Appendix C5.06

Section 3
N14-N15 to A5 Link Structures Options Report

N14-N15 to A5 Link

PMG Phase 3

Design Working Paper No 5

Bridge Options Report
River Finn Crossing

Issue 1
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N14 / N15 to A5 Road Link Scheme

Design Working Paper No 5

Bridge Options Report
River Finn Crossing

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N14 / N15 to A5 Road Link Scheme

Design Working Paper No 5

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1.0 INTRODUCTION

1.1 Consultants Brief

Donegal County Council, in conjunction with Donegal National Roads Design Office, has commissioned Roughan and O'Donovan Consulting Engineers to undertake the preliminary design and Environmental Impact Assessment of the proposed N14 / N15 to A5 Link. Design Working Paper No. 2 "Geometry, Junction Strategy, Departures and Relaxations" describes the alignment options considered and recommends Option B is progressed. The bridge options described in this report have therefore been developed based on the Option B Alignment.

The requirements of the Consultants brief includes for the preparation of a Bridge Options Report in accordance with NRA BD 02/09 "Technical Acceptance of Structures on Motorways and Other National Roads" to agree the structural form of the proposed bridge prior to progressing to Preliminary Design Stage. This report is the Bridge Options Report submitted in accordance with the requirements of BD 02/09.

1.2 Background to the Project

County Donegal is situated in the north-west of the Republic of Ireland. The National Primary Roads form the main links between the County and the rest of the Republic, the N15 to the south-west and the N14 to the south-east of Ireland. The N14 link, however, passes through Northern Ireland where it continues as the A5 from Strabane until the border is crossed again at Aughnacloy where it becomes the N2 National Primary Road.

At present the existing N14 meets the N15 at a roundabout near the centre of Lifford. A short link from here leads to the existing Lifford Bridge which carries the single carriageway road over the River Foyle and into Strabane. In Northern Ireland the road becomes the A38 for a short 600m stretch before culminating in a roundabout junction where it joins the A5.

Currently this single carriageway link carries all the through traffic on the N14, N15 and A5 and all the interurban movements between Lifford and Strabane.

The N14 / N15 to A5 Link Scheme involves the design of a road linking the A5 Western Transport Corridor in County Tyrone, Northern Ireland to the proposed N14 Letterkenny to Lifford / Strabane and the N15 Lifford to Stranorlar Schemes in County Donegal, Republic of Ireland. A Site Location Map is included in Appendix 1.

The distance between the junction on the A5 Western Transport Corridor and the proposed N14 / N15 junction is approximately 450m. The scheme will require a crossing of the River Finn cSAC and associated floodplains.

The National Roads Needs Study has highlighted the need to upgrade the N14 between Letterkenny and Strabane to a standard two lane carriageway. This is in keeping with the regional importance of the N14 which provides a strategic link between north western Donegal, Letterkenny and Strabane and Northern Ireland / Dublin.

Similarly the National Roads Needs Study and Transport 21 recognise the need to upgrade the N15 between Stranorlar and Lifford such that it is in accordance with the standard requirements of a National Primary Route.

In parallel to the development of the N14 and N15 scheme proposals in the Republic of Ireland, the Roads Service in Northern Ireland has been developing the planning and design of the A5 Western Transport Corridor. This 86km dual carriageway scheme runs from Aughnacloy in the South to Derry in the North and includes a western bypass of Strabane. A Preferred Route Corridor has been selected and the Environmental Impact Assessment Statement was published in November 2010.

As a consequence of the development of the above three schemes it was perceived that any improvement would be greatly enhanced by upgrading the link between the N14/N15 in Lifford and the A5 in Strabane.

Following the confirmation of the need for the scheme a Constraints Study was undertaken. Subsequently a Route Selection Report, published in April 2006, examined 8 possible crossing points. This assessment resulted in the selection of Route Option Link 4 as the preferred crossing point as it scored the highest of the eight options in environmental, economic and engineering impacts. This route linked in to the existing A5 Strabane Bypass considerably to the north east of the current proposed crossing point. The subsequent development, route selection and preliminary design of the A5 WTC directed the need to re-examine the route options assessment. The location of a roundabout on the A5 WTC directly south of the proposed N14/N15 roundabout has had the outcome of dictating the existing proposed crossing point. Any other crossing point and link road will have substantially greater impact.

Donegal County Council has since commenced the planning process to advance the development of the N14/N15 national primary route and associated infrastructure linking the A5 Western Transport Corridor in Co. Tyrone to the proposed N14 Letterkenny to Lifford/Strabane and N15 Lifford to Stranorlar Schemes in Co. Donegal.

The strategic aim of the proposed N14 / N15 to A5 Link is to eliminate the bottleneck at the border between Strabane and Lifford which will be exacerbated by the proposed road schemes. The Link will increase the capacity of the crossing between the N14 / N15 and the A5 resulting in shorter journey times on the strategic route, Letterkenny to Strabane / Northern Ireland and Dublin.

The key objectives for the scheme thus include:

- To remove a major bottleneck on the national road network;
- To improve facilities and provide linkage for strategic, cross border traffic;
- To improve safety for all road users;
- To improve economic efficiency and journey time reliability;
- To reduce impacts on local residents;
- To improve the local environment for residents, commercial businesses and tourism; and
- To minimise environmental impacts.

1.3 Previous Studies

Previous studies carried out along the proposed route relevant to this Bridge Options Report are listed below. The results and findings of these studies have been considered in this report:

- Traffic Reports;

  - N14/N15 to A5 Link
  - N13/N15 Ballybofey and Stranolar Bypass
  - N14 Letterkenny to Lifford
  - N15 Strabane to Lifford (Jacobs)
- N14/N15 to A5 Link Road Constraints Study (Mott MacDonald EPO Limited)
- N14/N15 to A5 Link Road – Route Selection Report (Mott MacDonald EPO Ltd.)
- N15 Lifford / Stranolar / Ballybofey – Constraints Study Report (Babtie Pettit)
- Draft EIS N14 Letterkenny to Lifford / Strabane (RPS)
- N14/N13 (Manorcunningham) to Lifford / Strabane Scheme Geotechnical Interpretative Report (Mott MacDonald)
- N14/N13 (Manorcunningham) to Lifford Constraints Study (Mott MacDonald EPO Ltd.)
- N14/N13 (Manorcunningham) to Lifford Route Selection Report (Mott MacDonald EPO Ltd.)
- N15 Lifford to Stranolar Environmental Impact Statement (Jacobs)
- N15 Lifford to Stranolar Preliminary Ground Investigation (Glover Site Investigations Ltd.)
- N15 Lifford / Stranolar Preliminary Design Reports (Jacobs)
- N15 Lifford / Stranolar / Ballybofey Route Selection Report
- A5 WTC Mourne River Bridge Options Report (Mouchel)
- A15 WTC Structures Aesthetics Report (Mouchel)
- N14-N15 to A5 Link Stage 1 Road Safety Audit (ROD)
- Design Working Paper No. 1 Traffic Modelling, Road Type, Road Safety Audit (ROD)
- Design Working Paper No. 2 Geometry, Junction Strategy, Departures and Relaxations (ROD)
- Design Working Paper No. 4 Pavement Design (ROD)
- Geotechnical Investigation – Ongoing
- Topographical Survey

1.4 Scope

This document is the Bridge Options Report prepared for the crossing of the River Finn between the A5 Western Transport Corridor in County Tyrone to the N14 in County Donegal.

2.0 SITE LOCATION AND DESCRIPTION

2.1 Introduction

The proposed scheme provides a crossing of the River Finn and flood plain and has an overall length of approximately 450m between the proposed roundabout on the A5 Western Transport Corridor in County Tyrone and a proposed roundabout connecting to the N14/N15 in County Donegal. The Finn Valley is a broad valley

predominantly overlooked by residential development on rising slopes west of the N15 at Coneyburrow / Curraghalane. The Link Road is located to the south of Lifford and the south east of Strabane. A Location Map is included in Appendix 1.

The proposed cross-section for the Link Road is Type 2 Dual Carriageway in accordance with NRA TD27 of the National Roads Authority (NRA) Design Manual for Roads and Bridges (DMRB) as described below:

1 x 1.5m Central Median including median barrier

2 x 7.0m Carriageway

2 x 0.5m Hard Strips

2 x 1.5m Footway (on bridge)

The cross-section is proposed for the full length of the Link Road, however, the verge width will increase off the bridge.

2.2 River Finn Crossing

At the proposed crossing location there is an extensive flood plain on the west side of the river extending some 250m while on the east side the existing ground river to the west giving a flood plain of approximately 70m, however, the A5 Western Transport Corridor is on embankment at the location running parallel to the River Finn.

A photograph of the crossing at the proposed location is shown below:

Photo 1 - Looking East from Donegal to Tyrone

Photo 2 - Crossing Location – November 2010

A drawing showing the extent of the 100 year flood plan is included in Appendix 2.

3.0 DESCRIPTION OF STRUCTURES AND OPTIONS CONSIDERED

3.1 General Key Constrains

During the development of the options presented in this report a number of constraints have been considered, including:

- The extensive flood plain
- Geotechnical considerations
- Required tie-in and interface with the proposed A5 WTC roundabout
- Designation of the site as a cSAC
- Requirements of Strabane and Lifford Anglers, Ulster Angling Federation and the Loughs Agency
- Requirements of the Rivers Agency / OPW
- Requirements of the National Parks and Wildlife Service / Northern Ireland Environmental Agency
- Requirements of the Roads Service NI / NRA / Donegal County Council

See also Chapter 13.0 for Environmental Considerations

The River Finn has extensive flood plains particularly on the west side at the crossing location. Preliminary hydraulic analysis has been carried out and defined a minimum soffit level of 7.56m OD and a minimum length of bridge of approximately 160m. The options presented comply with these minimum requirements. The overall minimum length for Option 1, 3 and 4 require further review on completion of more detailed hydraulic analysis.

In addition, the River Finn is an important habitat for protected species and it is not appropriate to provide a pier in the main river channel. Furthermore, the link road crosses a cSAC and any proposed structure should minimise the impact on the designated area.

At the tie into the A5 Western Transport Corridor on the east side, it is understood that the road designers are considering a surcharge programme to mitigate the effect of soft underlying soil on the design of the permanent works. It is important that the form of end support is agreed at this interface. The options considered provide a secant piled wall at the east end support which will require further discussion and agreement with the Roads Service Northern Ireland and their Designer / Contractor on this section of the A5 WTC.

3.2 Description of Bridge Options

The following options have been considered for the N14/N15 to A5 Link crossing of the River Finn:

Option 1	4 Span Steel Composite
Option 2	8 Span Steel Composite
Option 3	5 Span Steel Composite with Tied Arch Main Span
Option 4	5 Span Concrete Box with Propped Cantilever and Steel Composite Drop in Span made Monolithic with Intermediate Supports
Option 5	3 Span Asymmetric Cable Stay Bridge

Drawings showing the proposed arrangement are included in Appendix 2.

3.3 Option 1 – 4 Span Steel Composite

The proposed structural arrangement comprises of 3 pairs of haunched plate girders made composite with reinforced concrete deck slab, monolithic with reinforced concrete piers at the intermediate supports and supported on reinforced concrete piled bankseats with reinforced earth abutment on the west abutment and secant piled wall at the east abutment. As described above in Section 3.1 a secant piled wall is proposed at the interface between the A5 WTC and the N14/N15 to A5 Link, this required further discussion and agreement with Roads Service Northern Ireland and their Designer / Contractor.

The Geotechnical Investigation is ongoing, however, at this stage it is considered that piled foundations will be required.

The overall length of the bridge is approximately 160m with the following span arrangement:

West Approach Span	30m and 33m
Main Span	63m
East Approach Span	33m

This minimum soffit level is in excess of 7.56m which allows for the 100yr flood event plus 20% climate change plus 0.5m freeboard.

Hydraulic analysis is ongoing and the span arrangement requires review on completion.

3.4 Option 2 – 8 Span Steel Composite

The proposed structural arrangement consists of 3 pairs of plate girders made composite with reinforced concrete deck slab and haunched over the river mainspan. At this stage the proposed structure is supported on bearings at intermediate supports with reinforced concrete piers and piled foundations (subject to findings of the Geotechnical Investigations). If this option is to be progressed to preliminary design stage, further analysis will be carried out with a view to eliminating the bearings at the intermediate supports and providing a monolithic connection.

The proposed end supports are as described for Option 1.

The overall length of the bridge is approximately 287m with the following span arrangement:

West Approach Span	26m, 5 x 33m
Main Span	63m
East Approach Span	33m

The proposed span arrangement provides a soffit level in excess of 7.56m and reduces the impact on the existing cSAC.

3.5 Option 3 – 5 Span Steel Composite with Tied Arch Span

The superstructure comprises a steel box girder with propped cantilevers made composite with reinforced concrete deck and single central vertical steel/concrete

composite arch supporting the main span with inclined intermediate supports connected to the superstructure.

Provision of the supporting arch along the centreline of the proposed road requires a marginal widening of the central reserve to allow provision of a median safety barrier to protect the main arch and supporting cables.

Longitudinally, the arch crosses the deck with a monolithic joint and continues to ground level, the horizontal thrust of the arch is supported by an inclined prop-column that is connected to the deck providing a span with a portal frame/triangular cell shape. This structural layout avoids horizontal forces being transferred to the ground as the arch is tied by the two triangular frames on each side.

The overall length of the bridge is approximately 170m with the following span arrangement:

West Approach Span	3 x 20m
Main Span	90m
East Approach Span	20m

The proposed end supports are as described for Option 1.

The Geotechnical Investigation is currently ongoing and it is considered that piled foundations will be required, this will be confirmed on completion of the Geotechnical Investigation and interpretation.

Dynamic analysis will be carried out at Detailed Design Stage to detail the response to the bridge to asymmetric loading and the comfort criteria experienced by pedestrians using the bridge.

3.6 Option 4 – 5 Span Concrete Box with Steel Composite Drop in Span

The proposed superstructure provides two approach spans on either side of the river with cantilever sections formed in reinforced concrete and made monolithic with inclined intermediate supports. The deck cross section comprises twin cell concrete box with propped cantilevers for the backspan and steel box girder, with propped cantilevers, drop in span made composite with a reinforced concrete deck.

The overall length of the bridge is approximately 155m with the following span arrangements:

West Approach Span	40m
Main Span	85m
East Approach Span	30m

The proposed end supports are as described in Option 1 and it is proposed that the inclined intermediate supports will be supported on piled foundations.

3.7 Option 5 – Span Asymmetric Cable Stayed Bridge

This option proposes the construction of a three span asymmetric cable stayed bridge with a single central tower and a single plane of cables located in the middle of the deck. The spans are approximately 40, 45.0 and 97.0m. The total depth of the deck will be 2.2m giving a span depth ratio of 1/44. In general, single plane cable stayed bridges require a deeper section since the torsional resistance is provided by

the deck for the full span and not by two different planes of cables. Given the total width of the deck at 22.0m the span depth ratio is well proportioned.

A cross section consisting in a single box with long cantilevers supported by props at a certain spacing is proposed. This cross section enhances the visual impact due to the large relationship between the deck depth and the cantilever, which is more than 1:2. Additionally, it allows the construction of the transversal cantilevers independently from the central box with light temporary works, which reduces the auxiliary works during construction.

The pylon will be approximately 2m wide and will be accommodated in the central reserve integrated with the concrete barrier. This requires a total width of structure of 22.2m.

The overall length of the bridge is approximately 182m with the following span arrangements:

West Approach Span	40m, 45m
Main Span	97m

Should this option be preferred further analysis will be carried out at preliminary design stage to determine if the 40m approach span on the west side can be reduced or omitted with the use of an inverse bearing. Alternatively the mainspan deck cross section could be fabricated in steel made composite with reinforced concrete deck to reduce the weight and resultant effects.

The proposed end supports are as described in Option 1 and it is proposed that the intermediate supports and pylon will be supported on piled foundations.

4.0 TECHNICAL EVALUATION

4.1 Span Arrangement

The governing criteria for the crossing of the River Finn is to provide a single clear span to the existing channel with sufficient clearance to the river banks. On the east side the proposed supports have been located behind the existing bund whilst on the west side the river bank forms a flood plain and the pier has been located approximately 8m from the edge of the naturally formed river channel.

Hydraulic analysis is ongoing at the time of production of this report and it is currently considered that an overall minimum length of structure of approximately 160m is required to satisfy the requirements of the Office of Public Works and the Rivers Agency. Furthermore the proposed N14/N15 to A5 Link crosses the River Finn cSAC / River Foyle and Tributaries cSAC and it is therefore a requirement to minimise the impact of the proposed development on the cSAC.

The span arrangement for the Options considered are given in Table 4.1 below:

Table 4.1 Bridge Option Span Arrangements

Bridge Option	West Approach (m)	Mainspan (m)	East Approach (m)
1	30 + 33	63	33
2	26 + 5x33	63	33
3	3x20	90	20
4	40	85	30
5	40 + 45	97	N/A

4.2 Structural Depth

The structural depth of the structure is related to the span and the structural system provided for the deck. When the deck has beam behaviour, as is the case with a constant or variable deck soffit, the span/depth ratio at supports is typically between L/18 and L/25.

Additionally, the construction method can have an important impact on this factor requiring deeper sections if the bridge is going to be erected using launching methods.

Structural systems that involve suspending the deck from cables at intermediate locations allow for span/depth ratios in excess of 1:40.

It is important to note that the total structural depth of the deck will have an important visual impact as it has a significant influence on the appearance of the structure. This is more critical with relatively low piers.

Table 4.2 below summarises the structure depth associated with each of the options presented:

Table 4.2 Bridge Option Structural Depth Comparison

Bridge Option	Depth at Piers (m)	Depth at Mainspan (m)	Span to Depth Ratio Average	Depth to Clearance Ratio
1	3.2	1.9	22.5	0.35 – 0.58
2	3.2	1.9	22.5	0.35 – 0.58
3	2.5	2.5	36	0.41
4	2.9	2.9	20	0.48
5	2.2	2.2	44	0.36

4.3 Cross Section

Options 1, 2 and 4 are beam and slab type construction with the carriageway supported from below and the minimum cross sectional width of 20.5m can be accommodated with flaring of the east approach span at the interface with the roundabout.

Options 3 and 5 provide a deck supported from a centrally located arch and pylon respectively with tension system connecting the deck to the arch/pylon.

Provision of supports along the centreline of the bridge for Option 3 and 5 are feasible given the relatively short support span and improve the aesthetic merit of the structural form without significantly increasing the construction costs. However, a widening of the median is required to accommodate the cables and supporting structure.

Table 4.3 shows the minimum cross section dimensions for the design options presented:

Table 4.3 Bridge Option Minimum Cross Section

Option	Central Reserve (inc Hard Strip) (m)	Hard Strip (m)	Carriageway (m)	Footpath (m)	Parapet Upstand (m)	Total (m)
Option 1, 2, 4	1.5	2x0.5	2x7.0	2x1.5	2x0.5	20.5
Option 3, 5	3.2	2x0.5	2x7.0	2x1.5	2x0.5	22.2

5.0 ECONOMIC EVALUATION

5.1 Estimated Construction Cost

The estimated cost of the bridge options presented in this report are given in Table 5.1 below. In order to give comparable costs the overall length has been taken as 287m (i.e. the length of Option 2) and where the bridge option under consideration has a shorter overall length an additional amount has been provided to include the approach embankment and associated road construction.

