
Dimensions in millimetres.
Chainages and reduced levels in metres.
Reduced levels are to AHD.
ES denotes existin surface.
F denotes fixed bearing.
R denotes restrained bearing.



PLAN
1:500

1:200 0 1m 2m 3m 4m 5m 1m 0.5m
1:500 0 2.5m 5m 7.5m 10m 12.5m 2m 1m

PROPOSAL DRAWING
NOT FOR CONSTRUCTION

DRAWING SCALES TRUE AT A3

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DESIGN:	JRA	-
DRAWING:	BNC	-

MANAGER
JIM ALEXANDER BRIDGE DESIGN

City of Shoalhaven North Nowra- Bomaderry Link Road
BRIDGE OVER BOMADERRY CREEK

PROPOSED GENERAL ARRANGEMENT
OPTION 1 - CENTRAL ROUTE

JOB NUMBER	DOCUMENT NUMBER		REVISION
1014	DSK01	SHEET 1 OF 1	A1

100mm on original
200mm on original

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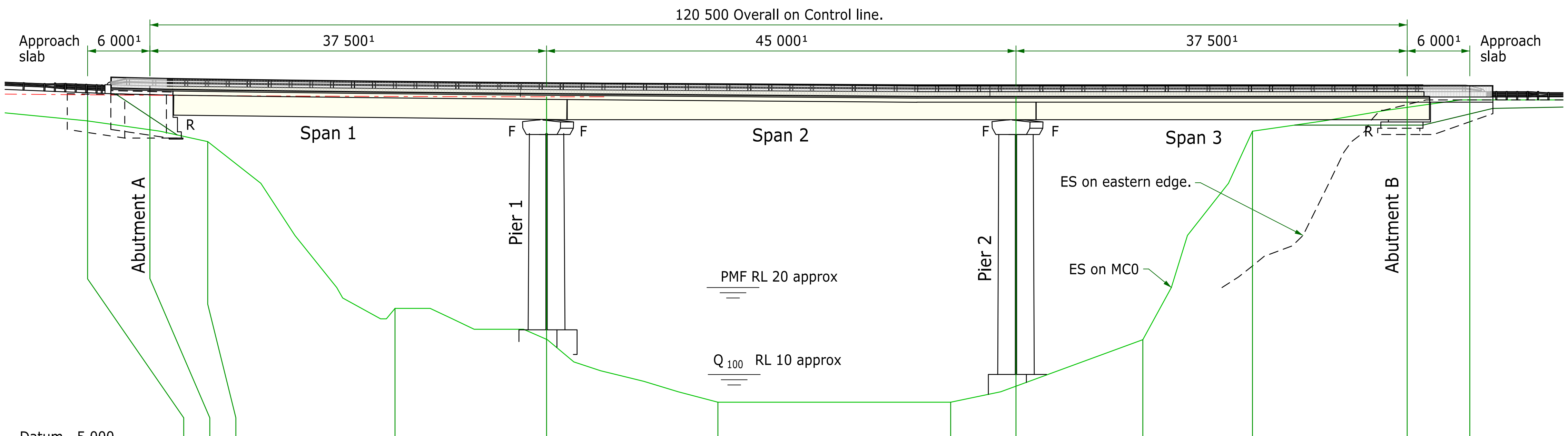

