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NORTH HYKEHAM RELIEF ROAD
INITIAL SCOUR ASSESSMENT AND OPTIONEERING

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CONTENTS

1. INTRODUCTION

1.1 Background

The following technical note sets out the initial optioneering for managing the risk of scour to the of the proposed River Witham bridge, and the associated Environment Agency flood defence infrastructure. The optioneering is based on the currently available information relating to the viaduct design and pier arrangement, hydraulic modelling results and estimated flow velocities along with local ground and wider catchment conditions.

Whilst this Technical Note sets out an options appraisal and identifies an initial preferred option, it should be noted that the this is intended to inform design team and stakeholder consultation, and all conclusions should be regarded as provisional.

1.2 Report Objectives

It is proposed to develop the scour assessment over two stages. The initial stage (described in this report) will undertake a qualitative assessment of the likely scour that could be caused by the introduction of the Proposed Scheme and identify options to mitigate their impacts. The second stage will undertake a full and detailed assessment of scour, including scour depth calculations, and develop a preferred option.

The objectives of this initial stage are as follows:

- Undertake a review of the local conditions, including hydrology, ground conditions and topography;
- Review the extent and location of all abutment, piers and embankment associated with the Proposed Scheme, and their proximity to local Environment Agency Flood Defence Assets;
- Undertake a high-level assessment of scour, identifying parts of the proposed scheme and Environment Agency defences that could be susceptible to scour and/or erosion; and
- Identify options that could mitigate the impact of the Proposed Scheme on scour, and develop a preferred option to initial concept.

The report is concerned with scour occurring to a) existing Environment Agency assets and b) the proposed structure. As both these elements are located within the proximity of the proposed viaduct over the River Witham, the 'Study Area' refers to this specific location and the immediately adjoining area. This is to say that the report does not cover the whole route, just that adjacent to the proposed viaduct and the Witham.

1.3 Proposed Scheme

The scheme consists of the construction of an approximately 8km stretch of 120 kph Dual All-Purpose 2 Lane Carriageway between the A46 Hykeham Roundabout and the A15 Sleaford Roundabout at the west end of the Lincoln Eastern Bypass (LEB). The route also includes a segregated footway/cycleway at all new sections of the road and connections will be provided to existing footways.

The new road will pass around to the south side of South Hykeham and through Station Road near Waddington, before passing north around RAF Waddington. The proposed scheme alignment can be seen on the General Arrangement Plan, included in Appendix A.

It is understood the proposed NHRR will consist of a formed earth embankment for the majority of its route. The exception to this will be where the route crosses a watercourse. For the River Witham crossing, an approximately 90m clear span viaduct is proposed, which will be supported by two sets of 4no. bridge piers to provide support to the deck. The location of the piers is included on the Proposed Bridge General Arrangement, included in Appendix B.

1.4 Consultation

To provide guidance to the scour assessment elements of the project, regular consultation has been undertaken with the Environment Agency. The consultation has been used in the initial project stages to determine the following:

- The Environment Agency assets in need of assessment, and protection (as required);
- A suitable design storm and scenario for assessing scour; and

- Information regarding the existing condition of local Environment Agency assets.

The consultation took the form of several workshops, and email discussions; specific points relating to the consultation undertaken are referenced to as required throughout the report.

2. LOCAL CONDITIONS

2.1 Site Topography

The topography of the site and surrounding area has been analysed using the Environment Agency's 2 m Digital Terrain Model (DTM) LiDAR dataset (Figure 2.1). The lowest elevation is through the River Witham channel at approximately 2 m above ordnance datum (AOD), and the highest elevation along the Lincoln Cliff Escarpment through the east of the Proposed Scheme at approximately 75 m AOD. Elevations to the west of the Proposed Scheme are approximately 12 m AOD. There is no significant north-south gradient relative to the Proposed Scheme. The lowest elevation is where the Proposed Scheme crosses the River Witham.

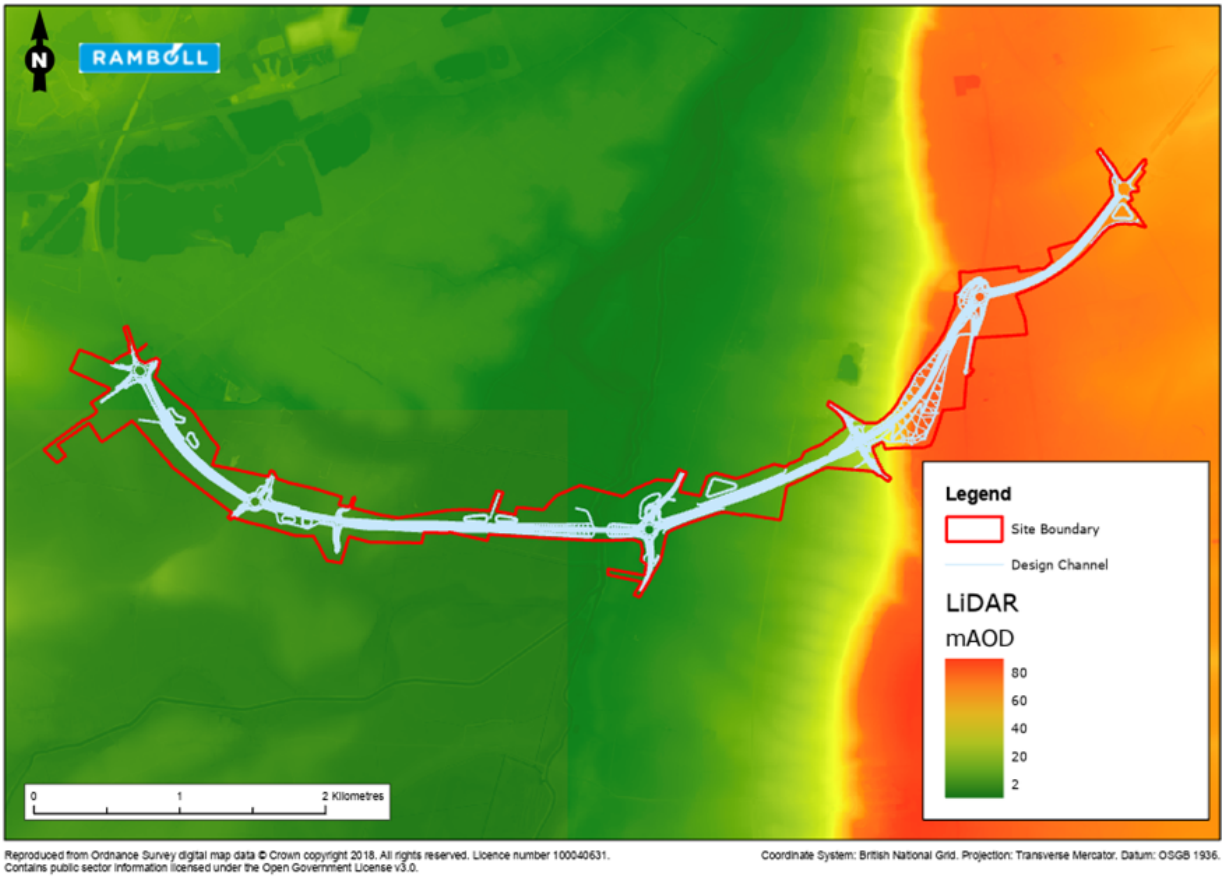

Figure 2.1 LIDAR Composite DTM 2022 - 2m

2.2 Geological Setting

British Geological Society (BGS) mapping of the area (1:50,000 scale map series) was accessed via the online BGS Onshore GeoIndex digital mapping database[1]. The map indicates that most of the site is not underlain by superficial deposits; however, some superficial deposits are present within localised areas. These consist of Alluvium (Silt, Sand and Gravel) adjacent to the River Witham perpendicular to the Proposed Scheme alignment, and a localised area of the Balderton Sand and Gravel Member (Sand and Gravel) in South Hykeham along the north of the site boundary.

Bedrock is broadly mudstone west of the Lincoln Cliff escarpment. These units are the Scunthorpe Mudstone Formation, Charmouth Mudstone Formation, and Whitby Mudstone Formation. The Grantham Formation and Northampton Sand Formation (Undifferentiated), which is a narrow band of sandstone and ironstone east of Waddington, is also present. East of Waddington and through the escarpment is primarily limestone, consisting of the Lower Lincolnshire Limestone Member and the Upper Lincolnshire Limestone member.