Option	Description	Length	Additional Length of Embankment / Road Construction	Construction Cost Estimate Bridge (ex VAT) (Euro)	Construction Cost Estimate Embankment / Road Construction (ex VAT) (Euro)	Total (ex VAT inc Preliminaries and Contingency (Euro)	Whole Life Cost	
1	4 span steel composite	159	128	€5,039,250	€384,000	€6,372,318.75	Protected Steel Weathering Steel	€350,899 €264,515
2	8 Span Steel Composite	287	0	€8,169,250	€0.00	€9,598,868	Protected Steel Weathering Steel Reduction for omission of bearings	€534,528 €406,325 -€73,677
3	5 Span Steel Composite with Tied Arch Span	179	117	€8,680,200	€351,000	€10,611,660	€489,567	
4	5 Span Concrete Box with Steel Composite Drop in Span	155	132	€7,943,750	€396,000	€9,799,206	€332,940	
5	3 Span Asymmetric Cable Stayed Bridge	182	105	€8,996,550	€315,0009	€10,941,071	€513,682	

5.2 Assumptions Made Cost Estimate

Cost estimates are based on the following assumptions:

(i) Cost estimates are based on current September 10 rates;

(ii) The cost of excavating to earthworks outline taken under roadworks;

(iii) Estimates are based on initial Topographical Survey data;

(iv) Estimates are based on initial Geotechnical Investigations and may require revision on completion of the Geotechnical Investigation;

(v) 10% has been allowed for Preliminaries;

(vi) 7.5% has been allowed for Contingencies;

(vii) Cost estimate for Option 1 includes €150,000 for masonry cladding.

6.0 AESTHETIC EVALUATION

Drawings, images and photomontages for the options considered are included in Appendix 2. The photomontage is taken from the west side of the bridge looking east on the southern elevation.

6.1 Option 1 – 4 Span Steel Composite

Provision of a 4 span steel composite bridge with varying depth girders provides a simple and slender bridge in elevation which is in keeping with the surrounding topography. However, the provision of the fourth span required to provide the conveyance area determined by hydraulic analysis results in a non-symmetrical elevation which detracts from the elegance of a slender haunched river crossing that would be achieved with a 3 span arrangement.

In order to provide a monolithic connection at the intermediate support whilst providing a crosshead to land the steel beam gives a pier with overall width of approximately 2.2m.

Exposed concrete faces at piers and end supports will receive either a patterned finish or masonry cladding.

Provision of the approach embankment on the west side of the bridge which pinches the valley, closes up the existing flood plain and has a negative impact on the existing view across the river.

Given the location of the proposed structure consideration will be given to the use of weathering steel for the plate girders.

6.2 Option 2 – 8 Span Steel Composite

Provision of an 8 span steel composite bridge with varying depth plate girders which span the flood plain on the west side of the river and ties into the A5 WTC on the east side provides a simple elegant crossing which is slender in elevation and minimises the visual impact and structural footprint on the existing topography.

Provision of 6 approach spans on the west side unlike Option 1 with 2 approach spans leaves the viewer in no doubt that the structure is provided to span the flood plain and River Finn. The low lying structural form supporting the carriageway from below is in keeping with the surrounding environment and integrates well into the landscape.

At this stage slender reinforced intermediate supports have been shown. It is considered that it will be possible to eliminate the bearings at the intermediate supports and make the piers monolithic with the superstructure and reduce the maintenance liability. Further analysis will be carried out if this Option is progressed to preliminary design stage. Omission of bearings at the intermediate supports and provision of a concrete diaphragm will require some additional temporary works during construction.

It is proposed for this arrangement to provide reinforced concrete intermediate and end supports with a patterned finish.

Provision of a multi span viaduct allows views to be maintained along the banks of the River Finn and reduces the visual impact of the proposed structure on the

immediate environs. The design is light and open and maximises retention of the visual amenity of the valley.

Again as with Option 1 it is considered that the use of weathering steel for the plate girders should be fully explored.

6.3 Option 3 – 5 Span Steel Composite with Tied Arch Span

Option 3 is a multi span bridge with continuous structural depth and a 90m mainspan crossing the river supported by a single centrally located tied arch thus increasing the overall span to depth ratio and increasing the slenderness of the bridge in elevation.

The arch is low and the profile is critically important to the visual success of the chosen form. The profile of the arch will be subject to rigorous visual analysis and refinement if this option is progressed to preliminary design stage to provide maximum aesthetic merit of the bridge.

Provision of a single arch along the centreline of the carriageway provides structural simplicity and reduces the visual impact for the road user. The inclined supports within the flood plain are considered to be visually interesting but not an enhancement to the environment in this location.

The superstructure comprises a steel box 8.0m in width with propped cantilevers to achieve the overall carriageway width which will increase the slenderness of the bridge in elevation.

It is proposed to provide masonry cladding to the end supports.

Provision of this arrangement requires embankment over a significant length of the flood plain on the west approach which negatively impacts the view parallel to the River Finn. However, the arch superstructure is light and defines the corridor of the watercourse without being overly dominant.

6.4 Option 4 – 5 Span Concrete Box with Steel Composite Drop in Span

Option 4 provides a constant depth superstructure formed from reinforced concrete over the approach span and cantilever and a steel box with propped cantilevers over the central span to reduce applied dead load. The superstructure is made monolithic with and supported by 2 pairs of inclined supports which reduce the main span to approximately 65m.

Whilst the overall span to depth ratio is appropriate for this form of structure and the slenderness of this bridge is enhanced by the use of significant propped cantilevers, it is considered that a 2.9m deep deck with approximately 6m vertical clearance to ground level does not provide an adequate clearance to structure depth ratio.

Further, in order to achieve the minimum conveyance area below the bridge that has been calculated at this stage an asymmetric arrangement is provided with the west approach span longer than the east approach span and the river crossing not centrally located under the mainspan.

Provision of this span arrangement requires an embankment over a significant portion of the flood plain on the west approach which pinches the valley and negatively impacts the views parallel to the River Finn.

Careful detailing of the interface between the concrete and steel elements of the superstructure would be required and a rigorous visual evaluation will be undertaken if this option is progressed to preliminary design stage.

6.5 Option 5 – 3 Span Asymmetric Cable Stayed Bridge

Provision of a cable stayed bridge with the deck supported from a single centrally located pylon allows the structural depth to be reduced and the apparent span to depth ratio to be increased. This is further enhanced by the use of a centrally located box beam with significant propped cantilevers.

As the proposed cable stayed bridge is asymmetric it is proposed to provide a 40m approach span on the west side to resist uplift from the asymmetric arrangement, this also serves to open up the views parallel to the River Finn and reduce the impact of the road embankment on the cSAC.

The overall height of the pylon is approximately 32m above finished road level and should this option be progressed to preliminary design stage rigorous visual analysis of the form of pylon is required to enhance the visual merit of the proposed structure.

As with Option 3 provision of a centrally located pylon that is only 2m wide supporting the deck with cable stays along the central median provides a simple arrangement that reduces the visual impact for the road user.

7.0 EVALUATION OF MAINTENANCE REQUIREMENTS

7.1 General

All structures require regular inspections and routine maintenance during their life and some years ago the NRA commenced a programme of principal inspections for bridges and other structures on National Roads.

The River Finn bridge should be subject to regular principle inspections and routine maintenance during its design life by suitably experienced and qualified personnel. All of the options will require access by boat or mobile bridge inspection unit to enable inspection of the deck soffit.

All of the options presented can be designed to achieve the required 120 year design life. In addition the specification of suitable materials will enhance durability and reduce the maintenance liability, the following measures are proposed:

- Provide grade 50 concrete with 50% GGBS cement replacement in the superstructure and grade 40 concrete with 50% GGBS cement replacement in the substructure.
- Exposed concrete will be surface impregnated and buried concrete surfaces will be waterproofed in accordance with the NRA Specification for Roadworks. In addition the Contract Documents should make allowance for impregnation and coatings of concrete.
- It is proposed to provide stainless steel reinforcement in elements that are subject to de-icing salts and that are particularly vulnerable i.e. parapet edge beam adjacent to the carriageway and below movement joints at the end supports.
- Structural steel will be grade S355J2 to EN 10025 and hollow sections will be S355J2JH to EN10210.
- Bridge deck to be waterproofed with a spray applied system that has a current BBA/IAB Certificate
- Exposed formed concrete surfaces shall be F4/F3.
- Tension systems adopted in the design shall use current technology and best practice. The Contract Documents shall include sufficient requirements including testing to ensure the maximum lifetime of each tension system.
- Structural steel will require maintenance painting and in accordance with the NRA Specification a system will be specified that provides no maintenance up to 12 years, minor maintenance from 12 years and major maintenance after 20 years. It is considered that current protection systems will exceed the minimum 20-year period before requiring major maintenance. The superstructure undercroft can be accessed from the banks and using scaffolding from the structure or a barge. The arch can be painted using suitable means of access from the footway and cycletrack whilst maintaining reduced traffic lanes in both directions.
- The proposed structure is inland over a river with 2.5m minimum vertical clearance over normal water level and it is considered that for Options 1 and 2 which provide a steel superstructure below the deck which is not subject to direct spray from de-icing salts weathering steel could be adopted in the design. It should be noted that BD 7/01 "Weathering Steel for Highway Bridges" Clause 2.2 states that weathering steel should not be used in the following situations:

(a) in a marine environment where the structure would be affected by chloride. Where it is unclear whether a location should be classed as marine, the level of chloride in the atmosphere may be assessed according to the international Standard ISO 9223: Corrosion of metals and alloys – Corrosivity of atmospheres - Classification. The test procedure is given in ISO 9225 – Corrosion of metals and alloys - Corrosivity of atmospheres - Measurement of pollution. Further details of the test procedure are given in Appendix A. A Salinity Classification of S3 shall rule out the use of weathering steel.

(b) for structures or parts of structures where the use of de-icing salt is likely to lead to substantial deposits of chloride on steel. Surfaces, i.e. where salt laden water would flow directly over the steel.

(c) where the steel would be continuously wet or damp (see 2.5 below).

(d) where the steel would be buried in soil.

(e) in an atmosphere containing extremes of atmospheric pollution or concentrated corrosive industrial fumes. Where the classification is unclear the level of atmospheric pollution can be classified according to ISO 9223 using the measurement procedures given in ISO 9225.

(f) for crossings over water where the headroom is less than 2.5 metres.

(g) environments with pollution levels above P3 would rule out the use of weathering steel. Note, however, that this classification is based on levels of atmospheric sulphur compounds. If a source of other contamination is suspected, such as a specific industrial pollutant this will require special consideration.

2.2(f) requires a minimum headroom of 2.5 over water. Whilst the 100 year flood level is within 2.5m this equates to a 1:5 year flood return period.

Weathering steel bridges offer the following advantages over conventional steel bridges;

- Low maintenance – periodic inspection and cleaning should be the only maintenance required to ensure the bridge continues to perform satisfactorily. Weathering steel is therefore ideal where access is limited or dangerous;
- Initial cost benefit – cost savings from the elimination the protective paint system outweigh the additional material costs (the use of weathering steel requires a sacrificial thickness of approximately 1mm to be provided to exposed surfaces);
- Whole life cost benefits – the minimal future maintenance requirements reduces the whole life cost of weathering steel bridges;
- Speed of Construction – construction durations are reduced as both shop and site painting operations are eliminated;
- Appearance – the appearance of mature weathering steel bridges blends pleasingly with a rural environment;
- Environmental and Health and Safety – the environmental and health and safety problems associated with painting operations are eliminated.

However, the use of weathering steel where expansion joints are used requires careful consideration. A positive non metallic drainage system will be provided to convey any water away from the steelwork, in addition the ends of the beams will either be painted or cast into a concrete diaphragm.

Runoff from the steelwork during the initial years, as the protective rust patina develops, will contain corrosion products which may stain substructures. This problem can be avoided by providing drip details on the bottom flanges of girders and ensuring that bearing shelves have adequate falls to internal substructure drainage systems. It is considered that rust staining should not occur on a well detailed weathering steel bridge. As an additional precaution concrete substructures should be protected from rust staining by wrapping them in a protective sheet until construction is complete.

During handling and erection care is required to ensure that the developing rust patina is not damaged. Although the patina will redevelop it will appear non-uniform until that time. In addition grout runs from concrete deck pours should be avoided.

Whilst the use of weathering steel is not common in Ireland, a report completed by McKenzie; 'The performance of in-situ weathering steel in bridges' indicates that weathering steel bridges built over the last 20 years are generally performing well. Where problems have been encountered they have typically been the direct result of specific faults such as leaking deck joints, rather than any inadequacy in corrosion performance. It is considered that benefits of weathering steel outweigh the potential problems, which can be avoided by good detailing at design stage and good construction practice.

The following gives an indication of the durability and future maintenance needs for each Option.

7.2 Option 1 – 4 Span Steel Composite

Substructure – the substructure consists of reinforced concrete and reinforced earth which should not incur any substantial maintenance requirement.

Bearings and Joints – it is proposed to make this Option fully monolithic at the intermediate support thus reducing the number of bearings required. However, mechanical bearings and expansion joints are required at the end supports. Bearings and movement joints will require maintenance and replacement at the end of their design life. The end supports will include provision for abutment galleries to allow full inspection of these components and to assist with the eventual replacement. The bridge will be designed to allow bearing and joint replacement with single lane closures.

Superstructure – the superstructure comprises a steel beam with 3 pairs of fabricated plate girders made composite with a reinforced concrete deck. For steel plate girders sacrificial thickness of steel would be allowed for in the design. Carbon steel will require maintenance painting alternatively consideration should be given to the use of weathering steel as discussed in Section 7.1 above.

Parapets and Guardrails - aluminium alloy vehicle parapets are virtually maintenance free and the performance of protection is also acceptable.

7.3 Option 2 – 8 Span Steel Composite

The durability and maintenance requirements for the structural elements are similar to Option 1. However, for this Option the drawings included in Appendix B currently describe a continuous superstructure supported on bearings at intermediate supports thus increasing the maintenance liability. It is considered that it may be possible to make the superstructure monolithic at intermediate supports and if this Option is

preferred, further analysis will be carried out at preliminary design stage to mitigate this maintenance liability.

7.4 Option 3 – 5 Span Steel Composite with Tied Arch Span

Substructure – the substructure end supports and intermediate supports on the west approach comprises reinforced concrete and reinforced earth which should not incur any substantial maintenance requirement.

Bearings and Joints – it is proposed to provide mechanical bearings and expansion joints at the end supports. Bearings and movement joints require maintenance and replacement at the end of their deign life. The end supports will include provision for abutment galleries to allow for inspection of their components and to assist with eventual replacement. The bridge will be designed to allow bearing and joint replacement with single lane closures.

Superstructure – the superstructure comprises a double cell steel box with propped cantilevers made composite with a reinforced concrete deck slab. A single centrally located tied arch supports the main span.

The steel elements of the superstructure will require maintenance painting and access provision. However, the main arch member is not of sufficient size to allow access within the box there are a number of methods to improve durability within steel box sections as follows:

(i) Ensure the section is adequately sealed and free from durability problems and verify with adequate leak testing to be specified in the contract documents. The design and detailing of the steelwork will minimise the risk of any corrosion occurring. Completely sealing the box will prevent the ingress of atmospheric, surface and sprayed moisture / water and hence the onset of corrosion. However, the risk of condensation within the box section is an issue, which will have to be negated in order to reduce the probability of corrosion initiated by the build up of condensation.

(ii) The installation of a de-humidifier, which does not provide a sealed section. The relative humidity of air in normal atmospheric conditions in Ireland is approximately 70%, which is a sufficient value for the onset of corrosion. However, if the relative humidity is kept below 45-50%, steel will not corrode. Therefore, by keeping a constant, low atmospheric humidity, the steel internal plates will be protected from corrosion. This principle has been used successfully on a number of major steel cable-stayed bridges around the world (e.g. Nordhordlandsbroen in Bergen, Norway, constructed in 1995 and the newly built Lupu Bridge in Shanghai). Air / water vents can be included in the design, this does not provide a sealed section. These would be located at discrete locations. Careful detailing would be required to ensure that any such vents will themselves not lead to a local corrosion problem. Whilst the presence of vents and good bridge detailing will significantly reduce the risk of free standing water building up within the section (which would result in the corrosion process starting very quickly), corrosion will still nonetheless start at relative humidity values in excess of 60%.

However, in this case it is proposed to provide a steel / concrete composite section for the main arch and therefore particular additional requirements are not applicable.

The structure will be designed to allow replacement of individual cable stays which can be replaced using suitable mobile elevated working platforms and temporary

works in the median and adjacent lanes whilst maintaining traffic lanes reduced to 3.5m in both directions.

Parapets and Guardrails – aluminium alloy vehicle parapets are virtually maintenance free and the performance of protected steel is also acceptable.

7.5 Option 4 – 5 Span Concrete Box with Steel Composite Drop in Span

Substructure – the substructure end supports consists of reinforced concrete and reinforced earth and should not incur any substantial maintenance requirements.

Bearings and Joints – it is proposed to provide mechanical bearings and expansion joints at the end supports. Bearings and movement joints require maintenance and replacement at the end of their design life. The end supports will include provision for abutment galleries to allow for inspection of these components and to assist with element replacement. The bridge will be designed to allow bearings and joint replacement with single lane closures.

Superstructure – the superstructure comprises post-tensioned reinforced concrete twin cell box with propped cantilevers for the approach span and a twin cell steel box made composite with reinforced concrete deck slab for the central section of the mainspan.

Concrete elements of the superstructure should not incur significant maintenance costs. The steel elements of the superstructure mainspan will require maintenance painting if carbon steel is adopted in the design and provision for a permanent means of access.

Parapets and Guardrails – aluminium alloy vehicle parapets are virtually maintenance free and the performance of protected steel is also acceptable.

7.6 Option 5 – 3 Span Asymmetric Cable Stayed Bridge

Substructure – the substructure end supports consists of reinforced concrete and reinforced earth and the intermediate support and pylon consists of reinforced concrete which should not incur any substantial maintenance requirements.

Bearings and Joints – it is proposed to provide bearings at the end supports and intermediate supports and movement joints at the end supports. Bearings and movement joints require maintenance and replacement at the end of their design life. The end supports will include provision for abutment galleries and jacking points will be provided at bearings to allow for inspection of these components and to assist with eventual replacement. The bridge will be designed to allow bearings and joint replacement with single lane closures.

Superstructure – the superstructure comprises a central post-tensioned reinforced box with propped cantilevers and additional back span is provided to reduce the environmental impact on the cSAC designated area, improve conveyance area for flooding and to balance the weight of the mainspan. Provision of concrete in the superstructure should not give rise to any substantial maintenance requirements.

In order to reduce the self weight of the mainspan and balance the dead load effects consideration has been given to the use of a single cell steel box with propped cantilevers for the mainspan. This will have an effect on the overall aesthetic merit of the bridge in elevation and will require careful detailing at the interface. Provision of

a structural steel section of the bridge will require maintenance painting during the life of the structure.

Parapets and Guardrails – aluminium alloy vehicle parapets are virtually maintenance free and the performance of protected steel is also acceptable.

8.0 HYDRAULIC CONSIDERATIONS

8.1 Previous Studies Considered

Roughan & O'Donovan have reviewed the following reports either received from Donegal NRDO or downloaded from the OPW Flood Hazard Mapping website and the Rivers Agency website:-

- River Finn Flood Study – Mott MacDonald
- Effect of Development at Lifford Road on Flood Levels Around Strabane – WL|Delft Hydraulics
- River Finn Model – Mouchel
- Strabane Flood Protection, Report on Feasibility Study – WDR & RT Taggart
- Rivers Agency Strategic Flood Maps
- Recorded Gauge Data from both OPW and Environment Agency

Table 8.1 gives details of the various flood levels obtained from the above reports.