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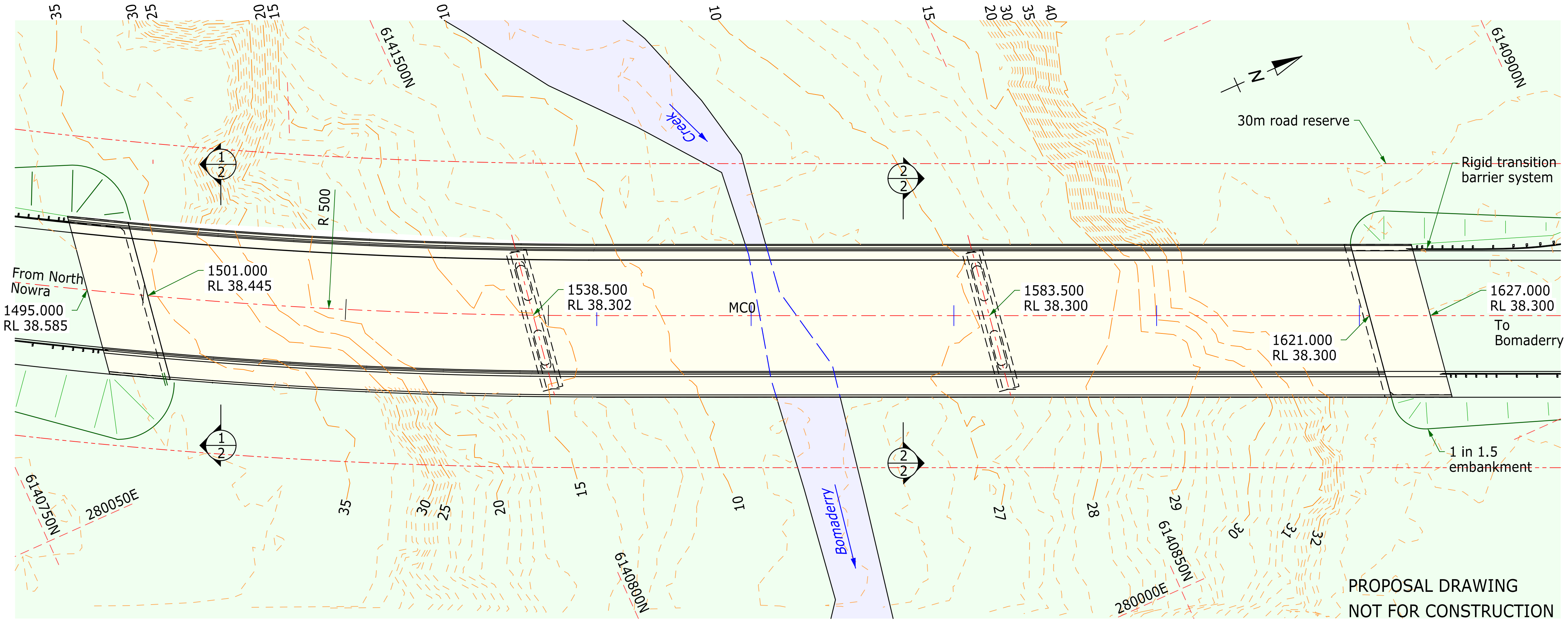
DEVELOPED ELEVATION
1:500



PLAN
1:500

1:500 0 2.5m 5m 7.5m 10m 12.5m 2m 1m

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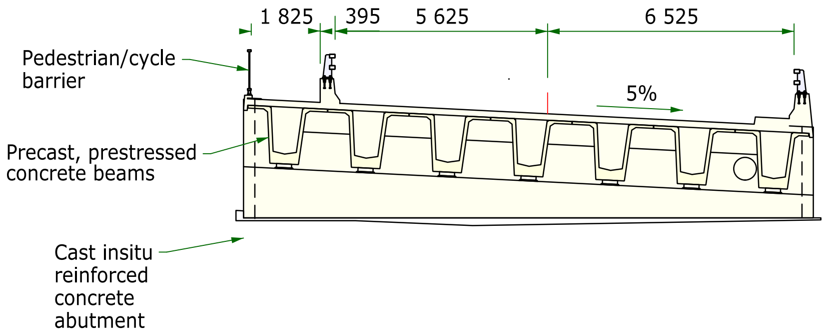
PROPOSED GENERAL ARRANGEMENT
OPTION 2 - SOUTHERN ROUTE SHEET A