[1] The British Geological Survey (BGS) Onshore GeoIndex, available at: http://mapapps2.bgs.ac.uk/geoindex/home.html (accessed 06/2023)

2.3 Ground Investigation Review

An intrusive investigation was undertaken by Coffey Geotechnics Limited along the Proposed Scheme to provide information on ground conditions for geotechnical and land contamination assessments. This was started in November 2022 and ran until February 2023. The Ground conditions have been assessed based on a review of this information, and are summarised in Table 2.1 below.

Table 2.1: Summary of Underlying Ground Conditions

Description	Depth to Base of Strata (m bgl)
Soft dark brown slightly gravelly slightly sandy silty CLAY / gravelly silty fine to coarse SAND with rare to frequent rootlets. Gravel is recorded as flint, limestone, mudstone, or sandstone.	0.10 – 0.80
Balderton Sand and Gravel Member - Brown mottled orangish brown slightly gravelly clayey fine to coarse SAND / orangish brown mottled grey gravelly sandy CLAY. Gravel of sub-angular to sub-rounded flint.	1.20 – 1.30
Alluvium - Very soft to soft grey and brown grey slightly silty CLAY with occasional peat.	1.70 – 4.00
Lincolnshire Limestone Member - Very strong grey to yellowish cream LIMESTONE.	8.50

The underlying geology indicates the presence of generally erodible upper layers, with both topsoil and superficial deposits being typically unconsolidated or hardened material; both of which can be susceptible to scour. The bedrock in contrast is limestone, which is known to generally have good resistance to erosion and scour, however given the depth of this layer it is unlikely to be exposed at surface level.

2.4 Hydrological Setting

The Proposed Scheme crosses the River Witham, a main river located approximately at the mid-point of the Proposed Scheme, flowing in a south-north direction. No other main rivers are crossed by the scheme. The River Brant, also a main river, joins the River Witham approximately 300 m south (upstream).

A main river known as 'The Beck' in Ordnance Survey (OS) mapping is situated approximately 100 m north (downstream) of the Proposed Scheme and flows in a west to east direction to also join with the River Witham. The Beck receives drainage from several IDB drains in the area. The Beck is only classified as a main river by the Environment Agency mapping in its final 900 m reach before entering the River Witham. A sluice gate on the River Witham for flood control is situated approximately 100 m south (upstream) of the Proposed Scheme alignment.

Several drainage watercourses are present throughout the agricultural landscape and are also crossed by the Proposed Scheme. These flow to the River Witham. These drains are part of the Upper Witham Internal Drainage Board (IDB) network. The Upper Witham IDB manages the drainage network within this floodplain, which is largely flat. Part of the IDB network around the scheme flows to an IDB pumping station, which lifts water from the network and into the River Witham.

2.5 Flood Defences

Flood defences are present adjacent to the Environment Agency main rivers described above. The River Witham is flanked by raised embankments that extend along the banks for several kilometres north and south of the site. According to the Environment Agency's AIMS Spatial Flood Defences data[2] the effective crest level of these defences downstream of the sluice gate, and up to 500 m downstream of the proposed alignment, ranges between approximately 6.5 – 7.0 m AOD, and have a design standard

[2] Defra Data Services Platform, AIMS Spatial Flood Defences (inc. standardised attributes), available at: https://environment.data.gov.uk/dataset/8e5be50f-d465-11e4-ba9a-f0def148f590 (accessed 06/2023)

of protection of 75 years. The condition of the embankments was rated '3' (Fair - Defects that could reduce performance of the asset) as of the most recent Environment Agency inspection in March 2021. Tributary main rivers in the River Witham floodplain, close to the proposed NHRR crossing, including The Beck and the River Brant, are also flanked by raised embankments.

A raised defence (River Witham Washland Defence) running perpendicular to the River Witham is present on the western floodplain. This creates the Flood Storage Area (FSA) to the south which is designed to mitigate flooding within the catchment during events up to and including the 1% AEP fluvial flood. The embankment is designed to withstand overtopping, and also features a concrete capping beam. The FSA has sufficient volume for it to be classified under the Reservoirs Act. It has a maximum water depth (when full) of approximately 1.5 m. The condition of the embankment was rated '3' (Fair - Defects that could reduce performance of the asset) as of the most recent Environment Agency inspection in March 2021.

There is a control structure on the River Witham adjacent to the perpendicular defence. If Lincoln is expected to flood and the sluice gate is raised, the side gates are opened to allow water to flood into the FSA.

Elsewhere, the river embankments were raised in the early 1990s. They are subject to vegetation growth and burrowing animals which may have reduced their ability to withstand a breach and/or erosion.

The Environment Agency's flood defence assets and the FSA are presented in Figure 2.2.

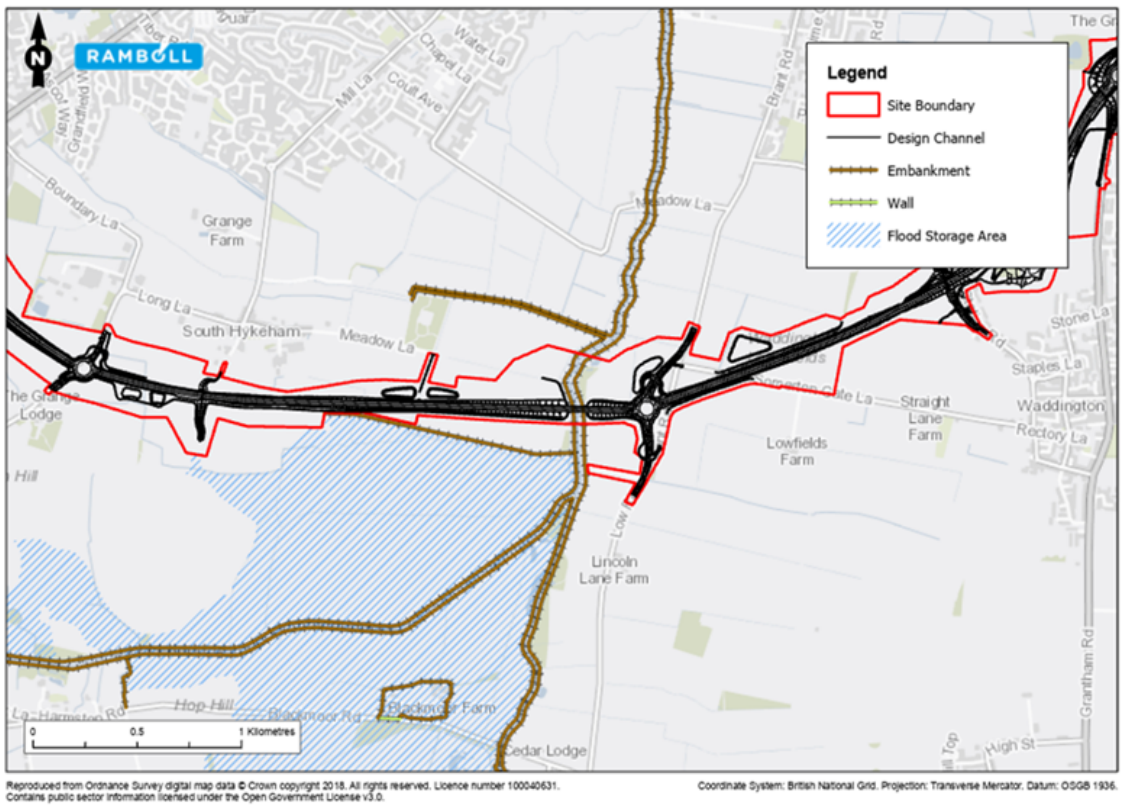

Figure 2.2 Flood Defences and Flood Storage Areas

2.6 Hydraulic Modelling

To support this assessment of scour, hydraulic modelling of the River Witham has been completed to establish the peak flow velocities, which in turn can be used to make an assessment of the likelihood of scour. The hydraulic model (NHRR Hydraulic Model (Witham_NHRR_~e1~_~s1~_050.tcf) utilises 1D-2D ESTRY-TUFLOW software and simulated 1 in 100 year (1% AEP) and 1 in 1,000 year (0.1% AEP) events, both with and without an appropriate allowance for climate change, following the latest

Government Guidance[3]. The model also simulates breaches of the River Witham and FSA embankments; during consultation discussions with the Environment Agency, it was agreed that the storm event/scenario of interest is the 1 in 100 plus climate change Flood Storage Area (FSA) breach scenario.