Table 8.1 Details of Flood Levels

Source	Location	Level (mOD Malin) / Flow m^3/s
River Finn Flood Study – Mott MacDonald 1 in 100yr + Climate Change	Approx 100m downstream	7.79mOD / 7.08m^3/s
Effect of Development at Lifford Road on Flood Levels Around Strabane – WL|Delft Hydraulics	Confluence of Mourne & Finn	6.66mOD (Malin) / na
River Finn Model – Mouchel (1in100yr)	At proposed bridge crossing	6.35mOD

8.2 Design Flood Estimation & Hydraulic Modelling

ROD have carried out flood flow estimation based on catchment characteristic methods which have been verified against Extreme Variable Distributions (Standard Gumbel 1 & Frechet) of the available annual maxima gauge data.

A 1-Dimensional Steady Flow Hydraulic Model of a localised reach (approx. 500m) of the River Finn has been developed using HEC-RAS in order to establish the flood levels.

The Design Flood Level has been estimated as 6.5mOD for the 1 in 100yr flood event (inc. Climate Change) based bridge length of 120m – 140m.

Further modelling will be carried out to develop a detailed Flood Risk Assessment for the scheme based on the selected bridge option.

The detailed flood modelling will be calibrated against the more extensive 2-Dimensional MIKE currently being undertaken by Mouchels as part of the A5 Western Transport Corridor Scheme.

8.3 Consultations

Consultations are ongoing with both the Rivers Agency and the OPW in order to determine their specific requirements for this bridge crossing. In general the following design criteria have been used for the Hydraulic analysis of the bridge:-

- Bridge to convey a 1 in 100yr Flood Event (1% AEP) including 20% increase for Climate Change
- Afflux to be assessed against risk of flooding of properties – general maximum level permitted 300mm where no significant risk exists (OPW)
- Bridge structure is not to increase risk of flooding either upstream or downstream
- Freeboard of 500mm to be provided above flood level

The proposed bridge will be subject to full OPW (Section 50) and Rivers Agency (PPS 15/Schedule 6) approvals.

9.0 HEALTH AND SAFETY CONSIDERATIONS

The brief for this project includes the appointment of ROD as Project Supervisor Design Process (PSDP). During all stages of the design process, ROD will comply with the General Principles of Prevention as specified in the Safety, Health and Welfare at Work (Regulations). In addition the brief requires that where relevant, Northern Ireland Health and Safety Legislation (Construction, Design and Management) Regulations (2007 NI) should be complied with.

A Designers Risk Assessment for the Bridge Options Stage has been completed during the development of the options described in this report which considers the risks associated with provision of a bridge crossing at this location and specific risks associated with each option. A copy of the "Design Options Study – Designer Risk Assessments" is included in Appendix 3.

The Designer Risk Assessment is a live document and will be reviewed and updated for the preferred option during the preliminary design and detailed design phases of the project.

The Project Supervisor Construction Stage (PSCS) is required to take specific measures to mitigate and manage residual risks during construction.

In addition it is considered that the Contract Documents should specify Independent Category 3 checks of all major elements of temporary works and the transportation and erection of prefabricated elements.

The drawings will include a detailed indicative construction sequence, which fully describes the construction sequence assumed in the analysis.

A safety file is required to be produced by the PSDP. The following is a non-exhaustive list of contents that should be included in the safety file.

- Risk Assessments;
- Road Safety Audits;
- Health and Safety Plan;
- Preliminary Design Report;
- Details of Subcontractors and Other Contractors on Site;
- Insurance Details of all Contractors on Site;
- Main Contractors and subcontractors Safety Statement / Policy;
- Traffic Management Layouts;
- Diversion Routes;
- Construction Drawings;
- As Built Drawings;
- As Built Erection Sequence;
- Data sheets for proprietary products;
- Specification;
- Copy of Method Statements;
- Details of temporary works including drawings, calculations and design/check certificates;

- Statement of General Design Criteria;
- Details of Equipment and Operation/Maintenance requirements;
- Maintenance Procedures and Manuals;
- Relevant Certificates from Suppliers / Manufacturers / Specialist Contractors etc;
- Details of Location and Nature of Utilities and Services

10.0 CONSTRUCTION AND BUILDABILITY

10.1 General

The design and construction of bridges with major spans, typically any span over 50m, needs a careful consideration of the methods of construction. The dimensions and quantities of many structural elements, which will be part of the permanent works, will be governed by transient loading scenarios during construction. Additionally, the relative costs of temporary works represent an important part of the total cost of the structure.

The influence of the construction sequence on the total cost of the structure is increased even more when there is no possibility of placing intermediate supports during construction.

In the particular case of the Finn crossing, where the river plus banks require a clear span of approximately 63m with a significant flood plain on the west side of the river. Provision of a bridge support within the river has a negative impact on the existing environment and hydraulic capacity.

The following gives an indication of the envisaged construction sequence associated with each option.

10.2 Option 1 - 4 Span Steel Composite

Stage 1	Secure site and provision of required access
Stage 2	Excavation, pile testing and installation of piles
Stage 3	Off site fabrication of structural steel
Stage 4	Construction of end supports, pile caps and intermediate piers
Stage 5	Prepare hard standing east and west side for cranage (including ground improvement if required – subject to Geotechnical Investigation)
Stage 6	Delivery of prefabricated steel plate girders to site
Stage 7	Prepare plate girders and brace together for erection
Stage 8	Install bearings
Stage 9	Mobilise and erect crane east side
Stage 10	Erect structural steelwork and permanent formwork approach spans and cantilever east side
Stage 11	Mobilise and erect crane east side
Stage 12	Erect structural steelwork and permanent formwork approach span and mainspan
Stage 13	Finishes

10.3 Option 2 – 8 Span Steel Composite

Stage 1	Secure site and provision of required access
Stage 2	Excavation, pile testing and installation of piles
Stage 3	Off site fabrication and protection of structural steel
Stage 4	Construction of end supports, pile caps and intermediate piers
Stage 5	Prepare hard standing east and west side for cranage (including ground improvement if required – subject to Geotechnical Investigation)
Stage 6	Delivery of prefabricated steel plate girders to site

Stage 7 Prepare plate girders and brace together for erection

Stage 8 Install bearings

Stage 9 Mobilise and erect crane east side

Stage 10 Erect structural steelwork and permanent formwork approach spans and cantilever east side

Stage 11 Mobilise and erect crane west side

Stage 12 Erect structural steelwork and permanent formwork approach span and mainspan

Stage 13 Finishes

10.4 Option 3 – 5 Span Steel Composite with Tied Arch Span

Stage 1 Secure site and provision of required access

Stage 2 Abutments and approach embankments are built up to deck soffit level. Simultaneously the inclined columns and arch section under deck level are built on temporary supports.

Stage 3 The steel section of the deck is assembled on both approach embankments and launched from both sides until the mid span of the main 90.0m span. The North launch is 115.0m long and the South section of the launch is 75.0m long. This will require works within the lands made available for the A5 WTC and will require co-ordination and agreement with the Designer/Contractor of that scheme and Roads Services Northern Ireland. To avoid overturning the south section requires a counter weight during launching, this can be provided with temporary elements or by pouring the top slab in the last 30.0m prior to launching.

The bottom 10.0m of the steel arch and its connection with the deck will be launched along with the deck.

Stage 4 Once the steel deck has been connected at midspan, the central part is lifted into position and the arch props are removed. Then the connection of the lower part of the arch and the inclined column are connected providing the full structural continuity of the triangular cell.

Stage 5 Once the structural arrangement for the main span has been provided, the concrete can be placed. The arch is then filled with self compacting concrete both in its section over the deck as well as in the lower leg under the deck and the inclined column.

Stage 6 When the arch concrete has achieved the required strength the vertical cables are placed and tensioned recovering the deflections on the steel section of the deck during launching.

Stage 7 Finishes

10.5 Option 4 – 5 Span Concrete Box with Steel Composite Drop in Span

Stage 1 Secure site and provision of required access

Stage 2 Abutments and approach embankments are built up to final road level. Simultaneously the inclined columns are built on temporary supports and scaffolding.

Stage 3 The central box for the side spans are built on temporary supports / scaffolding and connected to the inclined columns. Once the inclined columns are connected to the deck and the structure behaves

longitudinally as a triangular cell which is a very efficient system to support the loads form the main span.

Stage 4 At this stage, by using a transversal travelling form as described above, the remaining part of the cross section can be built. Simultaneously, the steel section of the main span is built in two stages, in a first stage the part outside the river is built with the help of temporary supports.

Stage 5 The remaining part of the deck is the section over the river this part is erected by lifting the section from the river where it is transported or by the use of heavy craneage from the river bank.

Stage 6 Once the central steel box is connected to the concrete approaches the top slab of the central section can be built and the bridge superstructure is completed.

Stage 7 Finishes

10.6 Option 5 – 3 Span Asymmetric Cable Stayed Bridge

Stage 1 Secure site and provision of required access

Stage 2 Abutments approach embankments are built up to final road level. Simultaneously the lower part of the pylon is built up to deck level.

Stage 3 The central box for the back spans is built on temporary supports / scaffolding and connected to the pylon support. At this stage the construction of the pylon using climbing forms will start as well.

Stage 4 In order to avoid a clash between the transversal travelling from constructing the cantilevers of the back span and the back stays the travelling form will advance from the central pylon towards the north abutment. Simultaneously, the main span central beam will be erected with first stage stressing of the fore sprays.

Stage 5 This procedure is repeated for the total length of the main span with independent transversal form constructing the cantilever to avoid a clash with the centrally located cable stays. Re-stressing the cables to achieve the final deck geometry, at this moment the scaffolding of the back span can be removed.

Stage 6 Finishes

11.0 GROUND CONDITIONS

11.1 General

This section considers the suitability of the different bridge design options to the ground conditions.

The general geomorphology of the wider region is influenced by bedrock geology as the Rivers Finn, Deele, Mourne and consequently the Foyle follow several structural features caused by faulting, volcanic and later glacial activities.

The study area itself includes various soils; glacial tills, glaciofluvial, alluvial and organic deposits associated with the River Finn.

11.2 Alluvium and Organic Deposits

Soft ground conditions are prevalent in the vicinity of the River Finn crossing. The soft ground conditions are caused by a combination of the geological faulting, river morphology and high water table.

These typically comprise soft cohesive and loose to medium dense alluvial flood plain soil deposits overlying glacial soils. A sandy river terrace feature is also evident in places. The river navigates the lowland areas towards Lifford, spilling over the river banks and artificial levees into the flood plains on either side during periods of high flow accompanied by intense rainfall. Ponding of surface water aids the development of these boggy/marsh areas. These soils are normally consolidated and thus are moderately to highly compressible.

On the northern approach from the ROI, the flood plain retains flood waters and allowing further deposition of soft sand and silt. Man-made drainage channels allow most of the flood waters to recede reasonably quickly however several discrete areas remain soft. The area closest to the riverbank is slightly firmer underfoot but even so, investigation of this area identified that loose sands and soft clays are present to a total of 25m depth, below which stiff clays and very dense gravels overly bedrock which is at >35m depth.

On the southern approach from NI, the flood plain is quite similar but lacks the man-made drainage channels that allow flood waters to recede so quickly. Investigation of this area identified that the loose sands and soft clays are present to depths of between 5m and 10m depth, below which glacial tills and glaciofluvial sands, gravels and clays overly bedrock which rises up to a minimum depth of 11m at the far-side of the proposed A5 roundabout.

Deep alluvium presents high risk areas which will be prone to large settlements and potential instability of road embankments and temporary works during construction.

11.3 Underlying Bedrock

The area surrounding Lifford is founded on Ballymore and Croghan limestone formations. The bedrock quality and strength is important if it is to support a large bridge structure.

The majority of the study area itself is founded in the Lough Foyle Succession, primarily that of the Claudy formation which consists of psammites/pebbly grit/quartzite/marble/schist. There exists several fault lines around this that cross the

study area in a south-west to north-east direction and converge close to Lifford. Therefore rock type and level in this region varies significantly.

Site investigation results for the location of the proposed Link are yet to reach bedrock within the confines of the river and its flood plain. It is at depths greater than 30m to 35m, and on occasion is beyond the capabilities of standard drilling equipment where sands and gravels are present. In very dense granular deposits it can be difficult to maintain sufficient pressure at the drilling head so blowing of sands leads to termination of drilling without proving rock.

Further drilling is yet to commence at several key foundation locations. The depth to rock and the density of soils suitable for providing skin friction and end bearing resistance to driven displacement piles will determine the appropriate foundation design. Variability in the strata may affect this, so an average depth of piling and liely range of minimum/maximum depths may need to be assessed in the structural design.

Rock testing results on quartzite/phyllite and marble in the area showed that the majority has unconfined compressive strengths of 60MN/m^2 or less, but occasional results of up to 300MN/m^2 were encountered.

11.4 Foundation Design

The existing ground conditions consist of soft soils overlying glaciofluvial deposits and moderate to very strong rock. For all the bridge options, it is considered that the intermediate and end supports will be supported on piles driven or bored into dense sands and gravels or very stiff to hard glacial tills to provide a solid foundation.

It is also considered that piled platforms or ground improvement will be required to support craneage required for the erection of steel beams.

The Geotechnical Investigation is ongoing at the time of production of this Bridge Options Report.

12.0 CONSULTATION WITH RELEVANT AUTHORITIES

ROD have prepared and issued an Environmental Impact Assessment Scoping Document to the following relevant Authorities:

Republic of Ireland:

Section	Authority
	The Office of Public Works
Environment & Planning	Fáilte Ireland
Heritage Officer	An Taisce - The National Trust of Ireland
	The Arts Council - Planning Department
Planning Officer	The Heritage Council - Planning Department
Director of Services	Donegal County Council - Roads and Transport
Director of Services	Donegal County Council - Planning and Economic Development
Director of Services	Donegal County Council - Water, Environment and Emergency
Director of Services	Donegal County Council - Community, Culture and Enterprise
Director of Services	Donegal County Council - Housing
Minister for Communications, Energy & Natural Resources	Department of Communications, Energy & Natural Resources
Co-Ordination Unit	Department of Communications, Energy & Natural Resources
Minister for Agriculture, Fisheries and Food	Department of Agriculture, Fisheries and Food
Minister for Environment, Heritage & Local Government	Department of Environment, Heritage & Local Government
Minister for Enterprise, Trade and Innovation	Department of Enterprise, Trade and Innovation
Minister for Transport	Department of Transport
	Waterways Ireland
Development Applications Unit	Department of Environment, Heritage & Local Government
National Monuments Section	Department of Environment, Heritage & Local Government
National Parks and Wildlife Service	Department of Environment, Heritage & Local Government
Environment Department	National Roads Authority
	The National Archaeology & History Museum
	National Museum of Ireland
	Bat conservation Ireland
	Birdwatch Ireland
	Irish Farming Association
	Teagasc
Ballybofey Local Advisory Office	Teagasc
	Geological Survey of Ireland
	Ordnance Survey Ireland

Section	Authority
	Department of Land Commissions

Northern Ireland

Section	Authority
Divisional Manager	Roads Service Northern Ireland
Divisional Planning Manager	Planning Service
Natural Heritage	Northern Ireland Environment Agency
CDP, Natural Heritage	Northern Ireland Environment Agency
Water Management Unit	Northern Ireland Environment Agency
Built Heritage	Northern Ireland Environment Agency
Geological Survey of Northern Ireland	Department of Enterprise, Trade & Investment
Chief Executive & Clerk	Strabane District Council
Director of Environmental Health	Strabane District Council
Director of Technical and Leisure Services	Strabane District Council
Director of District Development	Strabane District Council
Director of Administration	Strabane District Council
	Rivers Agency
	Crown Estate Managing Agent
	Loughs Agency
	Strabane/Lifford Anglers Association
	Ulster Angling Federation
	Sustrans Northern Ireland
Secretary	Strabane Chamber of Commerce & Trade
	Strabane Police Station

The scoping document gives an introduction to the scheme, describes the existing road network, how the scheme has developed and the aim of the proposed scheme with relevant drawings and location maps. ROD are currently tracking the responses received from the relevant Authorities and completing a database of specific requirements and responses issued. Relevant particular requirements which are agreed with the NRA and Donegal County Council will be adopted in the design.

13.0 ENVIRONMENTAL CONSIDERATIONS

13.1 Environmental – Ecological Impacts

Habitats and Flora

The terrestrial habitat present is primarily wet grassland which in itself is not considered to be of significant ecological interest. The aquatic habitat within the river is very limited as the river is heavily channelized in this area. There are a number of hedgerows and treelines within the site.

Fauna

Otter are present within the River Finn in the immediate vicinity of the proposed crossing. While no holts were recorded the lands on the County Tyrone side will need a pre-construction survey to confirm this situation.

There is considerable bat foraging activity along the Finn and some of the mature trees on the field boundaries may host bat roosts. The future bat surveys will further inform this situation.

Salmon do not spawn in the area although the river in this area is likely to be of importance to salmon as holding habitat where they will await flood conditions prior to moving upstream (and is likely therefore of interest to anglers).

There is a recognised wintering population of Whooper Swans in the Lower Finn Valley. However there are no records of swans using the area in the vicinity of the proposed Link. Similarly the river banks in the vicinity are not suitable for nesting Kingfisher.

River Finn cSAC / River Foyle and Tributaries cSAC

The primary ecological impact relates to the designation of the river and the floodplain (County Donegal) as candidate Special Area of Conservation (cSAC). As a result the project requires the completion of an Appropriate Assessment in accordance with Article 6.3 of the Habitats Directive.

Both otter and salmon are Annex 1 species and are selection features of the cSAC. As such it is imperative that impact on either species during the construction or operation of the scheme is minimal. It is considered that by clear spanning the river, timing construction adjacent to the river to avoid main salmon migratory periods and by adherence to strict water pollution prevention measures impact on these species can be avoided.

With respect to habitats the main impact will be loss of the wet grassland within the floodplain. This habitat is not a selection feature of the cSAC. However the conservation objectives for the cSAC refer to the need to maintain the 'integrity, extent and biodiversity of the cSAC'. Against that objective it is important that the impact on the floodplain is minimised as far as possible and that a hydrological assessment be undertaken to ascertain if there will be any impact on the existing hydrological regime. Any change to the existing hydrological regime which could influence habitats present or result in increased sedimentation will result in negative conclusions in the Appropriate Assessment.

Bridge Options

Based on the above information it is clear that the bridge which has the least impact on the candidate Special Area of Conservation will be the favoured option from an

ecological impact perspective. The impact on the cSAC will arise as a result of direct loss of floodplain habitat and the potential changes on the current hydrological regime. Bridge Options 1, 3 and 4 have a length of embanked approach road on the west side and will have the greatest impact on the cSAC. Bridge Option 5 has greater clearance than Options 1, 3 or 4 but Bridge Option 2 has the least direct loss of floodplain habitat and is therefore the favoured option.

13.2 Environmental – Archaeology and Cultural Heritage Impacts

There are 21 recorded archaeological sites within a 2km radius of the proposed development. None of these sites are located within the footprint of the bridge or associated road take. However, there are a number of recorded sites along the banks of the River Finn close to the scheme denoting activity from the Prehistoric onwards. These sites include a battle fought in 1588 (see below).

There are also several recorded Industrial Heritage sites within the vicinity of the scheme. While no recorded sites are located within the boundaries of the scheme, it should be noted that the former line of the Strabane to Killybegs railway ran across the County Tyrone end of the site. This railway line appears to have since been removed.

There are four Historic Buildings within the vicinity of the scheme. These are not located within the boundaries of the proposed development and will not be physically impacted upon. However, they have been awarded scheduled protected status which means that their setting must be taken into account and as such the visual impact on them must be taken into account.

Several battles are recorded within the area as it was an important crossing point between Tyrone and Donegal. One of these battles (Carricklee, 1588) is noted as incorporating the County Tyrone side of the scheme.