JOB NUMBER	DOCUMENT NUMBER		REVISION
1014	DSK02	SHEET 1 OF 2	A1



SECTION 1/1
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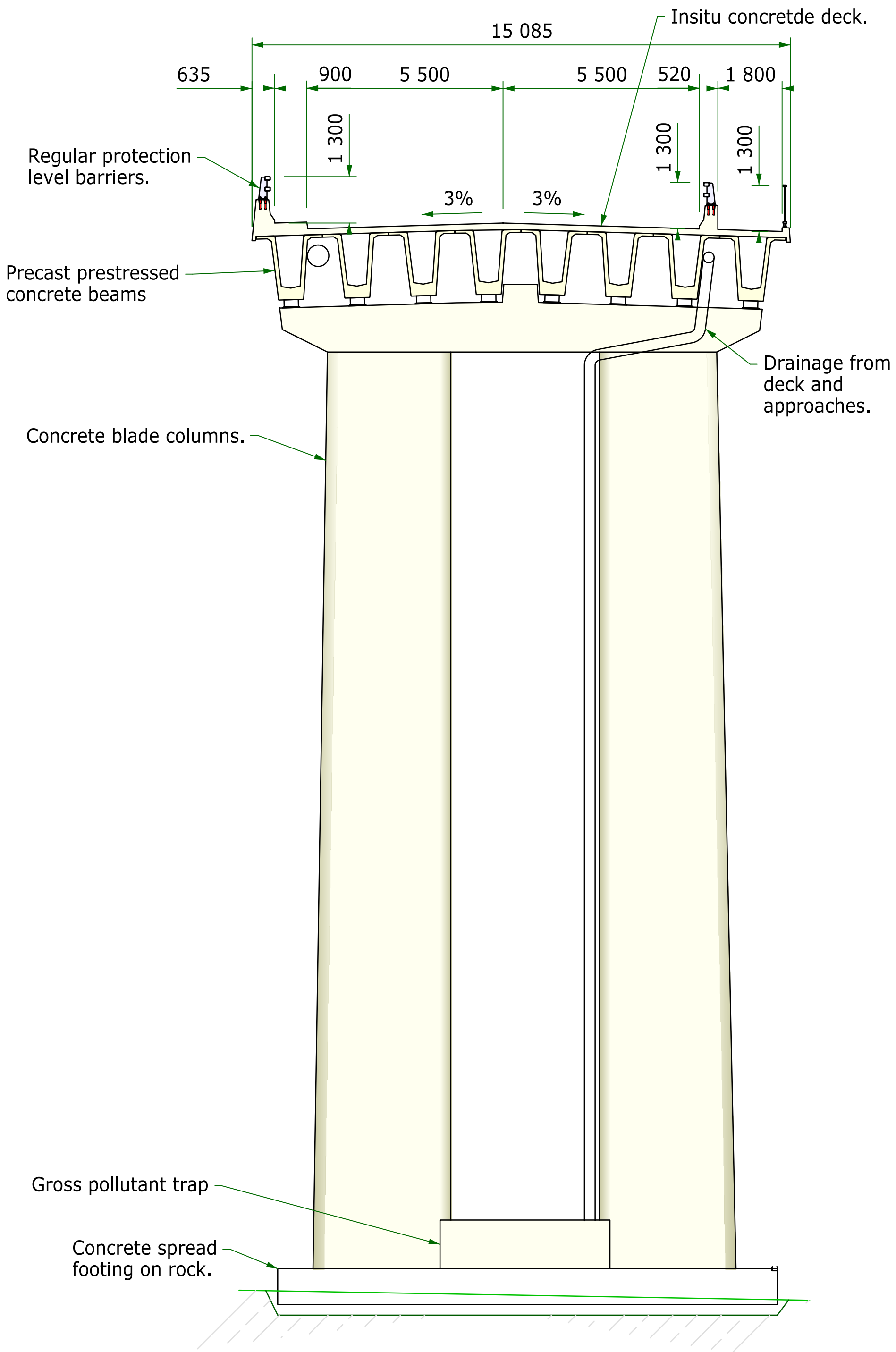

SECTION 2/1
1:200

General Notes

Dimensions in millimetres.
Chainages and reduced levels in metres.
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ES denotes existin surface.
F denotes fixed bearing.
R denotes restrained bearing.

1:200 — 0 1m 2m 3m 4m 5m — 1m 0.5m

PROPOSAL DRAWING
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Environment - Growth - Community

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City of Shoalhaven — North Nowra- Bomaderry Link Road