The peak velocities generated from the hydraulic modelling for the 1 in 100 year plus climate change Flood Storage Area Breach scenario are summarised in Table 2.2 below.

Table 2.2 Modelled Peak Velocity Results

Node Location	Node ID	*Peak Velocity (m/s)
Base of Flood Embankment	1031	1.38
Base of NHRR Road Embankment	2009	2.14
Base of NHRR Bridge Piers and Abutments	3003	2.22
Base of River Wall	3004	5.00
* Velocities were taken from a number of nodes across each of the location, to ensure a conservative approach, the highest velocity was taken.		

The full table of results, and the maps showing the node locations, are included in Appendix C. The map of node locations is additionally shown in Figure 2.3.

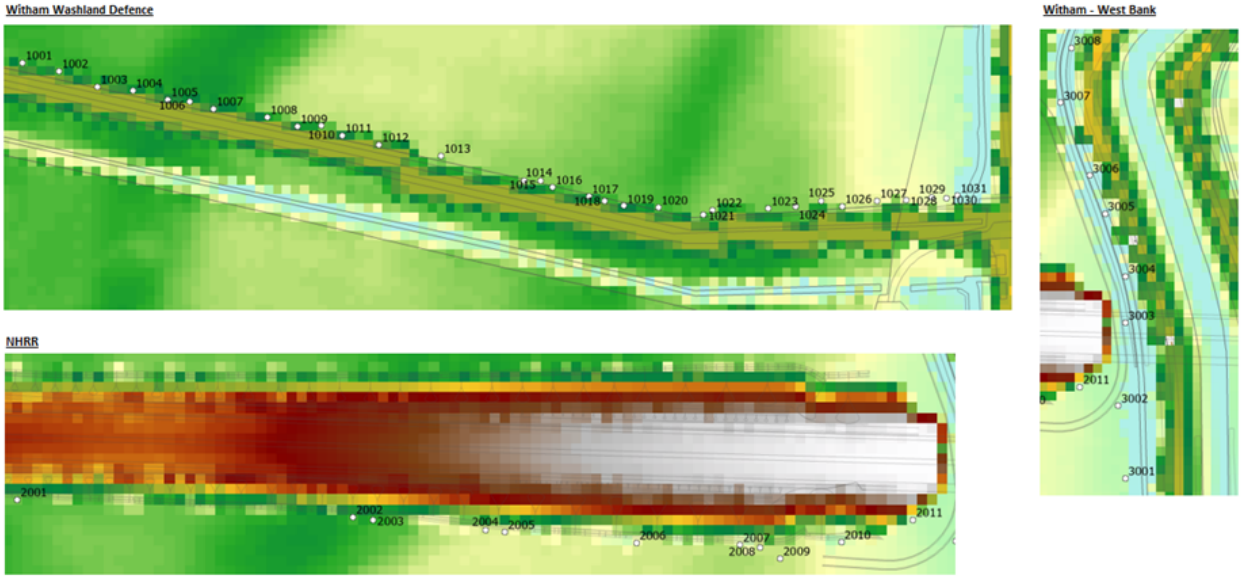

Figure 2.3: Map of Node Locations

[3] Gov.uk (2022) Flood risk assessments: climate change allowances, Peak river flow allowances, available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances#peak-river-flow-allowances (accessed 06/2023)

3. ASSESSMENT OF SCOUR

3.1 Overview

The following section of report reviews which aspects of the proposed scheme could potentially be susceptible to scour, and may need future protection. As identified during the initial consultation with the Environment Agency, the assessment of scour will need to consider the NHRR structure itself, along with the Environment Agency Flood Defence Assets. The review is based on of the site conditions, Scheme Proposals and hydraulic modelling results.

3.2 Environment Agency River Wall (Model Node 3004)

The hydraulic modelling results indicate that the flow velocities adjacent to the landward side of the River Wall (Witham West Bank) could increase to a peak velocity of 5.0 m/s. This is a result of the introduction of the NHRR embankment causing all flow from the upstream to be channelled between the abutment and wall, a width of around 30 m. This results in the build-up of hydraulic head immediately upstream of the embankment, accelerating velocities past the river wall.

3.3 Environment Agency Flood Embankment (Model Node 1031)

Under existing conditions, the Environment Agency flood embankment would be subject to erosive forces at the upstream face during periods of flood storage. However, erosive force against the downstream side is introduced as a result of the impounding effect of the NHRR embankment, causing peak flows velocities at the base of the downstream face of the Embankment to be exposed to peak velocities of 1.38 m/s.

3.4 NHRR Bridge Piers and Abutments (Model Node 3003)

The parts of a bridge or viaduct structure most susceptible to scour and erosion are typically the piers and abutments, and they tend to cause localised changes to flow resulting in turbulent phenomena such as eddying (circular movement of water) around a pier or abutment.

The results of the hydraulic model indicate a peak velocity of 2.22 m/s.

3.5 NHRR Embankment (Model Node 2009)

The NHRR embankment itself will consist of an earth embankment, with flood water during a breach event abutting against the embankment which will act as a defacto dam, retaining flood water on the upstream side. The hydraulic modelling indicates a peak flow velocity of 2.14 m/s in this location. Risk from scour to the reinforced earth structure will be considered within the Structure AIP, via the inclusion of an addendum. The requirement for a geotextile lining along the horizontal and vertical joints will be made clear and it will be ensured that this is provided, regardless of the reinforced earth system/provider selected.

3.6 CIRIA Report C683

The guidance contained within CIRIA C683 "The use of rock in hydraulic engineering (second edition) (C683)" has been used to assess the likelihood of scour for each individual location (summarised in Table 3.1 below).

Based on the review of underlying ground conditions as identified in Table 3.1 (indicating fine silt/sand) and the associated critical velocities required to initiate scour, it is considered likely that scour could occur at all elements of the structure identified above, were protection not to be introduced.

Table 3.1 – Selected critical velocities for very fine sand to gravel particle sizes (CIRIA C683)

Material	Sieve size D (mm)	Critical velocity (m/s)
Gravel	5-2	0.60
Coarse sand	2-0.5	0.40
Fine sand	0.5-0.1	0.25
Very fine sand	0.1-0.02	0.20

4. ASSESSMENT OF OPTIONS

4.1 Do-Nothing

A 'do-nothing' option was initially considered, which would see no scour protection being incorporated, instead relying on the natural cohesiveness of the soil not to succumb to erosive forces resulting in movement of material around the piers/abutments/flood embankments, and as a result not any structural risk.

Due to the high velocities which could occur, and notwithstanding the adverse hydraulic impact of the piers and NHRR embankment, the do-nothing option is not considered feasible as part of the long-term operation of the proposed viaduct. The option would also not fulfil the requirements set out by the Environment Agency at the project outset, and so is discounted.

4.2 Do-Minimum

A 'do minimum' option would represent no protection being provided, but the formation of scour being regularly inspected for. If required, reinstatement works are carried out (scour hole infilling, grass seeding). The main risk with this option, other than being non-compliant with the project requirements, is that retrospectively installing scour protection routinely over the lifetime of the development could out-weigh the costs and planning involved in including scour protection as part of the initial construction. The do-minimum option is therefore discounted.

4.3 River Training

The use of River training[4] techniques is not considered feasible; primarily they are used for a single stretch of river, with works being undertaken to the banks or approach to a structure. The training dissipates or deflects the focus of flow energy away from critical parts of a structure i.e., abutment or piers. To be applicable to the River Witham, this would require individual training to be undertaken to the upstream of all elements at risk. Whilst this approach may be effective in dissipating or deflecting the erosive force away from the piers, abutments and embankments, this could be to the detriment to other parts of the underbridge i.e., between the channel, riparian area, which may in turn require some form of scour protection. This option is therefore not considered feasible.