Bridge Options

In archaeological terms the five bridge options all have the potential to impact Archaeology and Cultural Heritage through direct impact on buried or unrecorded remains.

13.3 Environmental – Agricultural Impacts

The chosen route of the N14 / N15 to A5 Link road was directed by the location of the proposed roundabout on the A5 Western Transport Corridor in County Tyrone. The scheme will be approximately 450m in length, of which the link road lies primarily within lands in County Donegal.

In County Tyrone one landowner will be affected and in County Donegal three landowners will be affected. The route will not result in severance from main land holdings for any landholder and all five bridge options will have the same agricultural impact.

13.4 Environmental – Socio-economic Impacts

The strategic aim of the proposed N14 / N15 to A5 Link is to eliminate the bottleneck at the border between Strabane and Lifford which will be exacerbated by the coming online of the A5 WTC. The Link will increase the capacity of the crossing between the N14 / N15 and the A5 resulting in shorter journey times on the strategic route, Letterkenny to Strabane / Northern Ireland and Dublin. This will have positive

economic impacts for both Lifford and Strabane and the people living and working in the area.

All five bridge options can be considered equally beneficial in this respect as they provide the required link road.

13.5 Environmental – Air Quality

All five bridge options will have similar impacts on Air Quality during both Construction and Operational Phases.

13.6 Environmental – Noise and Vibration

The construction and operation of each bridge option will have similar noise and vibration impacts. The sensitive receptors are primarily the residential properties located along the N15 in County Donegal. For all five options the construction of the access road will be the main impact.

13.7 Environmental – Landscape and Visual Impact

The proposed bridge and link road is located in the low lying pastoral landscape of the Finn Valley. Upstream, to the south and west, the land is heavily agricultural with the Finn Valley giving way to gently rolling drumlins. To the north the ground rises quite steeply to the heather topped summit of Croachan Hill, while to the north and east the landscape quickly becomes urban in character as the view turns towards Strabane and Lifford.

A review of the Development Plans in both jurisdictions reveals that the landscape is not designated and is not considered sensitive to change.

Landscape impact depends on the sensitivity of the landscape resource and the magnitude of landscape change to be imposed by the development. As the proposed bridge does not lie within a sensitive landscape, the impact with respect to bridge options is based on the magnitude of change. In this instance the reduced length of embankment and the slim-line deck and supports of Bridge Option 2 ensure that this option will have the least impact, being sympathetic to the surrounding low lying ground. Bridge Options 3 and 5 will clearly produce the greatest change as they will, by their design, be dominant in the landscape and be visible from a significant distance.

Bridge Option 5 combined with its location on the urban entrance to Strabane and Lifford produces a dominant and very strong change in the landscape. However this bridge could serve to define the boundary between urban and rural. This place-making nature of this option also has the potential to become associated with the renowned steel sculptures (The Millennium Sculpture – 'Let the Dance Begin') on the Lifford Road roundabout on the Strabane Bypass and the proposed cable-stayed footbridges over the River Mourne in Strabane Town Centre.

Visual impact relates to the changes in the character of the available views and the changes in the visual amenity felt by the visual receptors. Views of the bridge crossing are considerably restricted as a result of the low lying nature of the area. It lies below the existing roads and the views are substantially interrupted by the presence of numerous hedgerows, treelines and woodland copses. On that basis the existing available views will not be significantly altered by Bridge Options 1, 2 and 4, with the slim-line nature of Bridge Option 2 again being the favoured option in this case. Due to the height of the structures Bridge Options 3 and 5 will impact the character of the existing available views.

With respect to visual amenity the primary receptors will be the local residents and people travelling through and visiting the area. People living locally are used to the existing rural environment and therefore a change as major as Bridge Options 3 and 5 will not appear in keeping with their environment. The subtleness of Bridge Option 2 is therefore the favoured design from this perspective.

However, in terms of people travelling through the area the main transport route, when in operation, will be the new A5 WTC. The bridge location will be visible from this road as you drive south from Strabane. The new road will introduce a substantially greater sense of development into the existing environment and Bridge Option 5 will provide clarity, defining the boundary of the urban environs of Strabane and Lifford and the rural countryside.

13.8 Environmental – Construction Impacts

The impacts of constructing the link road from the N15 and the connection to the A5 roundabout will be similar for each bridge option, with the length of the approach road and requirement for fill being the primary factor for consideration in terms of construction impact. Bridge Option 2 has the least impact when assessed against this issue.

13.9 Environmental – Conclusion

Each of the environmental constraints does not have the same significance as the others and certain constraints should therefore be considered more influential than others. In this instance the presence of the cSAC and the need to minimise any impact on it must be given higher weighting than the other constraints. With respect to this Bridge Option 2 is the preferred option.

The remaining environmental issues, which are secondary to the presence of the cSAC and for which the Bridge Options can be ranked, are primarily Archaeology and Cultural Heritage and Landscape and Visual. Both of these identify Bridge Option 2 or 5 as the preferred option.

14.0 RECOMMENDATIONS

The proposed bridge options crossing the River Finn described in this report have been evaluated under the key headings. For each criteria a mark of between 1 and 5 has been allocated (1 being the score highest score and 5 being the lowest score) and the results are tabulated below:

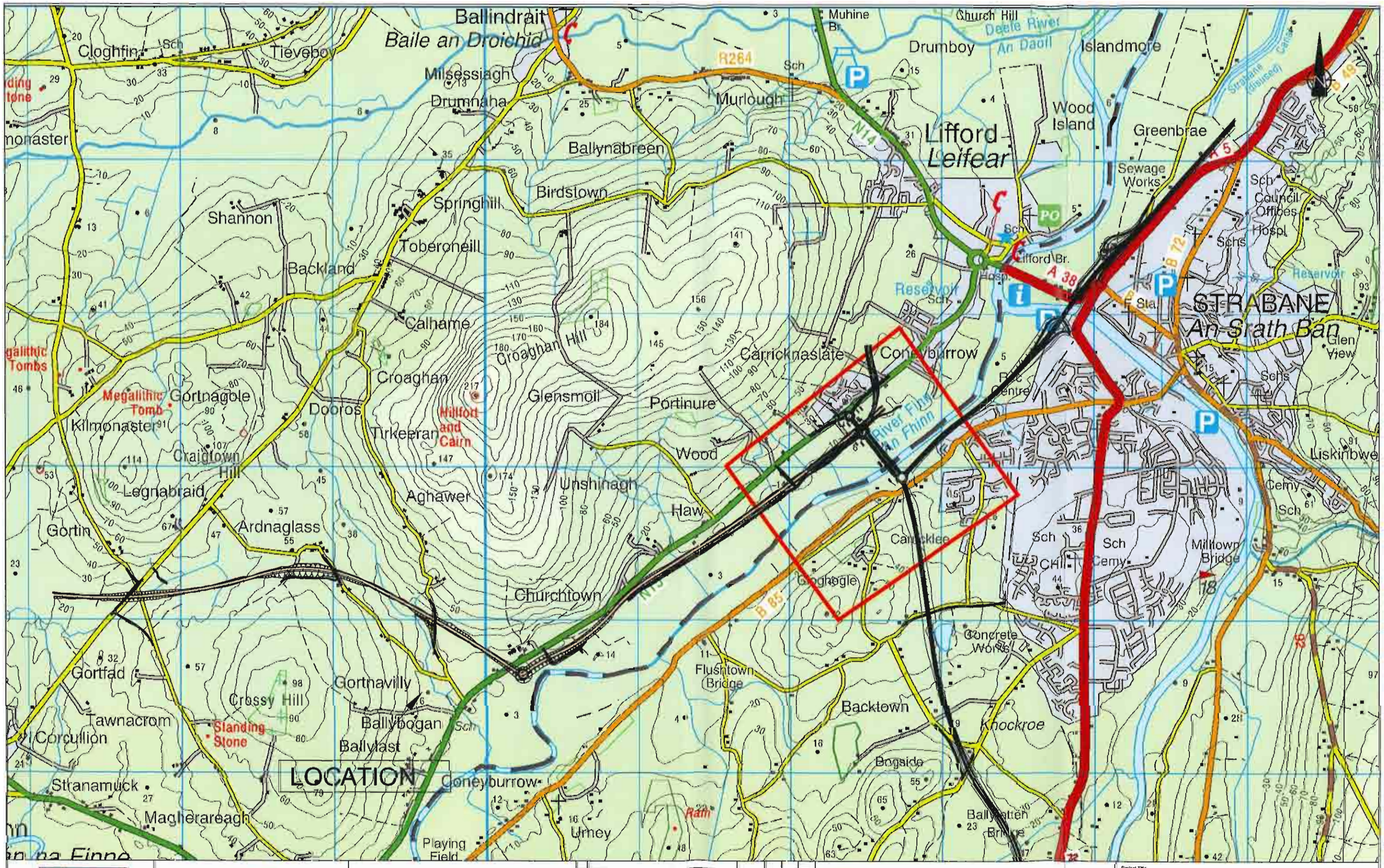
	Option 1	Option 2	Option 3	Option 4	Option 5	
Technical Evaluation	1	1	1	1	1	All options satisfy the technical requirements of the project
Economic Evaluation	1	3	4	3	4	See Section 5
Aesthetic Evaluation and Visual Impact	3	1	2	4	2	Option 2 least visual intrusion however Option 3 and Option 5 provide a slender addition to the landscape which is at the boundary between the urban and rural for the proposed development
Maintenance Requirements	1	1	3	2	2	Assumes weathering steel adopted in the design of options 1+2 and concrete in the case of Option 5 and Option 2 developed to omit bearings at intermediate supports
Maintenance Requirements	*2*	*3*	*3*	*2*	*2*	*Alternative score if Protected Steel used in Options 1 and 2*
Hydraulic Considerations	3	1	3	3	2	Option 2 spans the floodplains, Option 5 provides additional conveyance.
Health and Safety	2	2	3	3	3	See Risk Assessment Appendix 3
Construction and Buildability	2	2	4	3	2	Options 1 and 2 provide traditional forms of construction significant craneage required , Option 3 Launched requires additional land from A5 WTC, Option 4 temporary works and drop in span, Option 5 Temporary works and cable stayed staged construction
Environmental Considerations - Impact on the c SAC	4	1	4	4	2	Option 2 spans the cSAC with no embankment, Option 5 has reduced length of embankment with 2 intermediate supports (including pylon)
Total Weathering Steel used in options 1 +2	**17**	**12**	**24**	**23**	**18**	
Rank	**2**	**1**	**5**	**4**	**3**	
Total Protected Steel Used in Options 1 and 2	***18***	***14***	***24***	***23***	***18***	
Rank	***2***	***1***	***4***	***3***	***2***	

1 – Very Good 2 – Good 3 – Fair
4 – Poor 5 – Very Poor

Based on the evaluation criteria described above, it is recommended that Option 2 be progressed to preliminary and detailed design stage.

APPENDIX 1

SITE LOCATION MAP



No.	Revision / Stage	Date	By	Chk'd Date	App'd Date
	PRELIMINARY				
	APPROVAL				
	TENDER				
	CONSTRUCTION				

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Designed: MJ | Checked: MJ | Approved: RTP | Status: TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: SITE LOCATION MAP

Drawn: GM | Job No: 10.152 | Drawing No: STR-LOC-001 | Rev:

Scale: (A1) NTS | Date: JULY 10

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

Jan 11, 2011 - 5:21pm

Drawing Location: L:\acaddwg\2010\10152\Drgs\Prelimnary\STR-LOC-001.dwg

APPENDIX 2

Drawings & Images

WORK IN PROGRESS
11 January 2011

NDP
transport21
progress in million

NRA
An Oifigeach um Bóithre Náisiúnta
National Roads Authority
Department of Transport

No.	Revision Stage	Date	By	Chkd	Appd
			Date		Appd
	PRELIMINARY				
	APPROVAL				
	TENDER				
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Designed:	Checked:	Approved:	Status:
PD	MB	SMG	TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: 100 YEAR FLOOD PLAIN

Drawn:	Job No:	Drawing No:	Rev:
SP	10.152	SK-101	
Scale: (A1) 1:2500	Date: NOV 10		

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

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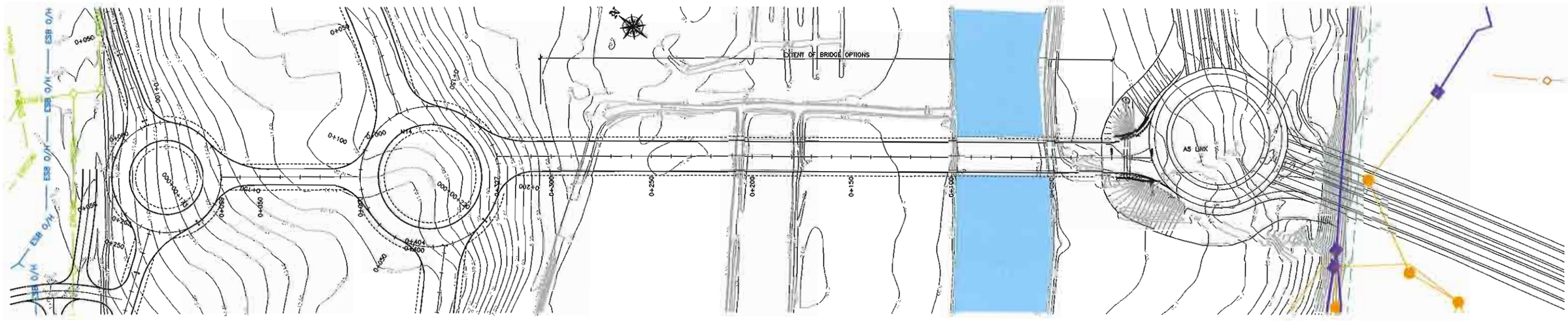

LEGEND:

- BT UNDERGROUND CABLE
- WATERMAINS
- BT OVERHEAD CABLES
- 11KV HV CONDUCTOR
- OVERHEAD ESB
- UNDERGROUND ESB
- EIRCOM

WORK IN PROGRESS
11 January 2011

No.	Revision Stage	Date	By	CHKd Date	App'd
	PRELIMINARY				
	APPROVAL				
	TENDER				
	CONSTRUCTION				

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Designed: PD | Checked: MB | Approved: SMG | Status: TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: N14-N15 TO A5 LINK - RIVER FINN CROSSING EXISTING SERVICES

Drawn: GM | Job No: 10.152 | Drawing No: UTILITIES-001 | Rev: -

Scale: (A1) AS SHOWN | Date: SEP 10

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

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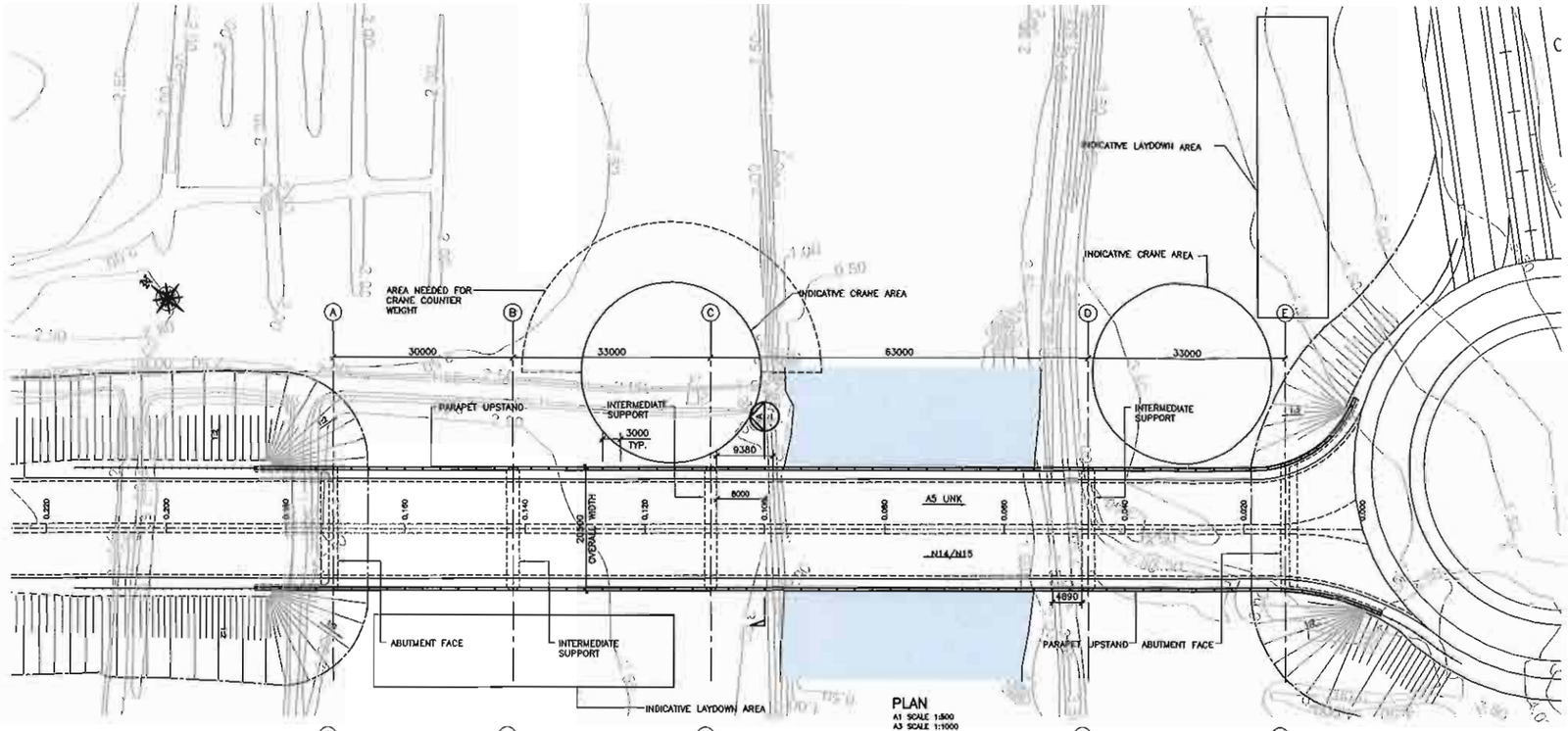

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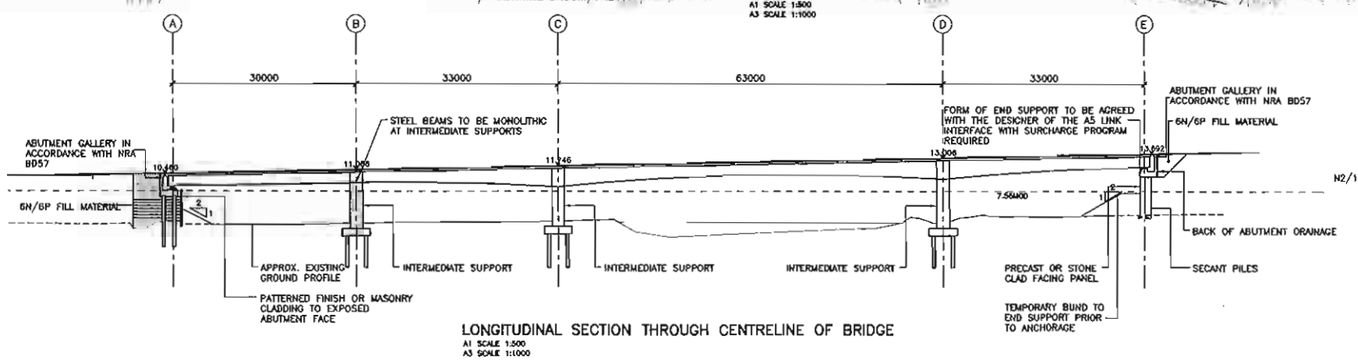
A3 SCALE 1:1000