BRIDGE OVER BOMADERRY CREEK

PROPOSED GENERAL ARRANGEMENT
OPTION 2 - SOUTHERN ROUTE - SHEET B

JOB NUMBER	DOCUMENT NUMBER		REVISION
1014	DSK03	SHEET 2 OF 2	A1

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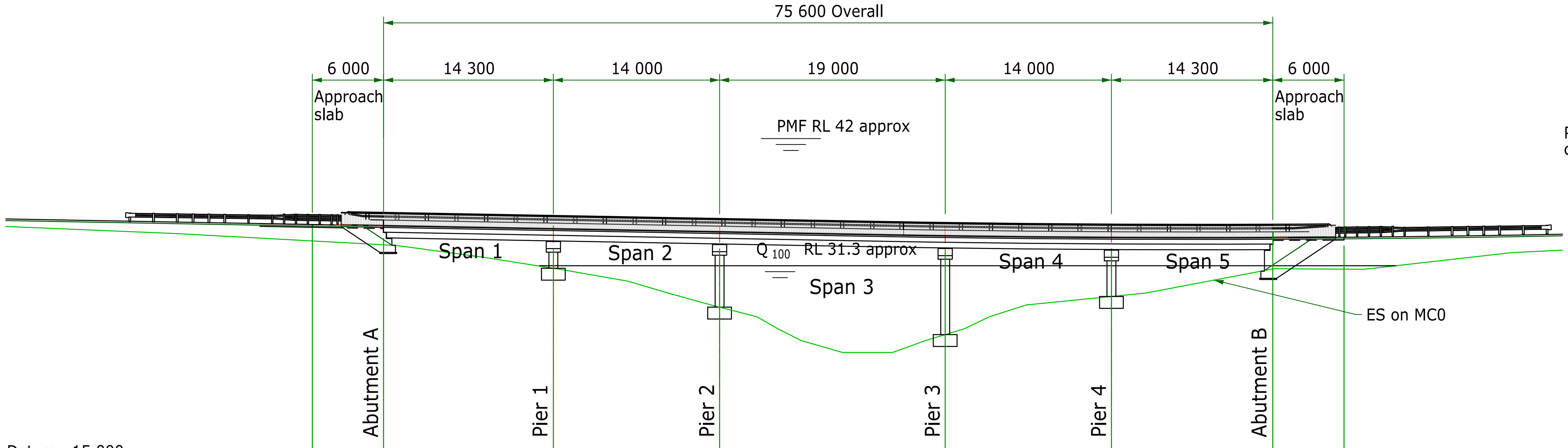

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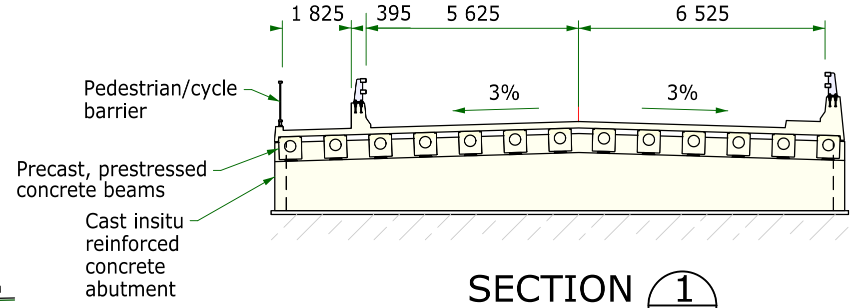
Existing surface on Control line MC0	33.4	33.1	31.1	27.8	25.5	28.7	31.0	31.0
Chainage on Control line MC0	1258.969	1264.969	1279.269	1293.269	1312.269	1326.269	1340.569	1346.569