4.4 Natural Erosion and Protection

Natural protection involves the use of natural materials and methods to reinforce areas of bed, bank and floodplain and provide protection to soft/vulnerable parts around a structure. It can include measures such as coir rolls, woven stems, natural bundles and biodegradable geotextile. This approach is typically more suited to an in-channel environment, where the natural morphology of the channel can be enhanced or reinforced. As the piers, abutments and embankments and immediate surrounds consist of relatively flat grass, there is minimal scope for undertaking natural erosion protection. This option is therefore not considered feasible.

4.5 Grass/Earth Reinforcement

In this scenario, protection is provided to the ground around the vulnerable elements, but would stop short of full excavation and installation of a scour layer. Instead, the option provides reinforcement to the grass/earth to resist downward scour. There are a number of options this could take, but the more popular techniques involve Grasscrete blocks or a polymer Truegrid system (approx. 100 mm thick). With either technique, a structure is woven into the grass to assist growth and facilitate drainage, and to prevent the formation of worn patches causing the subsequent dispersal of soil. An additional benefit of this option is that it can be also used as a hardstanding area for maintenance vehicle tracking. This option is considered feasible.

4.6 Hard Bed

The use of a hard rock or concrete bed layer at surface or below ground level would ensure that, if suitably sized and designed, that scour of surface material and encroachment onto the pier, abutment

[4] River training works include all measures taken to control and regulate river flow and river configuration with the aim of stabilising river channels for moderate flood flow.

and embankment would not occur. The advantage of this option is that it is permanent, and whilst requiring some excavation and construction up front, it can negate the requirement for any significant future maintenance/repair (limited to the depth of topsoil placed above the hard bed) and associated temporary works. It is also well suited to the floodplain environment, as it can be designed so to be below ground and not encroach upon floodplain storage.

Both options of locating the hard rock below or at grade with the existing ground are considered feasible.

4.7 Provisionally Preferred Option

Based on the review of options above, the initially preferred option would be installation of a grass/ground reinforcement layer to prevent the scour of material. The reason for the selection is it is passive (visually and environmentally), and can provide the long-term protection to the elements required.

During initial discussion with the wider design team, there was also a desire for maintenance vehicles to traverse the underbridge areas in order to undertake maintenance. This option would allow such access (although vehicle loading would need to be discussed/agreed).

It should be noted that whilst the provisionally preferred option is developed below, this is subject to a wider consultation with the design and stakeholder teams, which will consider all four of the options above which were regarded as feasible.

5. SCOUR PROTECTION DESIGN CONCEPT

A total of 4no. elements of the structure will require protection, however given the distance between each it is proposed to provide localised areas of protection, rather a continuous scour apron across all of the areas. It is also not required to provide scour protection to the entire underbridge area. Instead, local protection will be provided to each of the viaduct piers, and at the base of the abutment.

The protection may consist of a grasscrete apron to each part of the structure as follows:

- **Piers** – apron around each pier, spanning an appropriate length of 3 m from each column;
- **Abutments** – provided at the base of each abutment, spanning 2 m;
- **Environment Agency Flood Wall** – provided at the landward base of each bank, extending 2 m outwards from the base of wall, and 2 m up the wall slope (4 m total);
- **Environment Agency Flood Embankment** – provided along the entire face of the EA flood embankment, to all extent located below the 1 in 100 year plus climate change flood level (6.22 m AOD); and
- **NHRR Embankment** - provided along the embankment where necessary, below the 1 in 100 year plus climate change flood level (6.22 m AOD). To be confirmed during detailed design.

Based on the local conditions, the following design protection options have been selected, and are summarised and tabulated in Table 5.1 below.

Table 5.1 – Preferred Solution Overview

Design Element	Proposal	Justification
Depth	It is proposed to lay the protection layer at existing ground level i.e. no burial and no incorporated above the protection layer.	The site is not subject to any environmental designations, and there is no requirement for no visual impact. The hard protection at surface level will also support vehicular access, and allow for easier routine inspection.
Protection type	It is proposed to use grasscrete as the hard protection layer, in preference to a concrete or rock armour apron or similar technique.	The method provides protection to the existing ground, but doesn't require excavation/removal of material, importing of large quantities of rock or concrete.
Extent	As outlined above, proposed extent is proposed here notionally, but will need to be reviewed once the final viaduct/embankment design is available.	The extent of protection should be minimum extent required to provide sufficient protection. This is to minimise the scale of excavations and limit the cost of imported grasscrete. It is considered that a 2 m width of protection will be sufficient for the piers and abutments given the peak velocities expected. Similarly, providing protection to all aspects of the embankment below the design flood level is required necessary.
Thickness	Grasscrete consists of a single layer of protection, normally with a geotextile or gravel blinding layer. A range of thicknesses products are available, but typically these would be around 100mm of grasscrete units. Rock armour protection consist of a minimum of 2no. layers. Assuming a block size of 100-150 mm (minimum practical size), this would equate to approximately 300 mm thickness. This would also include a toe at the extent of the armour, which would be 400 mm.	A 300 mm layer thickness of rock armour is generally considered to be the minimum in order to incorporate a) minimum block sizing of 100-150 mm and a minimum 2no. layers. This equates to a layer thickness of 300 mm. The deeper toe will provide horizontal stability to the protection layers, along with reduce the risk of the protection layers being undermined at the extents.
Block sizes	The proposed block sizes are a function of the expected velocities they are likely to encounter i.e., the maximum floodplain or channel flow velocities.	As the protection layer is to remain submerged, will be subject to compaction and binding due to the action of the overlying and surrounding soil, it is considered that the minimum block sizes can be used. These are 100 to 150 mm.

Design Element	Proposal	Justification
Separation Layer	Consisting of a geotextile layer laid at the base of the excavation trench, with rock armour being laid on top. A geotextile, and if required a gravel layer should then be laid on top of the rock armour layer.	To prevent dispersal of rock armour blocks into the surrounding ground, or movement of blocks causing the protection layer to become uneven. Also, to prevent loss of soil into the rock armour layer.
Uniformity	It is proposed to provide the same extent and design of protection to each of the piers.	This will simplify the design process, but is also a reflection of the uniform pier design and comparable peak flood velocities.
Maintenance	and does not suffer the same risk of degradation as concrete which is at risk from ground movement and loading.	

An indicative scour protection layout and detail, based on the concept above, is included in Appendix D. The initial concept will be subject to final modelled velocities, which will incorporate the bridge geometry and reveal and localised hydraulic impacts on velocity and scour potential.

Once these velocities are available, the apron protection will be fully specified, including block sizes and weights and composition requirements.

It should be noted that whilst an initial assessment of options has led to selection and development of the preferred option, the purpose of this technical note is to form stakeholder and design team consultation. As such, the preferred solution as described above should only be regarded as provisional.

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APPENDIX A – SCHEME REDLINE BOUNDARY

SHEET SET LAYOUT FOR GENERAL ARRANGEMENT

NOT TO SCALE

SHEET IN USE

NO DISCIPLINE DESIGN INFORMATION REQUIRED ON THIS SHEET

Notes

1. DO NOT SCALE FROM THIS DRAWING.
2. ALL DIMENSIONS ARE IN METRES UNLESS SHOWN OTHERWISE.
3. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM UNLESS SHOWN OTHERWISE.
4. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL RELEVANT ARCHITECTS AND ENGINEERS DRAWINGS AND SPECIFICATIONS.