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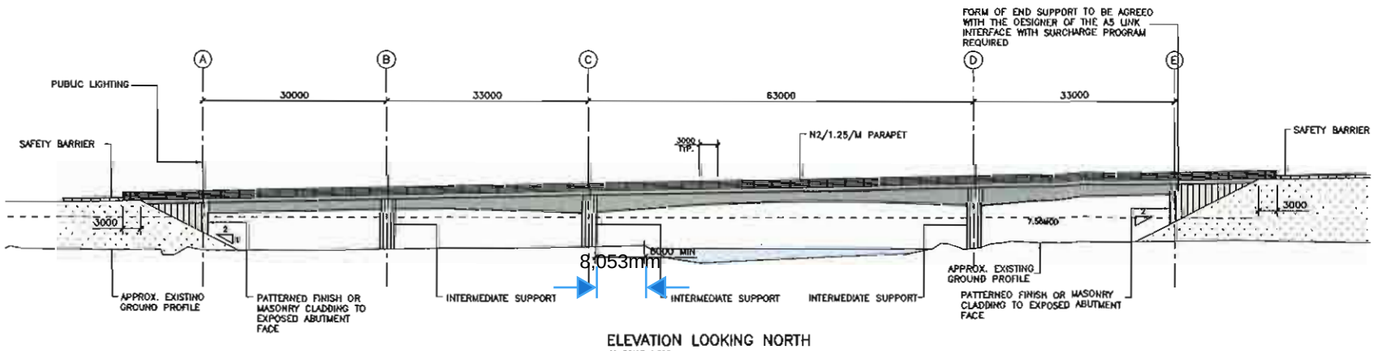
A3 SCALE 1:1000



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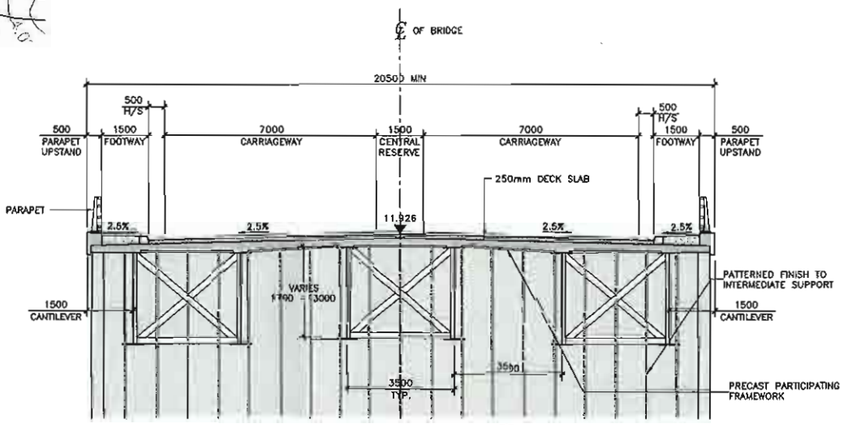
A3 SCALE 1:1000



SECTION A–A
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A3 SCALE 1:200

NOTES:

1. STRUCTURE IS CONTINUOUS OVER INTERMEDIATE SUPPORTS– INTERMEDIATE SUPPORTS TO BE MONOLITHIC WITH SUBSTRUCTURE.
2. LEVELS IN METERS TO MALIN HEAD.
3. CO–ORDINATES TO IRISH NATIONAL GRID.
4. FOUNDATION DESIGN SUBJECT TO REVIEW ON RECEIPT OF GEOTECHNICAL INVESTIGATION.
5. WEATHERING STEEL TO BE CONSIDERED AND AGREED WITH AUTHORITY.
6. HYDRAULIC ANALYSIS ONGOING – FINAL SPAN ARRANGEMENT TO BE CONFIRMED

No.	Stage	Revision	Date	By	Chk'd	App'd
B		CRANE AREA AND LAYDOWNS	20.12.10	GM	MB	RJM
A		MINOR CHANGES	07.12.10	GM	MB	RJM
	PRELIMINARY					
	APPROVAL					
	TENDER					
	CONSTRUCTION					

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www.roughanodonovan.com

Designed: RMJ | Checked: RMJ | Approved: RMJ | Status: TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: N14-N15 TO A5 LINK-RIVER FINN CROSSING ALIGNMENT OPTION B2 BRIDGE OPTION 1-4SPAN STEEL COMPOSITE

Drawn: EP | Job No: 10.152 | Drawing No: STR-01-001 | Rev: B

Scale: (A1) AS SHOWN | Date: NOV '10

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Jan 11, 2011 - 5:22pm Drawing Location: L:\acaddwg\2010\10152\Drgs\Preliminary\STR - 01 - 001.dwg

OPTION 1

NDP 2007-2013 | transport21 progress in motion | NRA An Bord um Bóithre Náisiúnta National Roads Authority | Department of Transport | NRDO

No.	Revision Stage	Date	By	Chk'd Date	App'd Date
	PRELIMINARY				
	APPROVAL				
	TENDER				
	CONSTRUCTION				

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Designed: RMJ | Checked: RMJ | Approved: RMJ | Status: TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: N14-N15 TO A5 LINK-RIVER FINN CROSSING BRIDGE OPTION 1-4SPAN STEEL COMPOSITE 3D VIEW

Drawn: PC | Job No: 10.152 | Drawing No: STR-01-011 | Rev:

Scale: (A1) AS SHOWN | Date: DEC '10

Jan 11, 2011 - 5:23pm Drawing Location: L:\acaddwg\2010\10152\Drgs\3d Structures\option1.dwg

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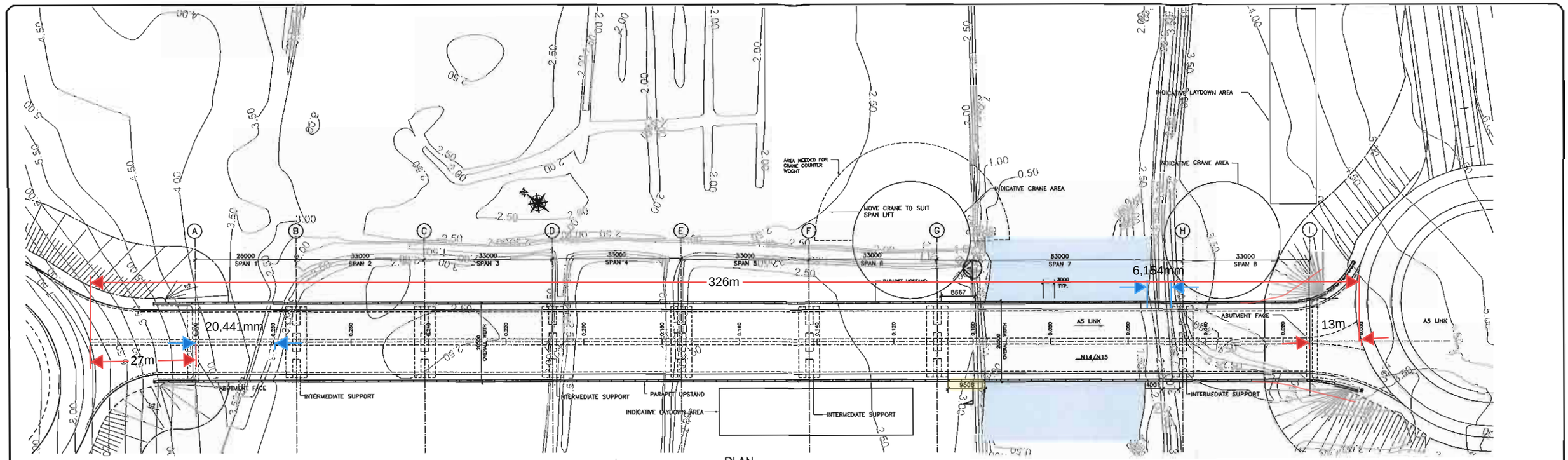
N14 – N15 to A5 Link River Finn Crossing View 1 – Option 1



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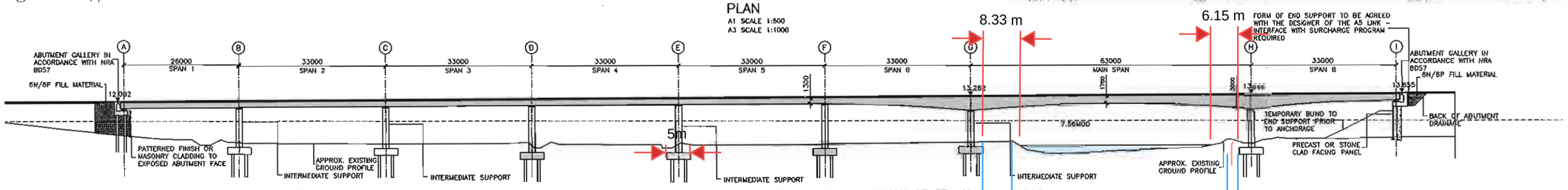
A3 SCALE 1:1000



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A1 SCALE 1:500
A3 SCALE 1:1000

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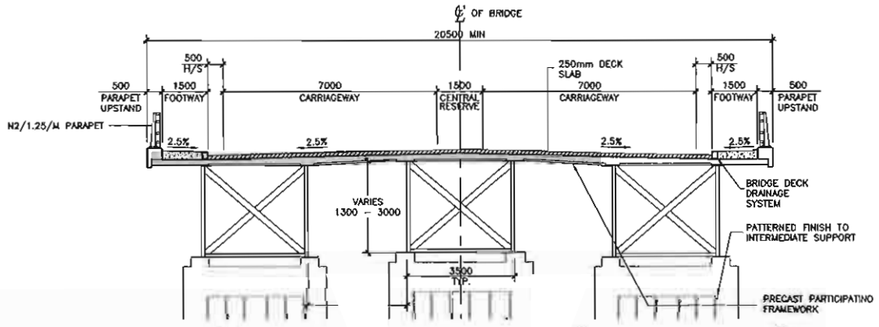
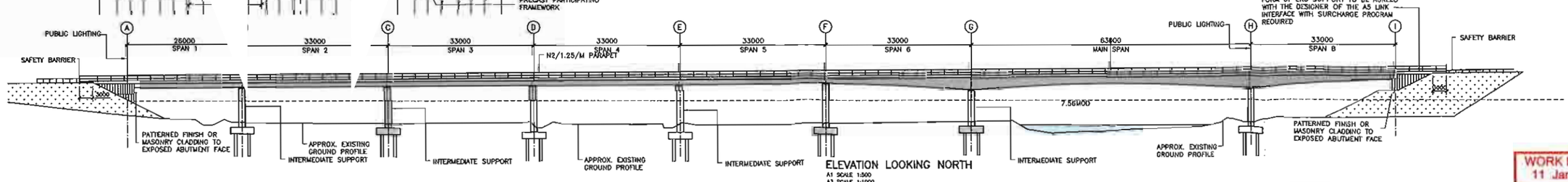
2,382mm





ELEVATION LOOKING NORTH
A1 SCALE 1:500
A3 SCALE 1:1000

NOTES:

1. LEVELS IN METERS TO MALIN HEAD.
2. CO-ORDINATES TO IRISH NATIONAL GRID.
3. FOUNDATION DESIGN SUBJECT TO REVIEW ON RECEIPT OF GEOTECHNICAL INVESTIGATION.
4. WEATHERING STEEL TO BE CONSIDERED AND AGREED WITH AUTHORITY.

WORK IN PROGRESS
11 January 2011

No.	Revision	Date	By	Chkd	Appd
B	CRANE AREA AND LAYDOWNS	20.12.10	GM	MB	RMJ
A	MINOR CHANGES	07.12.10	GM	MB	RMJ

Stage	Date	Appd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Designed: PO | Checked: MB | Approved: SMG | Status: TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: N14-N15 TO A5 LINK - RIVER FINN CROSSING
ALIGNMENT OPTION B3
BRIDGE OPTION 2 - MULTISPAN STEEL COMPOSITE

Drawn:	Job No:	Drawing No:	Rev:
GM	10.152	STR-01-002	B

Scale: (A1) AS SHOWN | Date: SEP 10

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Jan 11, 2011 - 5:22pm Drawing Location: L:\acaddwg\2010\10152\Drgs\Prelimnary\STR - 01 - 002.dwg

OPTION 2

No.	Revision / Stage	Date	By	Chk'd Date	App'd Date
	PRELIMINARY				
	APPROVAL				
	TENDER				
	CONSTRUCTION				

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Designed: RMJ | Checked: RMJ | Approved: RMJ | Status: TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: N14-N15 TO A5 LINK-RIVER FINN CROSSING
BRIDGE OPTION 2 - MULTISPAN STEEL COMPOSITE
3D VIEW

Drawn: PC | Job No: 10.152 | Drawing No: STR-01-012 | Rev:

Scale: (A1) AS SHOWN | Date: DEC '10

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Jan 11, 2011 - 5:23pm Drawing Location: L:\acaddwg\2010\10152\Drgs\3d Structures\option2.dwg

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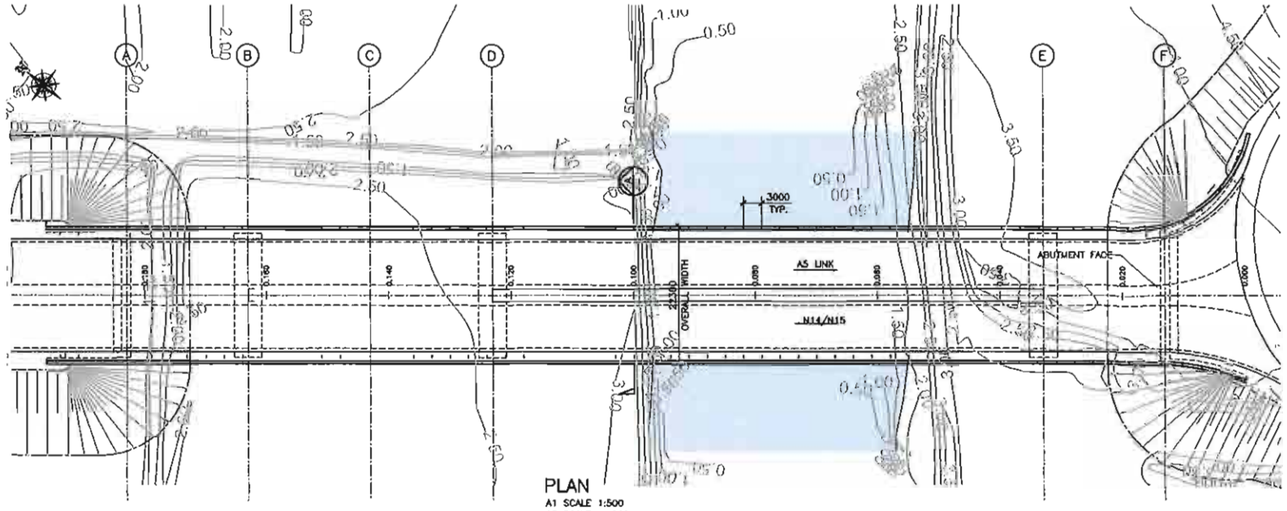
N14 – N15 to A5 Link River Finn Crossing View 1 – Option 2



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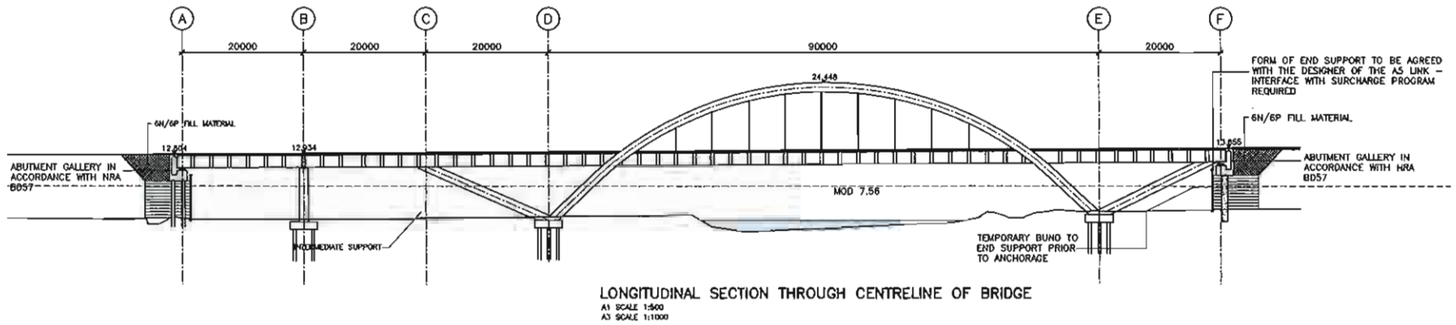
A3 SCALE 1:1000



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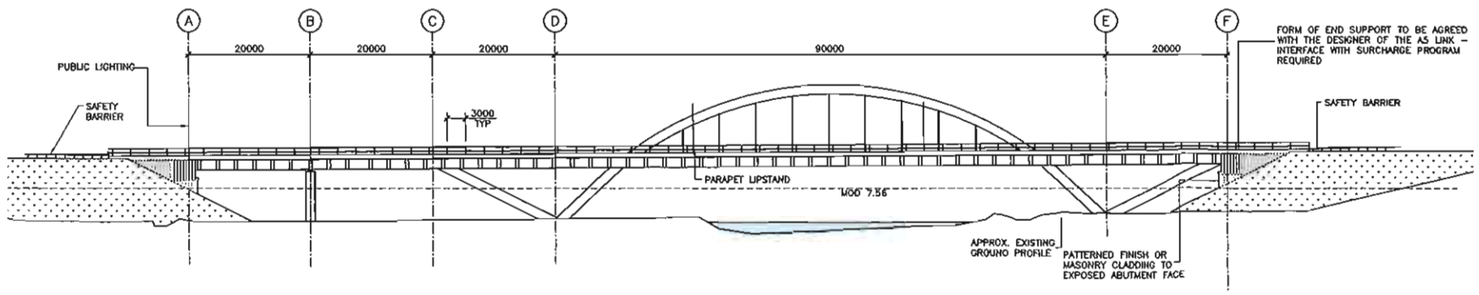
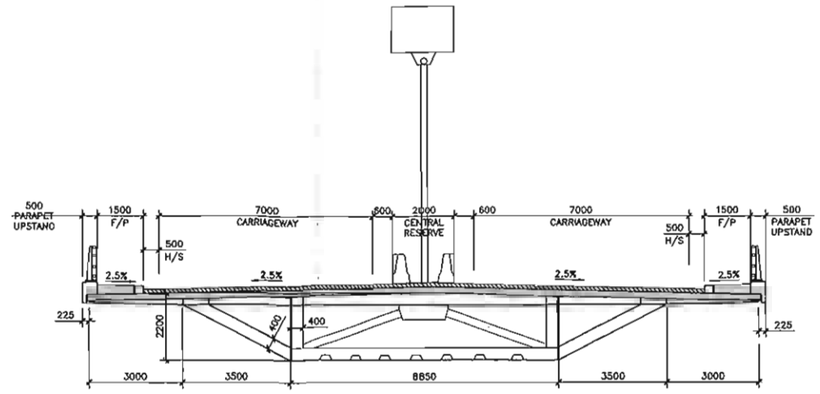


ELEVATION LOOKING NORTH
A1 SCALE 1:500
A3 SCALE 1:1000

NOTES:

1. LEVELS IN METERS TO MALIN HEAD.
2. CO-ORDINATES TO IRISH NATIONAL GRID.
3. FOUNDATION DESIGN SUBJECT TO REVIEW ON RECEIPT OF GEOTECHNICAL INVESTIGATION.
4. HYDRAULIC ANALYSIS ONGOING – SPAN ARRANGEMENT TO BE CONFIRMED