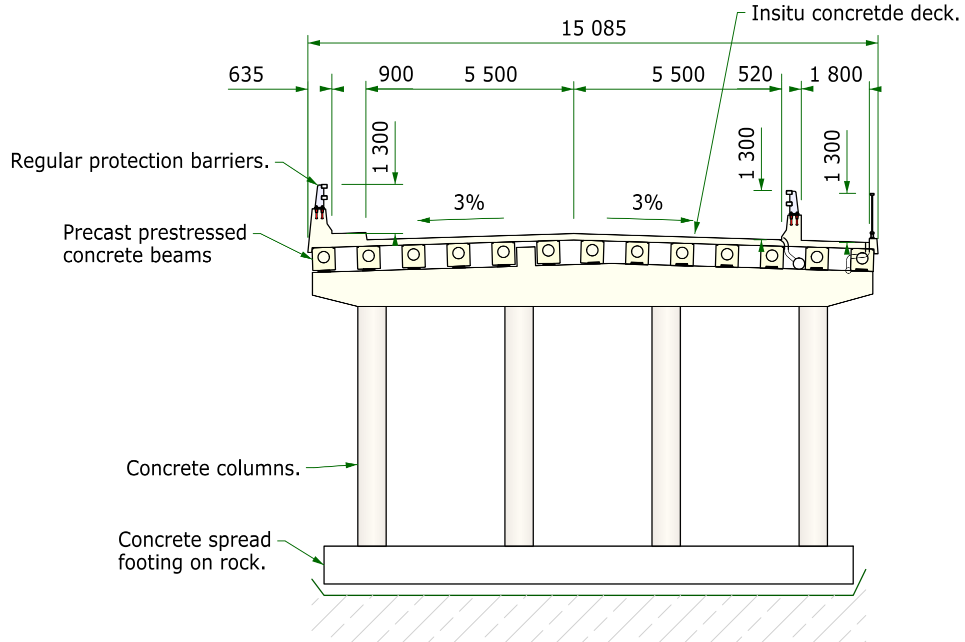
DEVELOPED ELEVATION

1:500



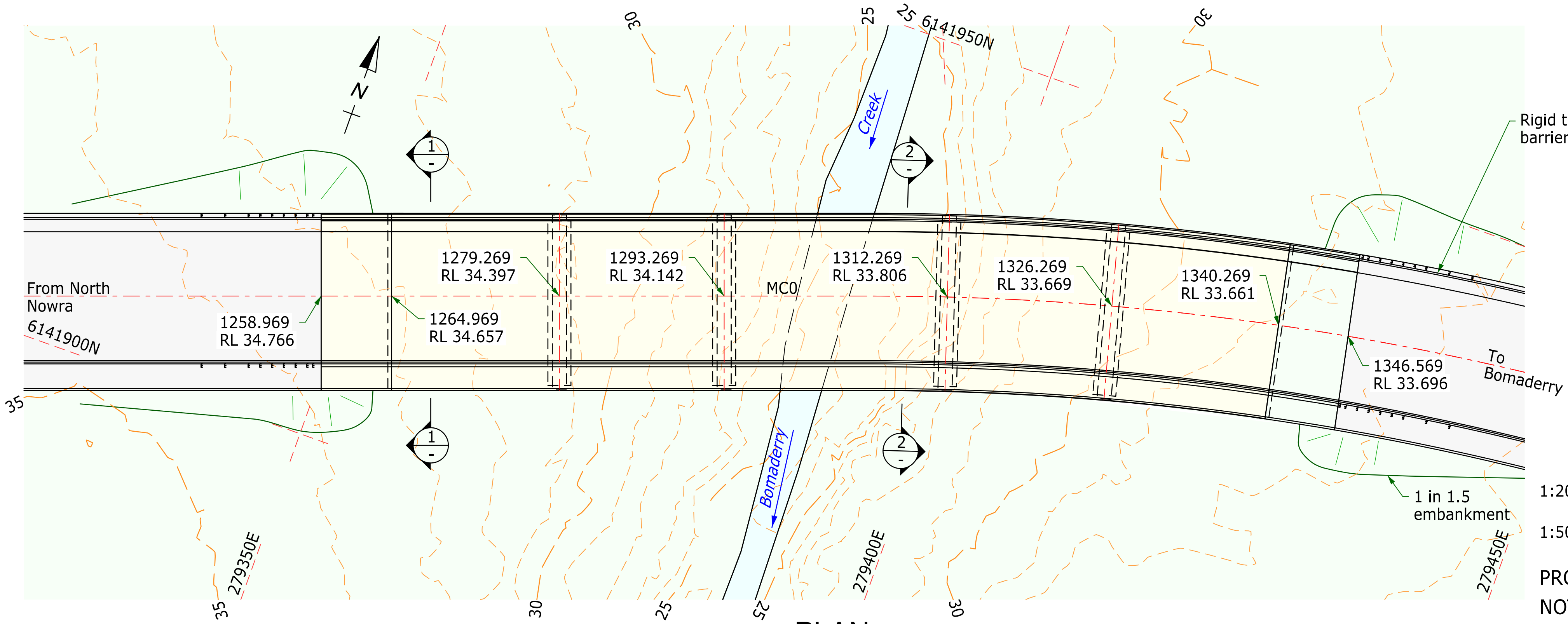
SECTION 1

1:200



SECTION 2

1:200



PLAN

1:500

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1:200 0 1m 2m 3m 4m 5m 1m 0.5m

1:500 0 2.5m 5m 7.5m 10m 12.5m 2m 1m

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DRAWING:	JAA	-

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PROPOSED GENERAL ARRANGEMENT
OPTION 3 - NORTHERN ROUTE - ALTERNATIVE 2

JOB NUMBER	DOCUMENT NUMBER		REVISION
1014	DSK04	SHEET 1 OF 1	A1