Rev	Description	Drawn	Checked	Approved	Date
P02	22/12/22	DB	LF	BW	22/12/22
P03	13/07/23	DB	2023/07/13	BW	13/07/23
P04	08/08/23	DB	LF	BW	08/08/23
C01	Fourth Issue	DB	LF	BW	08/08/23
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Project Contractor: Balfour Beatty

Project Designer: RAMBOLL

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www.ramboll.co.uk

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SERIES OVERVIEW

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1620013942	N/A	DB	13/10/23

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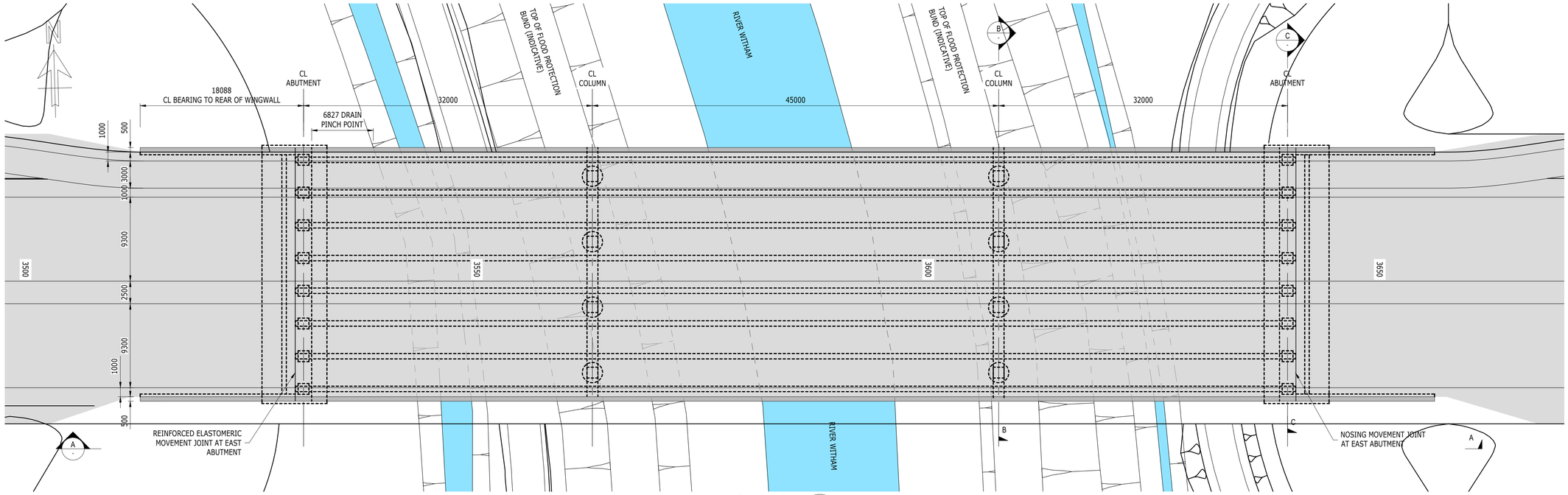
APPENDIX B – PROPOSED BRIDGE PLAN



PLAN

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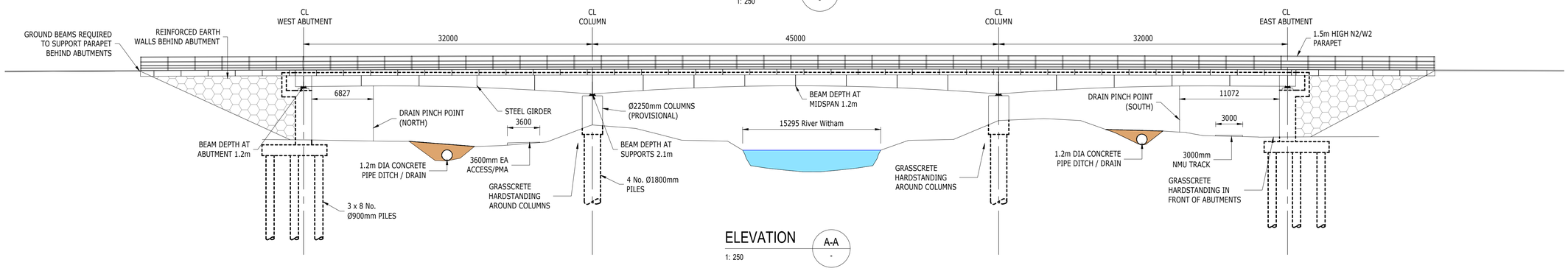

ELEVATION A-A

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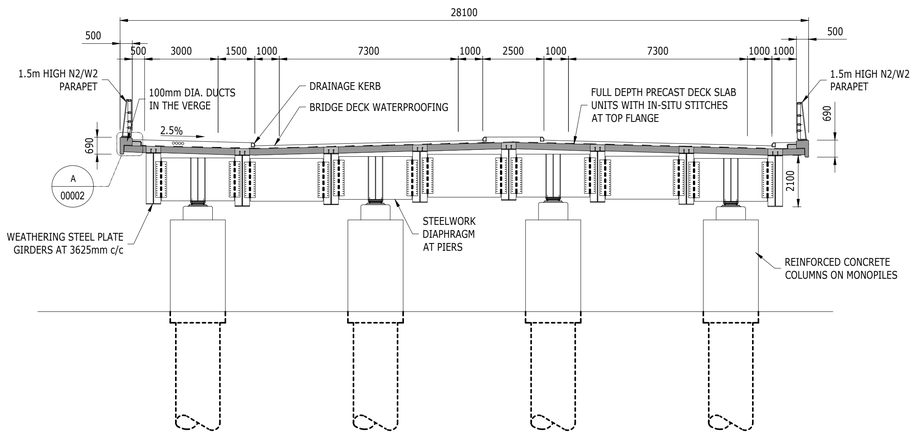
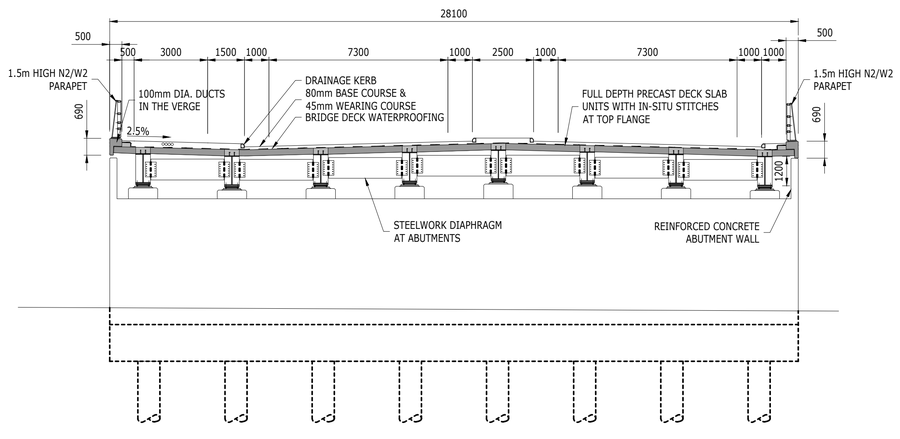


SECTION B-B

1: 125



SECTION C-C

1: 125

Notes

1. THIS DRAWING SHALL ONLY BE USED FOR THE DESIGN ELEMENT STATED IN THE DRAWING TITLE.
2. ONLY WRITTEN DIMENSIONS SHALL BE USED.
3. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.
4. ALL LEVELS ARE IN METRES RELATED TO ORDNANCE DATUM.
5. ALL CHAINAGES ARE IN METRES UNLESS NOTED OTHERWISE.
6. STEELWORK GRADE TO BE S355 J2W UNLESS OTHERWISE NOTED
7. CONCRETE GRADES TO BE AS FOLLOWS:
   IN-SITU/PRECAST DECK SLAB: C40/50
   PRECAST STRINGCOURSE: C40/50
   ABUTMENT AND PIERS: C40/50
   WINGWALLS: C40/50
   PILECAPS: C40/50
   PILES: C32/40
8. CONCRETE FINISHES:
   PRECAST STRINGCOURSE: F3, U3
   EXPOSED IN-SITU FACES: F4, U3
   BURIED IN-SITU FACES: F1, U1
   SURFACES TO BE WATERPROOFED: F2, U4
   EXPOSED PRECAST DESK SURFACES: F4
   EXPOSED IN-SITU DECK SURFACES: F4
9. THE FLOOD PROTECTION BUNDS ARE SHOWN INDICATIVELY. FURTHER TOPOGRAPHICAL SURVEY IS REQUIRED TO CONFIRM LOCATION PRIOR TO DETAILED DESIGN.