CROSS SECTION
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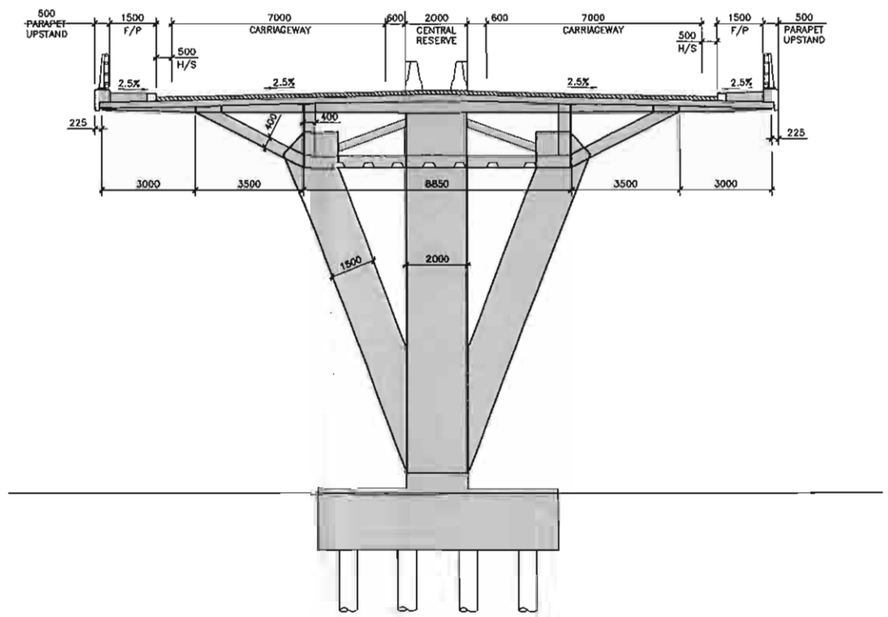

SECTION A
A1 SCALE 1:100
A3 SCALE 1:200

WORK IN PROGRESS
11 January 2011

No.	Revision	Date	By	Chk'd	App'd
A	MINOR CHANGES AND EXTRA SPAN ADDED	07.12.10	GM	MB	RMJ

Stage	Date	App'd
PRELIMINARY		
APPROVAL		
TENDER		
CONSTRUCTION		

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Designed:	Checked:	Approved:	Status:
PD	MB	SMG	TENDER

Project Title	N14-N15 TO A5 LINK
Drawing Title	N14-N15 TO A5 LINK RIVER FINN CROSSING ALIGNMENT OPTION B3 BRIDGE OPTION 3 - 5 SPAN ARCH

Drawn:	Job No:	Drawing No:	Rev:
GM	10.152	STR-01-003	A
Scale: (A1) AS SHOWN	Date: SEP 10		

DO NOT SCALE USE FIGURED DIMENSIONS ONLY

Jan 11, 2011 - 5:22pm Drawing Location: L:\acaddwg\2010\10152\Drgs\Preliminary\STR - 01 - 003.dwg

OPTION_3

NDP
transport21
progress in motion

NRA
Department of Transport

No.	Revision Stage	Date	By	Chk'd Date	App'd Date
	PRELIMINARY				
	APPROVAL				
	TENDER				
	CONSTRUCTION				

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Designed: RMJ | Checked: RMJ | Approved: RMJ | Status: TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: N14-N16 TO A5 LINK-RIVER FINN CROSSING
BRIDGE OPTION 3 - 6 SPAN ARCH
3D VIEW

Drawn: JH | Job No: 10.152 | Drawing No: STR-01-013 | Rev:
Scale: (A1) AS SHOWN | Date: DEC '10

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Jan 11, 2011 - 5:23pm Drawing Location: L:\acaddwg\2010\10152\Drgs\3d Structures\option3.dwg

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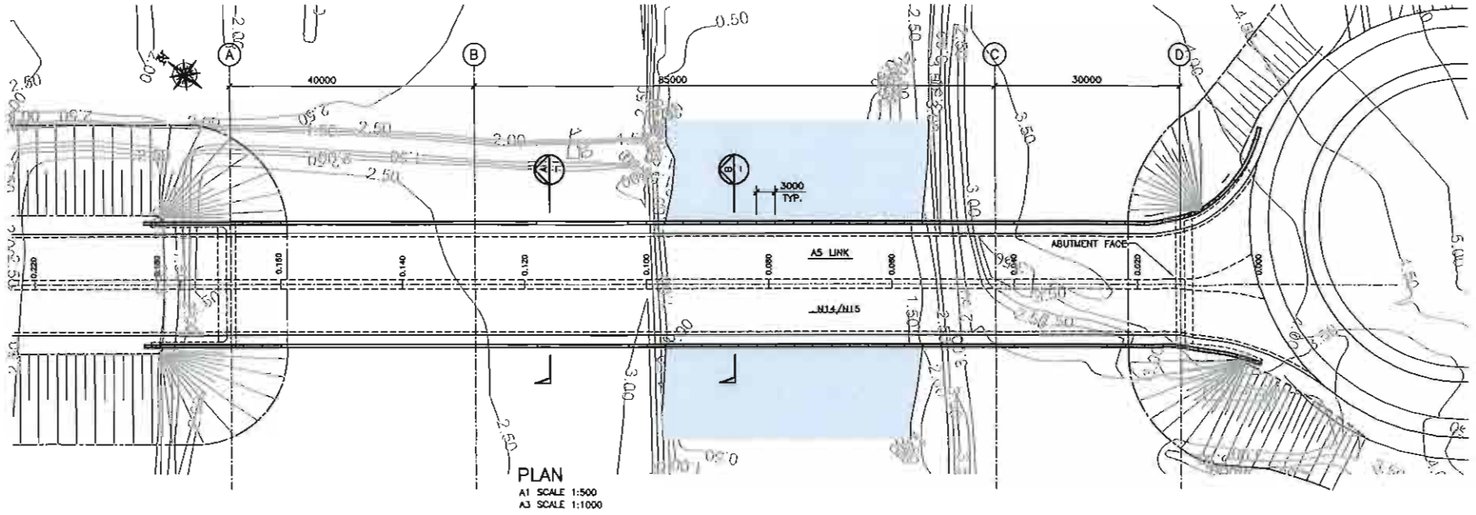
N14 – N15 to A5 Link River Finn Crossing View 1 – Option 3



PLAN
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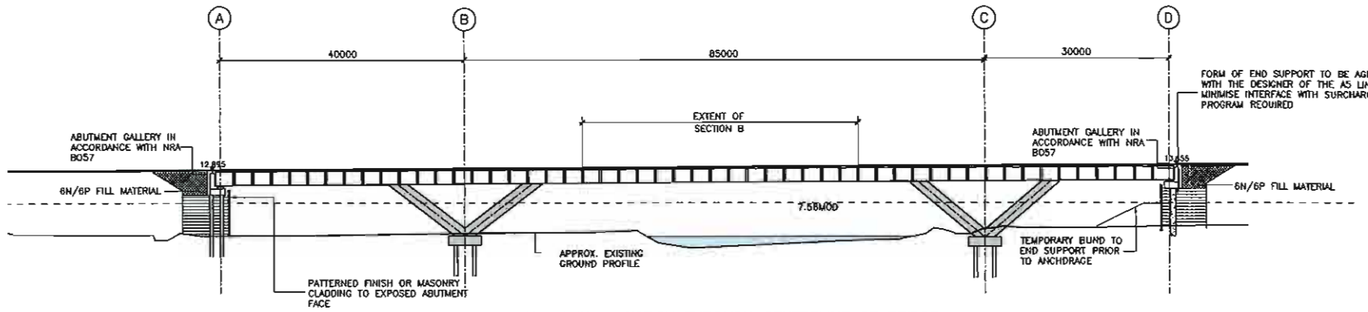
A3 SCALE 1:1000



LONGITUDINAL SECTION THROUGH CENTRELINE OF BRIDGE
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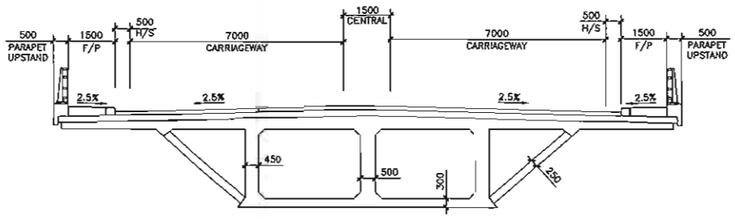

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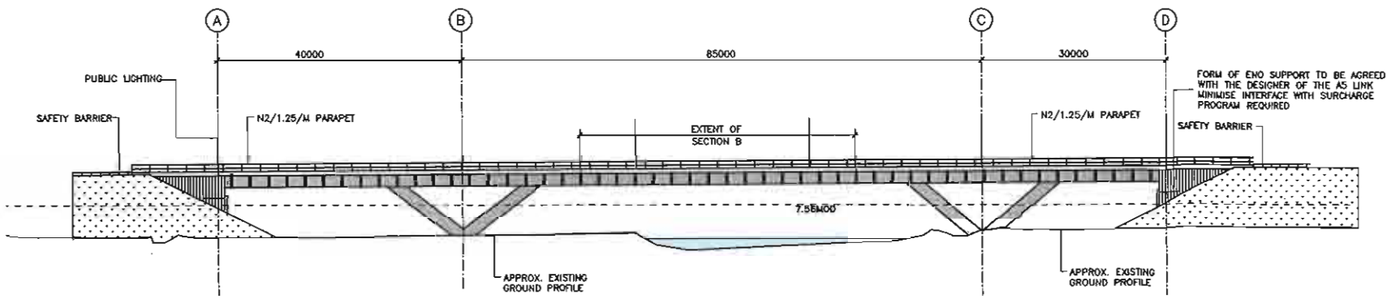

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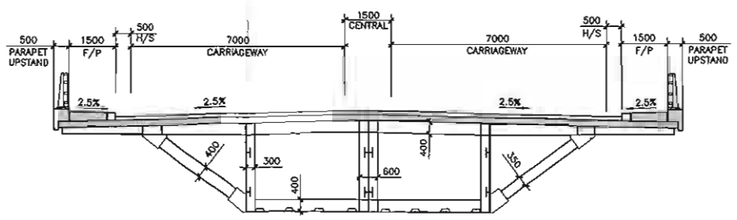

CROSS SECTION B
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NOTES:

1. LEVELS IN METERS TO MALIN HEAD.
2. CO-ORDINATES TO IRISH NATIONAL GRID.
3. FOUNDATION DESIGN SUBJECT TO REVIEW ON RECEIPT OF GEOTECHNICAL INVESTIGATION.
4. WEATHERING STEEL TO BE CONSIDERED AND AGREED WITH AUTHORITY.
5. HYDRAULIC ANALYSIS ONGOING – SPAN ARRAIGNMENT TO BE CONFIRMED

WORK IN PROGRESS
11 January 2011

No.	Revision	Date	By	Chk'd	App'd
	Stage			Date	App'd
A	MINOR CHANGES	07.12.10	GM	MB	RJJ
	PRELIMINARY				
	APPROVAL				
	TENDER				
	CONSTRUCTION				

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Designed: PD | Checked: MB | Approved: SMG | Status: TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: N14-N15 TO A5 LINK-RIVER FINN CROSSING
ALIGNMENT B3
BRIDGE OPTION 4 - 5 SPAN CONTINUOUS WITH IN CLINED PIERS

Drawn:	Job No:	Drawing No:	Rev:
GM	10.152	STR-01-004	A
Scale: (A1) AS SHOWN	Date: 6EP 10		

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Jan 11, 2011 - 5:23pm Drawing Location: L:\acaddwg\2010\10152\Drgs\Preliminary\STR - 01 - 004.dwg

OPTION 4

transport21 progress in motion

Department of Transport

No.	Revision / Stage	Date	By	Chk'd Date	App'd Date
	PRELIMINARY				
	APPROVAL				
	TENDER				
	CONSTRUCTION				

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Designed: RMJ | Checked: RMJ | Approved: RMJ | Status: TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: N14-N15 TO A5 LINK-RIVER FINN CROSSING
BRIDGE OPTION 4 - 5 SPAN CONTINUOUS WITH IN CLINED PIERS
3D VIEW

Drawn: PC | Job No: 10.152 | Drawing No: STR-01-014 | Rev:
Scale: (A1) AS SHOWN | Date: DEC '10

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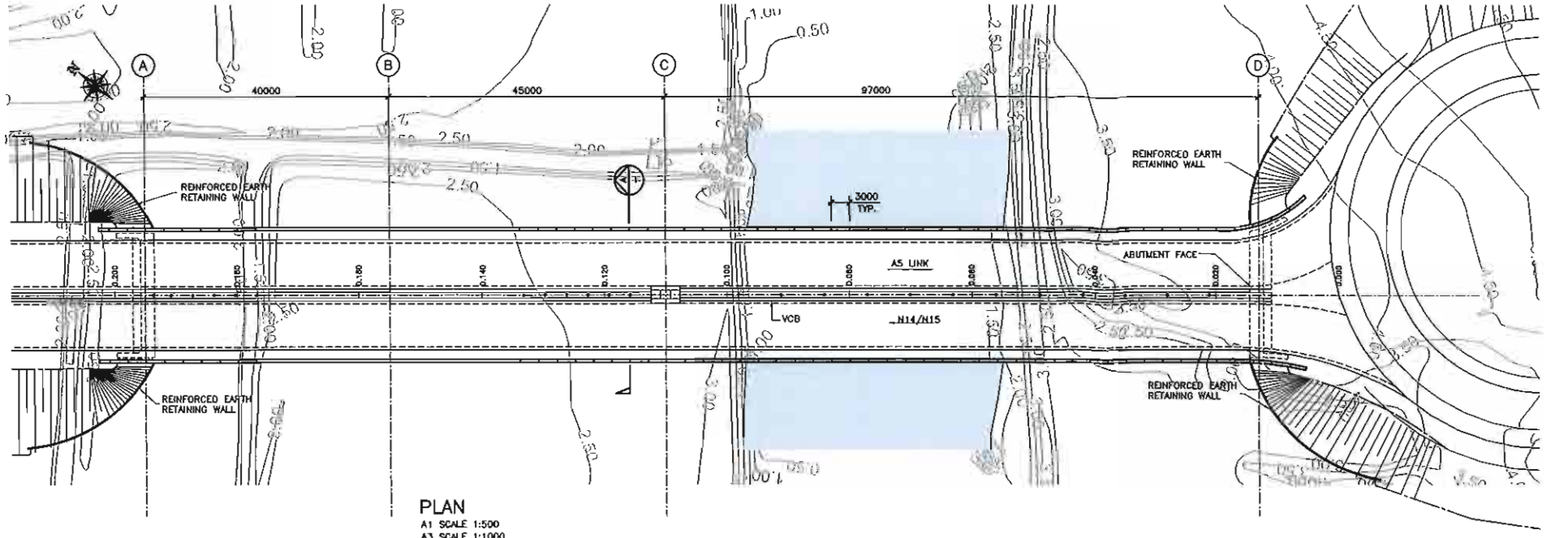
O'Donovan

N14 - N15 to A5 Link River Finn Crossing View 1 - Option 4



PLAN
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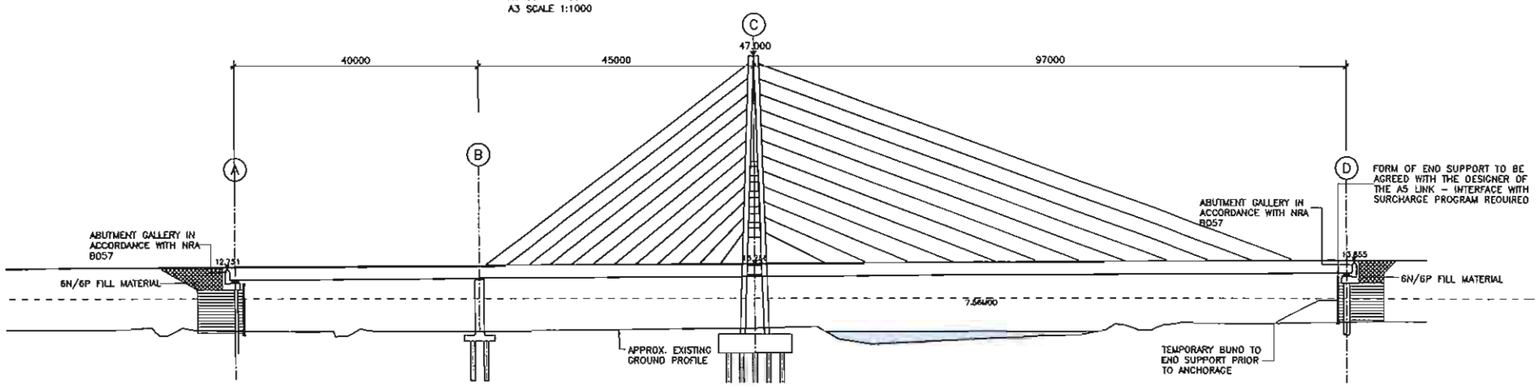

LONGITUDINAL SECTION THROUGH CENTERLINE OF BRIDGE
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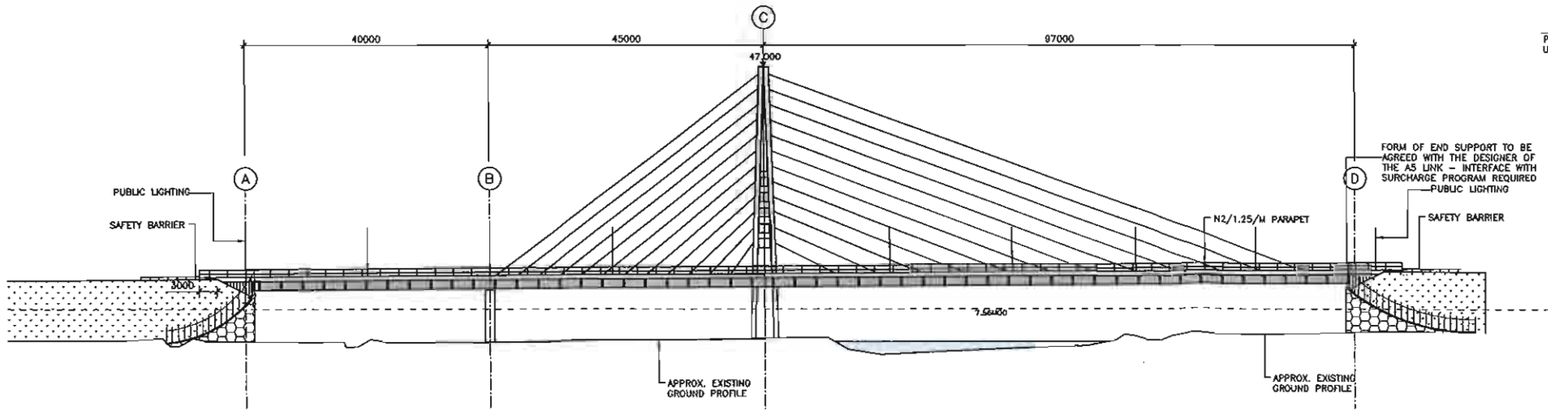
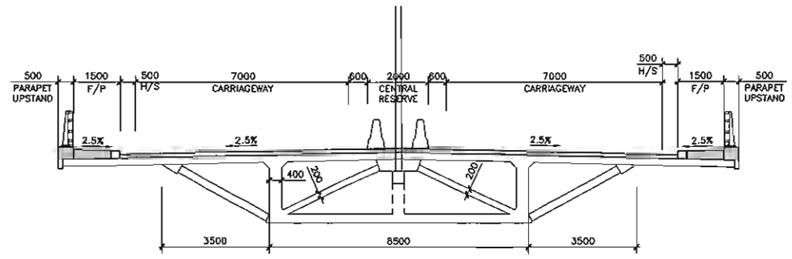


ELEVATION LOOKING NORTH
A1 SCALE 1:500
A3 SCALE 1:1000

NOTES:

1. LEVELS IN METERS TO MALIN HEAD.
2. CO-ORDINATES TO IRISH NATIONAL GRID.
3. FOUNDATION DESIGN SUBJECT TO REVIEW ON RECEIPT OF GEOTECHNICAL INVESTIGATION.