Rev	Description	Drawn	Checked	Approved	Date
P01	09/05/23	HR	GW	GW	09/05/23
P02	Revised following initial review	SP	GW	SC	08/08/23
P03	Approved and Accepted	SP	HW	AM	07/09/23
C01	Approved and Accepted	SP	HW	AM	07/09/23

Suitability: A3
Drawing Status: Approved & Accepted at Stage 3

Project Name: North Hykeham Relief Road

Project Client: Lincolnshire County Council – Working for a better future

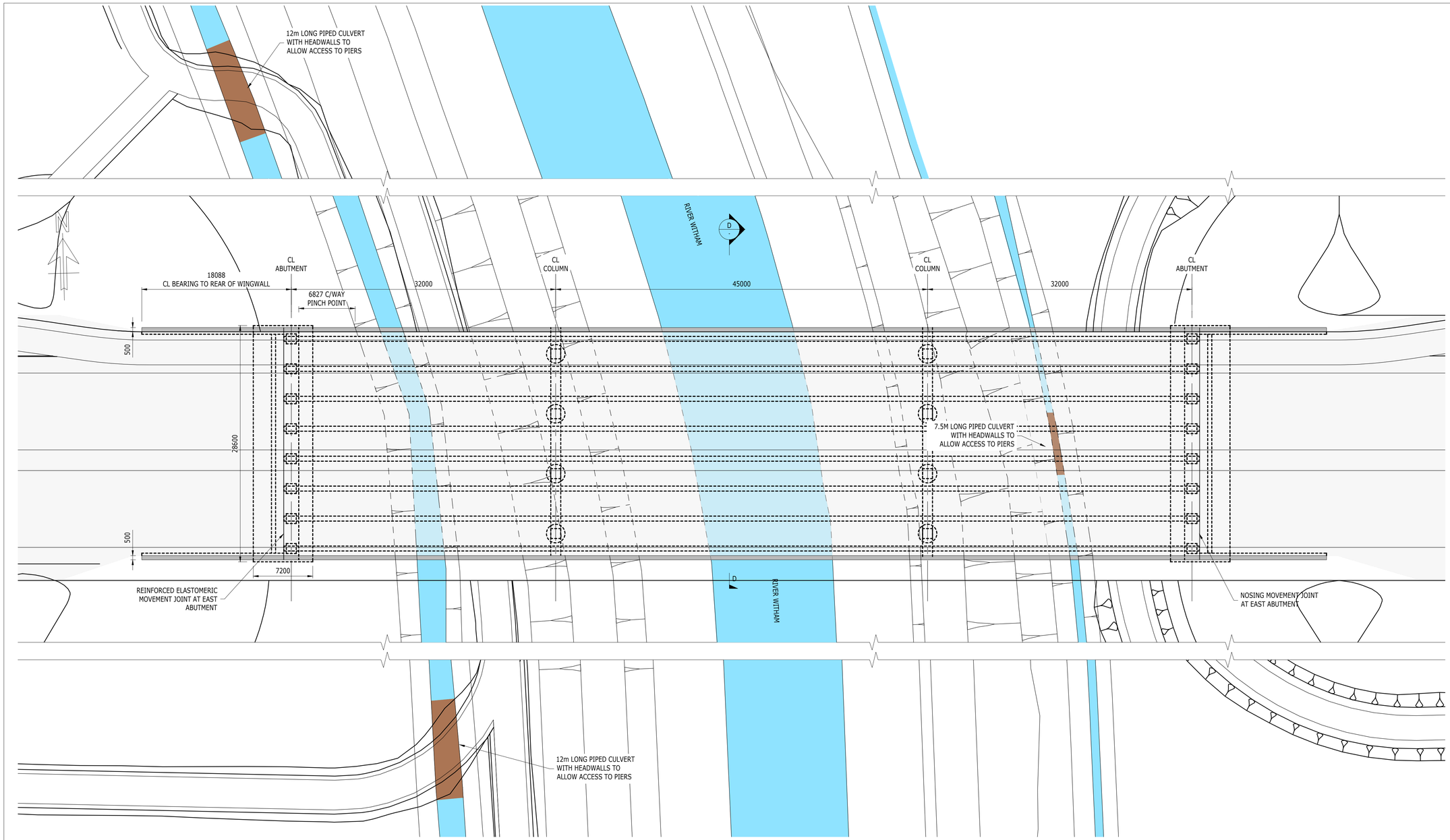
Project Contractor: Balfour Beatty

Project Designer: Ramboll
tel 01244 311855 chester@ramboll.co.uk
www.ramboll.co.uk

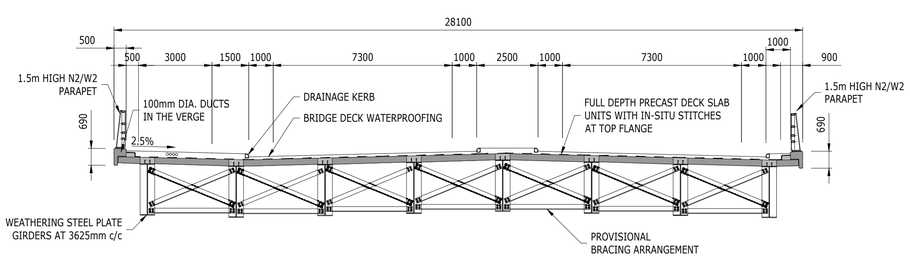
Drawing Title: NORTH HYKEHAM RELIEF ROAD
RIVER WITHAM BRIDGE
GENERAL ARRANGEMENT
SHEET 1 OF 2

Project No:	Scale (@A1):	Drawn:	Date:
1620013942	AS SHOWN	SP	07/09/23

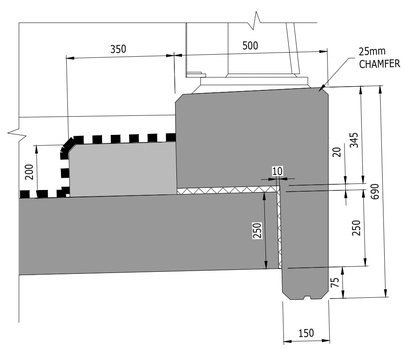
Drawing No: NHRR-RAM-SBR-BR03-DR-CB-00001
Rev: C01



PLAN
1: 250
-
-



SECTION
1: 125
D-D
-



DETAIL
1: 10
A
-
EDGE OF DECK

Notes

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4. ALL LEVELS ARE IN METRES RELATED TO ORDNANCE DATUM.
5. ALL CHAINAGES ARE IN METRES UNLESS NOTED OTHERWISE.
6. STEELWORK GRADE TO BE S355 J2W UNLESS OTHERWISE NOTED
7. CONCRETE GRADES TO BE AS FOLLOWS:
   IN-SITU/PRECAST DECK SLAB: C40/50
   PRECAST STRINGCOURSE: C40/50
   ABUTMENT AND PIERS: C40/50
   WINGWALLS: C40/50
   PILECAPS: C40/50
   PILES: C32/40
8. CONCRETE FINISHES:
   PRECAST STRINGCOURSE: F3, U3
   EXPOSED IN-SITU FACES: F4, U3
   BURIED IN-SITU FACES: F1, U1
   SURFACES TO BE WATERPROOFED: F2, U4
   EXPOSED PRECAST DESK SURFACES: F4
   EXPOSED IN-SITU DECK SURFACES: F4

Rev	Description	Drawn	Checked	Approved	Date
P01	09/05/23	HR	GW	GW	09/05/23
P02	Revised following initial review	SP	GW	SC	08/08/23
P03	Approved and Accepted	SP	HW	AM	07/09/23
C01	Approved and Accepted	SP	HW	AM	07/09/23

Suitability: A3
Drawing Status: Approved & Accepted at Stage 3

Project Name: North Hykeham Relief Road

Project Client: Lincolnshire County Council – Working for a better future

Project Contractor: Balfour Beatty

Project Designer: RAMBOLL
tel 01244 311855 chester@ramboll.co.uk
www.ramboll.co.uk