CROSS SECTION A
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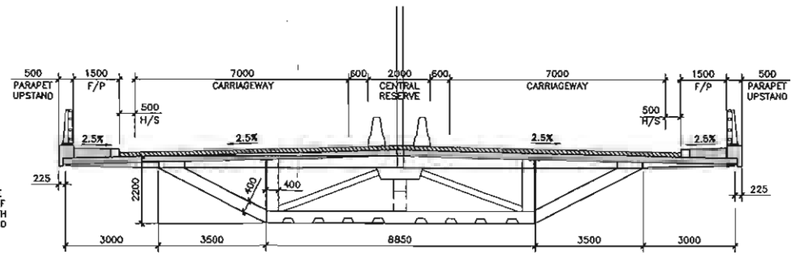
A3 SCALE 1:200



ALTERNATIVE CROSS SECTION FOR MAIN SPAN
A1 SCALE 1:100
A3 SCALE 1:200

WORK IN PROGRESS
11 January 2011

No.	Revision	Date	By	Chk'd	App'd
B	MINOR CHANGE ON PIER	30.12.10	GM	MB	RJU
A	EXTRA SPAN ADDED AND CROSS SECTION	07.12.10	GM	MB	RJU
	Stage		Date		App'd
	PRELIMINARY				
	APPROVAL				
	TENDER				
	CONSTRUCTION				

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Project Title: N14-N15 TO A5 LINK

Drawing Title: N14-N15 TO A5 LINK-RIVER FINN CROSSING
ALIGNMENT OPTION B3
BRIDGE OPTION 5 - 3 SPAN CABLE STAYED BRIDGE

Designed:	Checked:	Approved:	Status:	Drawn:	Job No:	Drawing No:	Rev:
PD	MB	SMG	TENDER	GM	10.152	STR-01-005	B

Scale: (A1) AS SHOWN | Date: SEP 10

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Jan 11, 2011 - 5:23pm Drawing Location: L:\acaddwg\2010\10152\Drgs\Preliminary\STR - 01 - 005.dwg

OPTION 5

NDP transport 21 progress in motion

NRA An Bord Pleanála Department of Transport

NRDO

No.	Revision Stage	Date	By Date	Chk'd	App'd
	PRELIMINARY				
	APPROVAL				
	TENDER				
	CONSTRUCTION				

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Designed:	Checked:	Approved:	Status:
RMJ	RMJ	RMJ	TENDER

Project Title: N14-N15 TO A5 LINK

Drawing Title: N14-N15 TO A5 LINK-RIVER FINN CROSSING BRIDGE OPTION 5 - 3 SPAN CABLE STAYED BRIDGE 3D VIEW

Drawn:	Job No:	Drawing No:	Rev:
JH	10.152	STR-01-015	
Scale: (A1) AS SHOWN	Date: DEC '10		

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Roughan &
O'Donovan

N14 – N15 to A5 Link River Finn Crossing View 1 – Option 5

APPENDIX 3

Design Options Study – Designer's Risk Assessment

N14-N15 to A5 Link

River Finn Crossing

Design Options Study
Designers Risk Assessment

January 2011
Issue 1

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DNRDO
Donegal Public Services Centre
Drumlonagher
Donegal Town
Co. Donegal

Donegal County Council
County House
Lifford
Co. Donegal

N14 / N15 to A5 Road Link Scheme
River Finn Crossing

Design Options Study
Designers Risk Assessment

Document No: 10.152.40/RA-DOS

Made: ..... Marc Jones

Checked: ..... John Lawrence

Approved:..... Tony Dempsey

Revision	Description	Made	Checked	Approved	Date
-	Risk Assessment Design Options Study	MJ	JL	TD	09/12/10
1	Risk Assessment Design Options Study	MJ	JL	TD	12/01/11

N14 / N15 to A5 Road Link Scheme
River Finn Crossing

Design Options Study
Designers Risk Assessment

TABLE OF CONTENTS

1.0 Introduction

This document constitutes the Risk Assessment carried out by the Designer, Roughan & O'Donovan Consulting Engineers, for the River Finn Crossing at the Design Options Study Stage. The purpose of this document is to achieve the following: identify hazards, qualitatively evaluate risk, design to avoid identified hazards where practicable, design and / or identify measures for mitigating risks from hazards that cannot be avoided. This document is a 'live' document and will be updated during the preliminary and detailed design processes.

Further health & safety documents will be prepared by the Project Supervisor Design Process (PSDP) as the design advances, including the Preliminary Safety and Health Plan. This plan will have the purpose of providing information for the Project Supervisor for the Construction Stage (PSCS). This Risk Assessment will be forwarded to the PSDP. Residual risks that cannot be designed out are identified in Tables 1.0-1.6. The PSCS shall take account of these risks in the construction of the permanent works.

2.0 Project Location and Description

The N14 / N15 to A5 Link Scheme involves the design of a road linking the A5 Western Transport Corridor in County Tyrone, Northern Ireland to the proposed N14 Letterkenny to Lifford / Strabane and the N15 Lifford to Stranorlar Schemes in County Donegal, Republic of Ireland.

The distance between the junction on the A5 Western Transport Corridor and the proposed N14 / N15 junction is approximately 450m. The scheme requires a crossing of the River Finn cSAC and associated floodplains.

At the proposed crossing location there is an extensive flood plain on the west side of the river extending some 250m while on the east side the existing ground rises to the west giving a flood plain of approximately 70m. The proposed A5 Western Transport Corridor is supported on an embankment running parallel to the River Finn.

Five design options have been considered for the bridge, namely:

Option 1 - 4 Span Steel Composite;

Option 2 - 8 Span Steel Composite;

Option 3 - 5 Span Steel Composite Tied Arch;

Option 4 - 5 Span Concrete Box with Propped Cantilever and Steel Composite Drop in Span made Monolithic with inclined Supports;

Option 5 - 3 Span Asymmetric Cable Stay Bridge.

The proposed cross-section for the Link Road is Type 2 Dual Carriageway in accordance with TD27 of the National Roads Authority (NRA) Design Manual for Roads and Bridges (DMRB) as described below:

1 x 1.5m Central Median including median barrier

2 x 7.0m Carriageway

2 x 0.5m Hard Strips

2 x 1.5m Footway (on bridge)

The cross-section is proposed for the full length of the Link road, however, the verge width will increase to off the bridge.

3.0 Examination of the Scheme Design and Hazard Elimination

During the design process members of the design team have identified hazards to the Bridge Project Engineer. The hazards are evaluated and, where reasonably practical, the design revised to eliminate identified hazards. Where it is not practicable to eliminate the risk, measures for mitigating risks from hazards are scheduled in Section 5.0 below.

The following items have been identified as presenting possible hazards:

- Deep excavation (below ground water level) required for the construction of the substructure;
- Use of temporary false work and scaffolding to construct the in-situ works or support pre-fabricated elements over the river;
- Transportation and assembly of large precast concrete and/or steel members and formwork;
- The craneage of large precast concrete elements, steel members and formwork;
- Construction and testing of piled foundations;
- Post-tensioning operations;
- Cable positioning and stressing operations;
- Chemical or Biological substances;
- Working over and adjacent to watercourses;
- Working adjacent to live carriageways.

4.0 Identification of Safety and Health Issues Relating to Key Areas

The following safety and health issues relating to the key areas have been identified and this document will be developed as the design process progresses and forwarded to the PSCS to enable them to address these issues during construction.

Site

- Access and egress points.
- Site boundary fencing for security and traffic management/safety barriers at tie in points.
- Storage areas for fuel and combustibles.
- Welfare facilities.
- Working on, over, adjacent to watercourses.
- Delivery of materials to site.
- Working near live carriageways.
- Laydown area for prefabricated elements.
- Access to laydown areas

Construction Methods

- Construction and road traffic management.
- Temporary safety barriers.
- Excavation for foundations (within river flood plain)
- Transport and lifting of pre-fabricated elements.
- In-situ concrete construction.
- Welding and painting.
- Working with hazardous materials.
- Piling and Pile testing operations.
- Use of heavy plant.
- Working near or adjacent to live services (overhead and underground).
- Cable stressing operations

Construction Sequences and Programme

- Construction and road traffic management.
- Temporary safety barriers.
- Sequence of construction of all elements of the bridge.
- Programme and site congestion.

Maintenance and Repairs

- Repairs to deck waterproofing.
- Repair to safety barriers.
- Access and repairs to flood protection and pedestrian guardrail.
- Access and repairs to lighting.
- Access and repairs to bearings.
- Access for repairs/replacement to cables.

5.0 Risk Assessment

The Risk Assessment is based on guidelines to the Safety Health & Welfare at Work (Construction) Regulations, issued by the Health & Safety Authority. The following Risk Rating Matrix is adopted:

		H	M	L
Severity	**H**	3	3	2
	M	3	2	1
	L	2	1	1

Likelihood

Severity	**Likelihood**	**Risk Rating**
H – Fatality, major injury causing long-term disability	H – Certain or near certainty	3 = High risk – action required
M – Injury or illness causing short-term disability	M – Reasonably likely	2 = Medium risk – action required unless good reason
L – Other injury or illness	L – Very seldom or never	1 = Low risk – no action required

Table 1.0 below details the list of works which involve particular risks to the Safety, Health and Welfare of people at work as given in Schedule 1 of S.I. No. 504 of 2006. Tables 1.1 – 1.6 below give an assessment of the risk posed by hazards that have been identified by the designer during the design process for the River Finn Crossing. Table 1.1 covers activities that are common to all design options currently being progressed. Tables 1.2 – 1.6 cover the activities that are specific to the individual design options.

Table 1.0 List of Works involving Particular Risks to the Safety, Health and Welfare of Persons at Work

Works	Work forms part of the works	The location where the works occur on the Site and the actions taken to reduce the potential of the risk occurring
(1) Works where there is a risk of falling from height	Yes	Refer to Table 1.1
(2) Works where there is a risk of being buried under earthfalls	Yes	Refer to Table 1.1
(3) Works where there is a risk of engulfment in Swampland	Yes	Refer to Table 1.1
(4) Works which puts persons at risk of harm from Chemical or Biological substances	Yes	Refer to Table 1.1
(5) Working with ionising radiation	Yes	Refer to Table 1.1
(6) Working near high voltage power lines	Yes	Refer to Table 1.1
(7) Work exposing persons to the risk of drowning	Yes	Refer to Table 1.1
(8) Work on Wells, underground earthworks and tunnels	No	N/A
(9) Work carried out by divers having a system of air supply.	No	N/A
(10) Working in a caisson with compressed-air atmosphere	No	N/A
(11) Work involving the use of explosives	No	N/A
(12) Work involving the assembly or dismantling of heavy prefabricated components	Yes	Refer to Tables 1.2, 1.3, 1.4, 1.5 and 1.6

Additional Risks identified have also been included in Tables 1.1 to 1.6 below.

Table 1.1 Detailed Design Risk Assessment for all Bridge Design Options

Activity, Design, Process, Material Description of activity	**Hazard** Outline what the potential is of the activity to cause harm	**Initial Risk Rating** See Severity/ Likelihood Matrix	**Actions by Designer to Reduce Risk Rating** (a) Is the initial risk rating >1? If yes, consider as a priority the need to avoid and reduce risks. (b) Can the risk be reasonably avoided by changing the design or specification? If yes, explain how and change it. (c) Can the risk be reasonably reduced by changing the design or specification? If yes, explain how the designer should address the risk and if not the final risk ratio reduced to 1 should be passed on to the PSDP and/or the PSCS. (d) If the final risk rating is >1, explain why and what others need to do to minimise the risk.	**Final Risk Rating** See Severity / Likelihood Matrix. If >1 the information is required for the PSDP	**Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?** Record information passed to the PSDP and/or PSCS for inclusion in the Preliminary Safety and Health Plan and/or Safety File
(1) General construction activity	Dust.	2	(a) Yes, risk rating > 1 (b) No – inherent to the nature of construction activity (c) No (d) Residual risk remains because it is impossible to eliminate dust. Personal Protective Equipment (PPE) should be used.	2	Copy Risk Assessment to PSDP
(2) General construction activity	Exposure to Noise Vibration.	2 2	(a) Yes, risk rating >1 (b) Yes – inherent to the nature of construction activity, however, acceptable limits to be specified in the contract documents. (c) No (d) Residual risk remains because it is impossible to eliminate exposure to noise / vibration on modern construction sites. Enclosures of noise should be provided where practical; ear defenders and PPE should be used.	2 2	Copy Risk Assessment to PSDP
(3) General construction activity	Handling.	2	(a) Yes, risk rating > 1. (b) No – inherent to the nature of construction activity. (c) No (d) Residual risk remains because it is impossible to eliminate handling. Attachment points should be provided on items to be handled. Self-release shackles should be provided. Weight details should be provided on elements.	2	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?
(4) General construction activity	Plant	3	(a) Yes, risk rating > 1 (b) No – inherent to the nature of construction activity. (c) Yes - allow for adequate working space and provide adequate access route(s). (d) Residual risk remains because it is impossible to eliminate plant. Adequate working space and access should be provided.	3	Copy Risk Assessment to PSDP
(5) General construction activity	Construction material falling from height.	3	(a) Yes, risk rating > 1 (b) No – inherent to the nature of construction activity. (c) No (d) Residual risk remains because it is impossible to eliminate the possibility of falling objects. Adequate working space and access should be provided. Temporary works and scaffolding provided with protection measures, which shall include handrails with netting and toe boards to prevent materials dropping from height. Suitability qualified banks men required for all crane lifting/ movement of materials operations within the site.	3	Copy Risk Assessment to PSDP
(6) General construction activity	Falling from height.	3	(a) Yes, risk rating > 1 (b) No - Bridge required to cross river Finn (c) No (d) Residual risk remains because it is impossible to eliminate the possibility of falls. Pedestrian restraint, temporary false works and scaffolding with handrails and toe boards are required for the construction of the bridge. Securely fixed ladders are required at all access points.	2	Copy Risk Assessment to PSDP
(7) General construction activity	Weil's Disease	3	(a) Yes, risk rating > 1 (b) No - inherent to the nature of construction activity, particularly adjacent to water (c) No (d) Residual risk remains. Contractor to establish safe systems of work and provide training and appropriate PPE to personnel.	3	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, In what form has information been passed to PSDP or PSCS?
(8) Unauthorised Access by members of the public	Risk to falls; Exposure to moving vehicles Tripping; Exposure to harmful substances.	3 3 2 2	(a) Yes, risk rating >1. (b) No – it is not possible to design out this hazard (c) Yes - the site layout shall be chosen so as to minimise the perimeter and to ensure it is feasible to secure the site, within the constraints of the scheme. It is not, however, possible to design out this hazard. (d) A residual risk remains in relation to this hazard. The Contractor must ensure that the site is secure.	3 3 2 2	Copy Risk Assessment to PSDP
(9) Working on or adjacent to water	Falling from height; Harmful substances; Drowning.	3 2 3	(a) Yes, risk rating >1. (b) No – the bridge must cross a river. (c) Yes – Structural elements should be designed to facilitate swift connection of edge protection and safety nets. Specify requirement for emergency safety vessel. (d) Residual risk remains. Method statements of all working in the vicinity of the river are to be reviewed with these hazards in mind. Contractor to provide safety vessel with trained boatsmen and flotation devices.	3 2 2	Copy Risk Assessment to PSDP
(10) River traffic management (during construction)	Collision with river traffic	2	(a) Yes, risk rating >1. (b) No – bridge must cross the River Finn which is lightly trafficked at the location. (c) Yes – Temporary works should be designed to withstand impact. Warning lights may be required. (d) Residual risk remains. River user should be notified of the commencement and duration of works and the available horizontal and vertical clearances at all stages.	2	Copy Risk Assessment to PSDP
(11) Installation of safety barriers / parapets	Risk of collision with moving vehicles Erecting and handling prefabricated elements; Drowning; Falling from height.	3 2 3 3	(a) Yes, risk rating >1. (b) No – safety barriers required by the contract. (c) Yes – specify NRA approved barrier system (d) Installation in accordance with manufacturer's detailed method statement. Provide temporary safety barrier and traffic management to protect operatives. Adequate working space and platforms to be provided to allow erection. Provide and use PPE.	2 2 3 3	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?
(12) Excavations and Backfilling Operations for the structure	Risk of falls; Being struck by machinery; Collapse; Buried in excavation; Drowning; Contamination.	3 3 3 3 3 2	(a) Yes, risk rating >1 (b) No – the design requires excavation in the flood plain for the construction of the abutment bases / foundation. (c) Yes – The foundations are to be designed to minimise the required excavation. Stability of the excavation will be assessed by a competent geotechnical engineer following excavation to the structure foundation depth. Excavation dewatering measures will be provided. Complete adequate GI to confirm stability analysis. (d) A residual risk remains in relation to this hazard. Safety barriers to be provided at the top of the excavation to prevent falls and vehicles coming too close to the edge of the excavation. Trench supports to be used where required. Details of contaminants in soils to be established prior to excavation.	3 3 3 3 3 1	Copy Risk Assessment to PSDP
(13) Working on or adjacent to existing live road	Collision between site plant and passing traffic; Site operative injured by passing traffic;	3 3	(a) Yes, risk rating >1. (b) No – bridge to be provided to connect the existing A5 WTC and proposed N14/N15 junction. (c) Yes – new crossing requires a tie in to the existing adjacent roads. Specify requirements for traffic safety and management, temporary diversions and permitted access routes. (d) Residual risk remains in relation to this hazard. Traffic management and safety, temporary diversions and permitted access routes to be subject to the approval of the Employer's Representative and Local Authority. All site operative to have safety induction training and task specific briefings. Personal Protective Equipment (PPE) should be used.	3 3	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?
(14) Service Diversions/ Existing Services	Electrocution.	3	(a) Yes, risk rating >1. (b) No – bridge is required to connect existing carriageways where existing services are provided. A tie-in to the existing road levels is required at the bridge approaches. (c) Yes – complete services tracking and identify locations of existing services, all known services and contact details to be shown on the drawings and requirements described in Appendix 1/16 of the specification. At this stage there are no services identified within the footprint of the bridge. (d) Residual risk remains in relation to this hazard. Contractor will be required to establish line, level, type of service and prepare a detailed method statement for diversion of services. Goal posts are to be used where required to protect existing overhead services.	2	Copy Risk Assessment to PSDP
(15) Piling operations	Risk of being struck by moving plant; Tripping; Noise and Vibration; Working adjacent to construction traffic.	3 1 2 3	(a) Yes, risk rating >1. (b) No – piles are required due to ground conditions. (c) Yes – provide piling specification and piling details on drawings to clearly define requirements. Specify limits on noise and vibration included in the Specification. (d) Residual risk remains because it is not reasonably practicable to eliminate the use of piles at this structure – work platforms and adequate working space will be required; method statements will be subject to approval, specific safety measures and exclusion zones around piling equipment shall be provided.	3 1 1 3	Copy Risk Assessment to PSDP
(16) Testing of Piles	Risk of being struck by moving plant; Noise and Vibration; Working adjacent to construction traffic.	3 2 3	(a) Yes, risk rating >1. (b) No –Testing is required to ensure adequacy of the piles. (c) Yes – optimise the design by completing adequate GI and limiting the number of piles to be tested and determine and agree the location of piles to be tested. Specify limits on noise and vibration in the specification. (d) Residual risk remains because it is not practicable to eliminate the testing of piles – temporary works and adequate working space will be required; the location of the tests should be agreed with the designer; specific safety measures and exclusion zones around pile testing equipment shall be provided.	3 1 3	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, In what form has information been passed to PSDP or PSCS?
(17) General construction activity – earthworks	Ionising radiation.	3	(a) Yes, risk rating >1. (b) No – in-situ nuclear density testing required by Series 600 Earthworks. (c) No. (d) Residual risk remains, Contractor / testing organisation to take particular measures to reduce the risk. Operator to monitor radiation exposure during use. Sample testing and regular calibration of equipment to be carried out.	2	Copy Risk Assessment to PSDP
(18) General construction activity – earthworks	Engulfment in Swampland; Collapse.	3 3	(a) Yes, risk rating >1. (b) No – bridge is required across the Finn river and associated floodplains (c) Yes. The foundations are to be designed to minimise the required excavation. Stability of the excavation will be assessed by a competent geotechnical engineer following excavation to the structure foundation depth. Excavation dewatering measures will be provided. Complete adequate GI to confirm stability analysis. (d) Residual risk of Engulfment or burial remains. Contractor to provide safety measures at excavations. Excavation to be pumped. Contractor to identify and mark areas of soft/boggy ground and provide appropriate PPE.	3 3	Copy Risk Assessment to PSDP
(19) Installation of bearings and movement joints	Falling from Height; Collapse; Manual Handling; Moving Objects;	3 3 2 2	(a) Yes, risk rating >1. (b) No – options are required to be articulated at the end supports with joints and bearings. (c) No. (d) Residual risk remains because it is not reasonably practicable to eliminate the use of bearings and movement joints at this structure – adequate working space will be required; method statements will be subject to approval, specify bearing schedule and detail required joint type.	3 3 2 2	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, In what form has information been passed to PSDP or PSCS?
(20) Construction of reinforced concrete / reinforced earth abutments and piers bases	Handling concrete and reinforcement; Falling from Height; Collapse; Burial; Drowning; Engulfment.	2 3 3 3 3 3	(a) Yes, risk rating >1. (b) No – options require abutments as well as piers bases and in-situ concrete with reinforced earth is considered to be the most technically appropriate form for the construction. (c) No – develop design to minimise material requirements. (d) Residual risk remains, temporary works will be required to ensure stability of formwork, access and stability of excavations; life jackets to be provided, PPE should be used when handling concrete and reinforcement; protective caps should be used on the exposed ends of reinforcement. Temporary works require Design and Check Certificates. Excavation to be pumped as required.	2 3 3 3 3 3	Copy Risk Assessment to PSDP
(21) Access for maintenance and repairs	Risk of falling from height; Electrocution; Drowning.	3 3 3	(a) Yes, risk rating > 1 (b) No – all structures require maintenance. (c) Yes - Design for easy access to areas and items for maintenance. Provide abutment galleries to allow inspection and maintenance of bearings and expansion joints at end supports in accordance with NRA BD57. For bearings on piers allow for jacking points to allow replacement. Design for durable and low maintenance lighting. (d) Residual risk remains as it is impossible to eliminate the eventual need for maintenance and repair; experienced maintenance Contractors to be used, proper planning and PPE is required for personnel involved with maintenance and repair; any temporary works used must be approved by the Authority. Traffic management proposals to be provided in the event of works required.	3 3 3	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?
(22) Demolition – the structure will be required to be taken down at the end of its useful life	Risk of falling from height;	3	(a) Yes, risk rating >1. (b) No – the bridge will be required to be demolished at the end of its useful life. (c) Yes – measures have been taken to enhance the durability. Specify requirements for as-built documentation, method statements, erection sequence, etc to be included in the safety file. (d) Requirements for PSCS to record erection sequence and as built drawings in the Health & Safety File. Proposed methods of taking down structure and associated traffic management, diversions and method statements will require review and approval by competent personnel. Demolition works to be carried out by an experienced demolition contractor. PPE required.	3	Copy Risk Assessment to PSDP
	Being struck by moving vehicles;	3		3	
	Tripping;	1		1	
	Collapse;	3		3	
	Manual handling;	2		2	
	Moving objects;	2		2	
	Electrocution;	3		3	
	Noise & Vibration;	2		1	
	Exposure to harmful substances;	2		1	
	Drowning.	3		3	