Drawing Title: NORTH HYKEHAM RELIEF ROAD
RIVER WITHAM BRIDGE
GENERAL ARRANGEMENT
SHEET 2 OF 2

Project No:	Scale (@A1):	Drawn:	Date:
1620013942	AS SHOWN	SP	07/09/23

Drawing No: NHRR-RAM-SBR-BR03-DE-CB-00002
Rev: C01

APPENDIX C – BASELINE WATERCOURSE PLANS

Location	ID	Coordinates		Velocity (m/s)			
		Easting	Northing	Baseline	NHRR	NHRR_FS	NHRR_RWUS
Witham Washland Defenc	1001	494667.32	364047.02	0.09608	0.06501	0.736718	0.503262
Witham Washland Defenc	1002	494687.2	364042.44	0.09815	0.25832	0.608732	0.390088
Witham Washland Defenc	1003	494708.71	364033.79	0.51341	0.51523	0.001294	0.232674
Witham Washland Defenc	1004	494727.86	364031.75	0.25648	0.34478	0.943906	0.533077
Witham Washland Defenc	1005	494747.43	364026.87	0.15186	0.30093	0.54189	0.444255
Witham Washland Defenc	1006	494759.29	364025.53	0.25523	0.14576	0.792014	0.647775
Witham Washland Defenc	1007	494772.25	364021.8	0.12031	0.24556	0.352794	0.525644
Witham Washland Defenc	1008	494802.08	364017.1	0.18219	0.40001	0.675655	0.427005
Witham Washland Defenc	1009	494818.56	364012.33	0.0975	0.42688	3.758236	0.301277
Witham Washland Defenc	1010	494831.73	364012.57	0.20697	0.29217	3.502788	0.572383
Witham Washland Defenc	1011	494843.09	364007.24	0.11141	0.42438	3.952305	0.299239
Witham Washland Defenc	1012	494863.33	364002.22	0.0492	0.43962	0.230444	0.150465
Witham Washland Defenc	1013	494897.42	363996.06	0.08933	0.08842	0.585822	0.551765
Witham Washland Defenc	1014	494943.14	363982.35	0.18343	0.22075	0.472019	0.325879
Witham Washland Defenc	1015	494952.23	363982.2	0.11527	0.1964	0.528741	0.542223
Witham Washland Defenc	1016	494958.77	363978.71	0.03126	0.32821	0.381799	0.404547
Witham Washland Defenc	1017	494978.74	363973.84	0.33012	0.30904	0.364381	0.348808
Witham Washland Defenc	1018	494987.64	363971.3	0.06538	0.24724	0.513116	0.510119
Witham Washland Defenc	1019	494998.19	363968.6	0.40187	0.3974	0.411214	0.525959
Witham Washland Defenc	1020	495016.96	363967.67	0.2235	0.22106	1.001965	0.774545
Witham Washland Defenc	1021	495041.97	363963.59	0.12868	0.20412	0.76928	0.504814
Witham Washland Defenc	1022	495046.74	363966.59	0.06625	0.06748	0.908339	0.789154
Witham Washland Defenc	1023	495077.45	363967.12	0.00021	0.11158	1.04683	0.712501
Witham Washland Defenc	1024	495092.41	363968.24	0.04714	0.08306	1.124259	0.764571
Witham Washland Defenc	1025	495106.84	363971.31	0.15837	0.14989	1.495954	1.018095
Witham Washland Defenc	1026	495118.05	363968.58	0.17305	0.25506	1.09723	0.83626
Witham Washland Defenc	1027	495137.41	363971.54	0.0724	0.0843	0.957576	1.02308
Witham Washland Defenc	1028	495153.16	363971.8	0.12427	0.12532	0.731194	0.925535
Witham Washland Defenc	1029	495167.65	363973.16	0.05275	0.05216	1.149986	0.930504
Witham Washland Defenc	1030	495175.34	363972.9	0.1216	0.12197	0.905404	1.175047
Witham Washland Defenc	1031	495181.49	363974.22	0.106	0.10935	1.375969	0.779067
NHRR	2001	494717.8	364152.43	0.02233	0.1905	1.318476	0.657756
NHRR	2002	494882.77	364143.95	<Null>	0.20796	1.073145	0.939928
NHRR	2003	494892.53	364142.44	<Null>	0.14624	0.885392	0.82967
NHRR	2004	494947.76	364137.44	0.04802	0.0875	1.49852	1.43857
NHRR	2005	494957.39	364136.45	0.04881	0.26814	1.599636	0.968229
NHRR	2006	495021.96	364131.3	0.05308	0.16929	1.559239	2.041985
NHRR	2007	495073.02	364130.05	0.01771	0.41977	1.754634	1.702527
NHRR	2008	495082.77	364128.7	0.01538	0.44858	2.001181	1.281284
NHRR	2009	495092.75	364123.57	0.01628	0.50988	2.138959	1.118959
NHRR	2010	495122.75	364131.41	0.08181	0.50024	1.920629	1.363181
NHRR	2011	495158.06	364142.54	0.16725	0.14838	1.400993	2.360778
Witham - West Bank	3001	495182.91	364092.47	0.47429	0.51023	2.558177	3.264614
Witham - West Bank	3002	495179.11	364132.1	0.46322	0.37364	1.549739	2.158187
Witham - West Bank	3003	495182.88	364177.28	0.30045	0.24653	2.219513	3.063418
Witham - West Bank	3004	495183.05	364202.85	0.41993	0.58874	8.092666	8.357648
Witham - West Bank	3005	495171.72	364236.98	0.51411	0.50618	5.001696	4.842503
Witham - West Bank	3006	495163.2	364257.68	2.11358	2.50022	5.709586	5.728492
Witham - West Bank	3007	495147.28	364297.39	3.12355	3.70938	9.103681	9.794284
Witham - West Bank	3008	495153.14	364327.22	1.46838	1.41927	2.879377	3.10349
Witham - East Bank	4001	495270.47	363972.93	<Null>	<Null>	<Null>	<Null>
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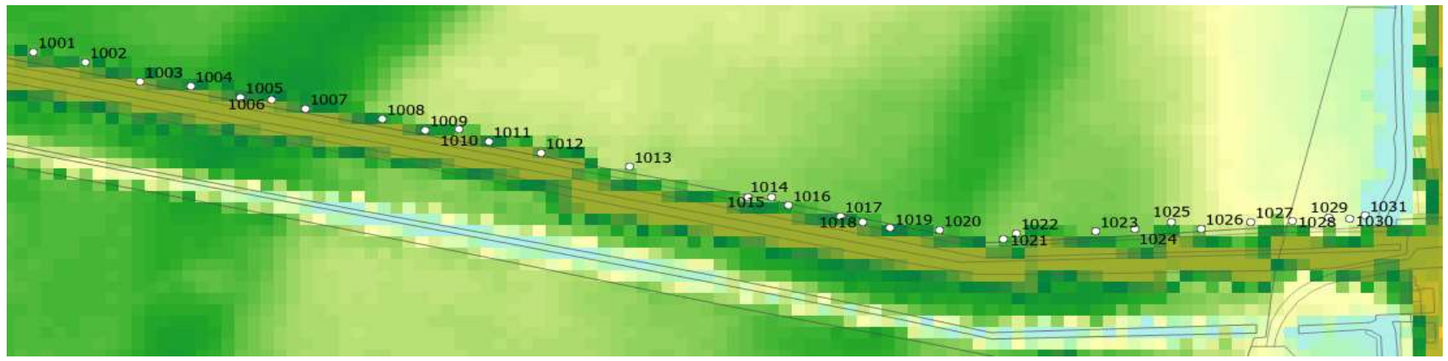
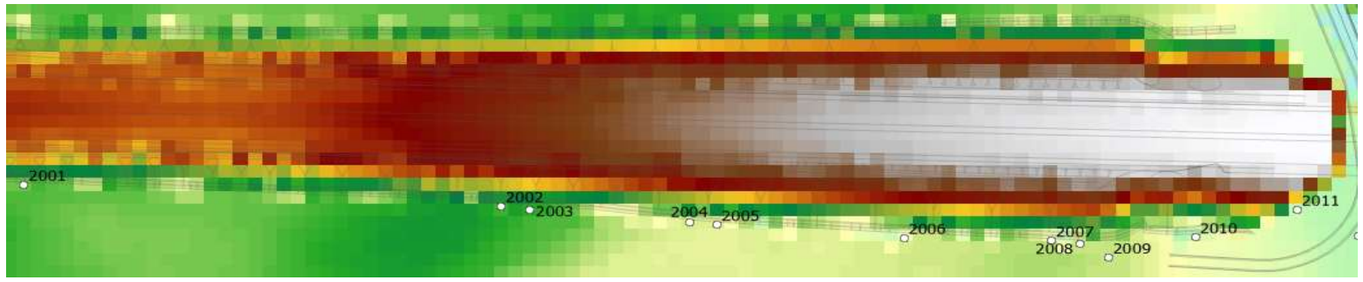
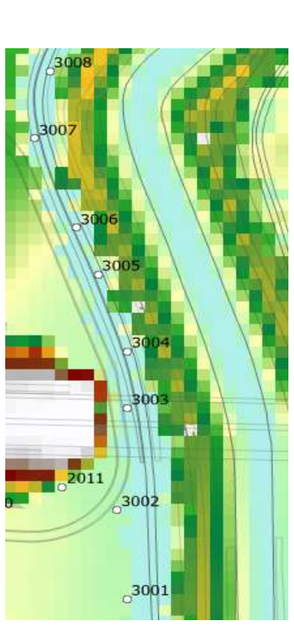
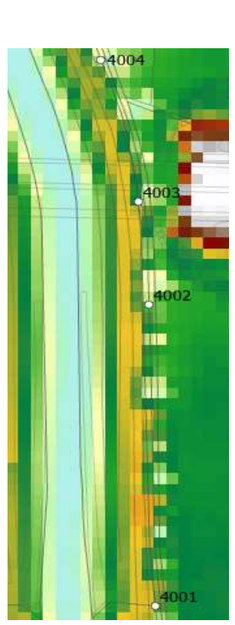
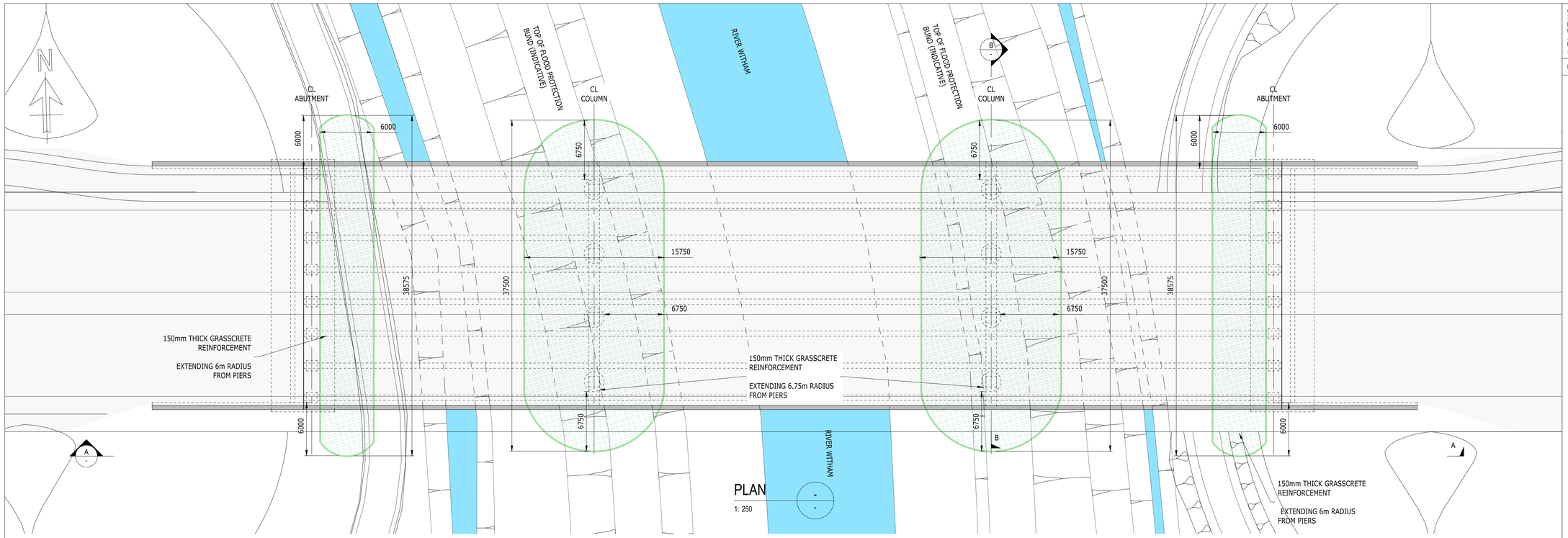






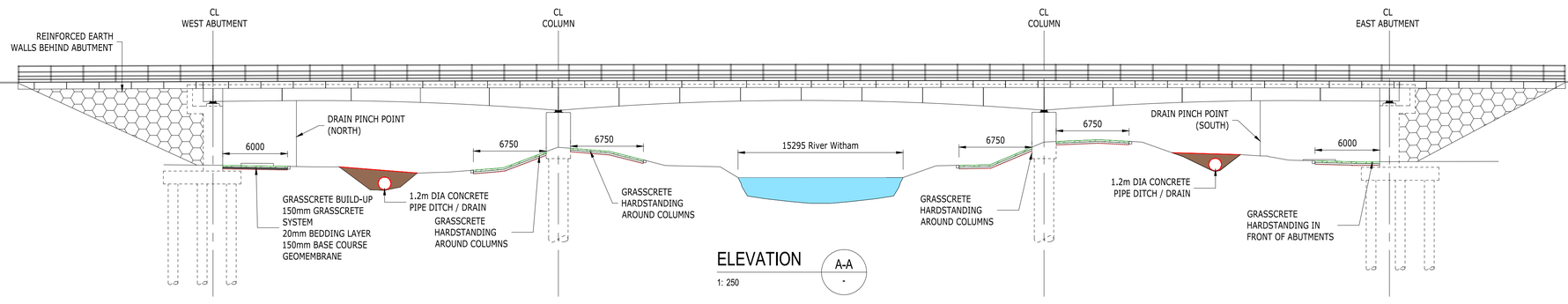


APPENDIX D – PREFERRED OPTION SKETCHES



PLAN

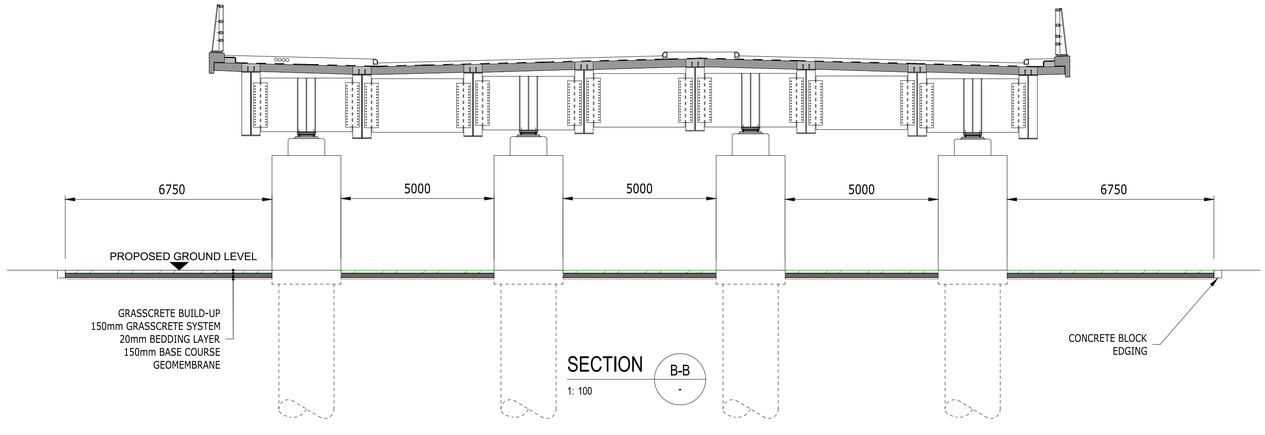
1: 250



ELEVATION

1: 250

A-A



SECTION

1: 100

B-B

Notes

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Rev	Description	Drawn	Checked	Approved	Date
P01	First Issue	MB	---	---	---

Suitability: S0

Drawing Status: Work in Progress

Project Name: North Hykeham Relief Road

Project Client: Lincolnshire County Council – Working for a better future

Project Contractor: Balfour Beatty

Project Designer: RAMBOLL

tel 01244 311855 chester@ramboll.co.uk
www.ramboll.co.uk

Drawing Title: NORTH HYKEHAM RELIEF ROAD RIVER WITHAM BRIDGE SCOUR GENERAL ARRANGEMENT SHEET 1 OF 1

Project No:	Scale (@A1):	Drawn:	Date:
1620013942	AS SHOWN	MB	---

Drawing No: NHRR-RAM-SBR-BR03-DR-CB-00002

Rev: P01