Table 1.2 Detailed Design Risk Assessment for Option 1 – 4 Span Steel Composite

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?
(1) Transportation and placing of prefabricated steel units	Risk of falls; Being struck by machinery/ crane; Drowning; Crushed or struck during lifting.	3 3 3 3	(a) Yes, risk rating >1 (b) No – the design requires the transportation and erection of prefabricated steel elements. The use of prefabricated elements reduces construction time, site welding and the number of staff working in the vicinity of water and therefore reduces the health and safety risks. (c) Yes – allow sufficient working space for access routes and hard standing area for craneage. The steel members should be designed to be temporarily connected on site prior to welding. The units to be designed are to be sufficiently robust to withstand the lifting loads. Specify requirements for independent check certificate for significant temporary works including the design of temporary access routes and platforms for craneage. (d) A residual risk remains in relation to this hazard. The lifting apparatus must have a current test certificate. The lifting arrangement must ensure that the load is evenly carried. Detailed temporary works calculations and method statements to be subject to approval, requirements for independent check certificates for temporary works. Appropriately trained operatives should carry out the lifting into place of the units.	3 3 3 3	Copy Risk Assessment to PSDP
(2) Access for maintenance and repairs to superstructure	Falling from heights; Manual handling; Drowning.	3 2 3	(a) Yes, risk rating >1. (b) No – all structures require maintenance and repair. (c) Yes – Adequate cover is given to reinforcement for the purpose of durability in accordance with the provisions of NRA BD 57/01; Weathering steel will also be considered to reduce maintenance requirements for main steel elements. (d) Residual risk remains as it is impossible to eliminate the eventual need for maintenance and repair; experienced maintenance Contractors to be used, proper planning and PPE is required for personnel involved with maintenance and repair; any temporary works used must be approved by the Authority. Traffic management proposals to be provided in the event of works required.	3 2 3	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, In what form has information been passed to PSDP or PSCS?
(3) Application of finishes – waterproofing, concrete impregnation, painting.	Risk from Chemical or biological substances;	3	(a) Yes, risk rating >1. (b) No – for durability reasons structural elements must be waterproofed/painted. Concrete impregnation will be required for durability. (c) Yes –Waterproofing to be provided to the top of the deck with an approved BBA / IAB Certificate. A suitable paint system will be provided to enhance durability of the main steel elements if weathering steel is not used. This will be applied in a controlled environment, i.e., fabrication facility with connections requiring on-site painting only. A hydrophobic pore liner will be applied to the exposed concrete surface. (d) Individual protective measures of persons applying waterproofing, surface impregnation and paint are necessary to limit contact with any potentially harmful substances and reduce the risk of falls during application. Others should be kept clear of such areas when this work is in progress. Painting of steelwork should be carried out in a controlled environment.	2	Copy Risk Assessment to PSDP
(4) Erecting/ maintenance and removal of temporary works and scaffolding required for the construction.	Risk of falling from height; Struck during lifting operations.	3 3	(a) Yes, risk rating >1. (b) No – Inherent to insitu reinforced concrete construction. (c) Yes – Prefabricated steel members and precast permanent formwork for the construction of the insitu concrete deck reduces the requirement for temporary works. Specify requirement for independent temporary works check certificate for major elements of temporary works. (d) Residual risk remains because it is not reasonably practicable to eliminate the use of temporary works and scaffolding for insitu concrete construction. The contractor should ensure suitability qualified personnel are in place for all crane lifting/ movement of materials operations, and for the erection of all false work and scaffolding. The Temporary works will require approval by the designer. Temporary works require Design and Check Certificates.	3 3	Copy Risk Assessment to PSDP

Table 1.3 Detailed Design Risk Assessment for Option 2 - 8 Span Steel Composite

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?
(1) Transportation and placing of prefabricated steel units	Risk of falls; Being struck by machinery/ crane; Drowning; Crushed or struck during lifting.	3 3 3 3	(a) Yes, risk rating >1 (b) No – the design requires the transportation and erection of prefabricated steel elements. The use of prefabricated elements reduces construction time, site welding and the number of staff working in the vicinity of water and therefore reduces the health and safety risks. (c) Yes – allow sufficient working space for access routes and hard standing area for craneage and launching platform. The steel members should be designed to be temporarily connected on site prior to welding. The units to be designed are to be sufficiently robust to withstand the lifting loads. Specify requirements for independent check certificate for significant temporary works including the design of temporary access routes and platforms for craneage. (d) A residual risk remains in relation to this hazard. The lifting apparatus must have a current test certificate. The lifting arrangement must ensure that the load is evenly carried. Detailed temporary works calculations and method statements to be subject to approval, requirements for independent check certificates for temporary works. Appropriately trained operatives should carry out the lifting into place of the units.	3 3 3 3	Copy Risk Assessment to PSDP
(2) Access for maintenance and repairs to superstructure	Falling from heights; Manual handling; Drowning.	3 2 3	(a) Yes, risk rating >1. (b) No – all structures require maintenance and repair. (c) Yes – Adequate cover is given to reinforcement for the purpose of durability in accordance with the provisions of NRA BD 57/01; Weathering steel will also be considered to reduce maintenance requirements for main steel elements. (d) Residual risk remains as it is impossible to eliminate the eventual need for maintenance and repair; experienced maintenance Contractors to be used, proper planning and PPE is required for personnel involved with maintenance and repair; any temporary works used must be approved by the Authority. Traffic management proposals to be provided in the event of works required.	3 2 3	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, In what form has information been passed to PSDP or PSCS?
(3) Application of finishes – waterproofing, concrete impregnation, painting.	Risk from Chemical or biological substances;	3	(a) Yes, risk rating >1. (b) No – for durability reasons structural elements must be waterproofed and painted. Concrete impregnation will be required. (c) Yes –Waterproofing to be provided to the top of the deck with an approved BBA / IAB Certificate. A suitable paint system will be provided to enhance durability of the main steel elements if weathering steel is not used. This will be applied in a controlled environment, i.e., fabrication facility with connections requiring on-site painting only. A hydrophobic pore liner will be applied to the exposed concrete surface. (d) Individual protective measures of persons applying waterproofing, surface impregnation and paint are necessary to limit contact with any potentially harmful substances and reduce the risk of falls during application. Others should be kept clear of such areas when this work is in progress. Painting of steelwork should be carried out in a controlled environment.	2	Copy Risk Assessment to PSDP
(4) Erecting/ maintenance and removal of temporary works and scaffolding required for the construction.	Risk of falling from height; Struck during lifting operations.	3 3	(a) Yes, risk rating >1. (b) No – Inherent to insitu reinforced concrete construction. (c) Yes – Prefabricated steel members and precast permanent formwork for the construction of the insitu concrete deck reduces the requirement for temporary works. Specify requirement for independent temporary works check certificate for major elements of temporary works. (d) Residual risk remains because it is not reasonably practicable to eliminate the use of temporary works and scaffolding for insitu concrete construction. The contractor should ensure suitability qualified personnel are in place for all crane lifting/ movement of materials operations, and for the erection of all false work and scaffolding. The Temporary works will require approval by the designer. Temporary works require Design and Check Certificates.	3 3	Copy Risk Assessment to PSDP

Table 1.4 Detailed Design Risk Assessment for Option 3 - 5 Span Steel Composite with Tied Arch Main Span

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?
(1) Transportation and placing of prefabricated steel units	Risk of falls; Being struck by machinery/ crane; Drowning; Crushed or struck during lifting.	3 3 3 3	(a) Yes, risk rating >1 (b) No – the design requires the transportation and erection of prefabricated steel elements. The use of prefabricated elements reduces construction time, site welding and the number of staff working in the vicinity of water and therefore reduces the health and safety risks. (c) Yes – allow sufficient working space for access routes and hard standing area for craneage and launching platform. The steel members should be designed to be temporarily connected on site prior to welding. The units to be designed are to be sufficiently robust to withstand the lifting loads. Specify requirements for independent check certificate for significant temporary works including the design of temporary access routes and platforms for craneage. (d) A residual risk remains in relation to this hazard. The lifting apparatus must have a current test certificate. The lifting arrangement must ensure that the load is evenly carried. Detailed temporary works calculations and method statements to be subject to approval, requirements for independent check certificates for temporary works. Appropriately trained operatives should carry out the lifting into place of the units.	3 3 3 3	Copy Risk Assessment to PSDP
(2) Access for maintenance and repairs to superstructure	Falling from heights; Manual handling; Drowning.	3 2 3	(a) Yes, risk rating >1. (b) No – all structures require maintenance and repair. (c) Yes – adequate cover is given to reinforcement for the purpose of durability in accordance with the provisions of NRA BD 57/01;. Adequate headroom and provision for lighting will be provided within the deck for inspection/maintenance. (d) Residual risk remains as it is impossible to eliminate the eventual need for maintenance and repair; experienced maintenance Contractors to be used, proper planning and PPE is required for personnel involved with maintenance and repair; any temporary works used must be approved by the Authority. Traffic management proposals to be provided in the event of works required.	3 2 3	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, In what form has information been passed to PSDP or PSCS?
(3) Application of finishes – waterproofing, concrete impregnation, painting.	Risk from Chemical or biological substances;	3	(a) Yes, risk rating >1. (b) No – for durability reasons structural elements must be waterproofed/painted and concrete impregnation will be required. (c) Yes – Waterproofing is to be provided to the top of the deck. A suitable paint system will be provided to enhance durability of the main steel elements. This will be applied in a controlled environment, i.e., fabrication facility with connections requiring on-site painting only. A hydrophobic pore liner will be applied to the exposed concrete surface. (d) Individual protective measures of persons applying waterproofing, paint and surface impregnation are necessary to limit contact with any potentially harmful substances and reduce the risk of falls during application. Others should be kept clear of such areas when this work is in progress.	2	Copy Risk Assessment to PSDP
(4) Erecting/ maintenance and removal of temporary works and scaffolding required for the construction.	Risk of falling from height;	3	(a) Yes, risk rating >1. (b) No – the method of construction (launching) requires temporary works and scaffolding. (c) Yes – The deck for the main span will be launched reducing the requirement for temporary works over the watercourse. Specify requirements for independent check certificate for Temporary works. (d) Residual risk remains because it is not reasonably practicable to eliminate the use of temporary works and scaffolding. The contractor should ensure suitability qualified personnel are in place for all crane lifting/ movement of materials operations, and for the erection of all false work and scaffolding. The Temporary works will require approval by the designer. Temporary works require Design and independent Check Certificates.	3	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?
(5) Deck Launching, arch erection and providing composite section	Crushed or struck during launching; Falling from height; Drowning.	3 3 3	(a) Yes, risk rating >1. (b) No – this construction method requires launching, this reduces construction time, temporary works/supports and the number of staff working near water - therefore reduces the health and safety risks. However, in order to reduce weight of steel in arch composite arch proposed requires in-situ concrete pouring. (c) Yes - drawings to show the assumed construction sequence so the contractor can fully understand the assumptions made in the design and specify requirements for independent check certificates for temporary works. (d) A residual risk remains in relation to this hazard. The erection apparatus must have a current test certificate. The erection arrangement must ensure that the load is evenly carried. Appropriately trained operatives should carry out the erection. Method statements and supporting documents to be provided for all launching operations. Independent Check Certificates for Temporary Works to be provided.	3 3 3	Copy Risk Assessment to PSDP
(6) Cable positioning and stressing operations	Falling from height; Cable rupture.	3 3	(a) Yes, risk rating >1 (b) No – the design requires the use of tension system; (c) Yes – specify requirements for Tension systems and clearly describe required stressing sequence on the drawing. Specify requirements for independent check certificates for temporary works. (e) A residual risk remains in relation to this hazard. Tensioning equipment must have a current test certificate. Others should be kept clear of such areas when this work is in progress. Adequate PPE should be used. Detailed Method statements with the required check certificates for temporary works to be provided.	2 2	Copy Risk Assessment to PSDP

Table 1.5 Detailed Design Risk Assessment for Option 4 – 5 Span Concrete box with Steel Composite drop in Span

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?
(1) Construction of in-situ concrete for intermediate supports and back spans	Risk of falls; Being struck by machinery/ crane; Drowning; Crushed or struck during operations.	3 3 3 3	(a) Yes, risk rating >1 (b) No – the design requires the use of in-situ concrete deck. (c) Yes – clearly describe the assumed indicative construction sequence and specify requirements for independent check certificates for temporary works. (d) A residual risk remains in relation to this hazard. Temporary works required to ensure stability of formwork, access and stability of foundation. Life jackets to be provided, emergency vessel with trained boatsmen to be provided, PPE to be used when handling concrete and reinforcement, protection caps should be provided on the ends of reinforcement. Temporary works require design and check certificates.	3 3 3 3	Copy Risk Assessment to PSDP
(2) Transportation and placing of prefabricated steel units	Risk of falls; Being struck by machinery/ crane; Drowning; Crushed or struck during lifting.	3 3 3 3	(a) Yes, risk rating >1 (b) No – the design requires the transportation and erection of prefabricated steel elements. The use of prefabricated elements reduces construction time, site welding and the number of staff working in the vicinity of water and therefore reduces the health and safety risks. (c) Yes – allow sufficient working space for access routes and hard standing area for craneage. The steel members should be designed to be temporarily connected on site prior to welding. The units to be designed are to be sufficiently robust to withstand the lifting loads. Specify requirements for independent check certificate for significant temporary works including the design of temporary access routes and platforms for craneage. (d) A residual risk remains in relation to this hazard. The lifting apparatus must have a current test certificate. The lifting arrangement must ensure that the load is evenly carried. Detailed temporary works calculations and method statements to be subject to approval, requirements for independent check certificates for temporary works. Appropriately trained operatives should carry out the lifting into place of the units. Provide buoyancy aids emergency vessel and trained boatsman.	3 3 3 3	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, In what form has information been passed to PSDP or PSCS?
(3) Access for maintenance and repairs to superstructure	Falling from heights; Manual handling; Drowning.	3 2 3	(a) Yes, risk rating >1. (b) No – all structures require maintenance and repair. (c) Yes –Adequate cover is given to reinforcement for the purpose of durability in accordance with the provisions of NRA BD 57/01. Adequate headroom and provision for lighting will be provided within the deck for inspection/maintenance. (d) Residual risk remains as it is not reasonably practicable to eliminate the eventual need for maintenance and repair; experienced maintenance Contractors to be used, proper planning and PPE is required for personnel involved with maintenance and repair; any temporary works used must be approved by the Authority. Traffic management proposals to be provided in the event of works required.	3 2 3	Copy Risk Assessment to PSDP
(4) Application of finishes – waterproofing, concrete impregnation, painting.	Risk from Chemical or biological substances.	3	(a) Yes, risk rating >1. (b) No – for durability reasons structural elements must be waterproofed/painted and concrete impregnation will be required for durability. (c) Yes – Waterproofing is to be provided to the top of the deck. A suitable paint system will be provided to enhance durability of the main steel elements. This will be applied in a controlled environment, i.e., fabrication facility with connections requiring on-site painting only. A hydrophobic pore liner will be applied to the exposed concrete surfaces. (d) Individual protective measures of persons applying waterproofing, surface impregnation and paint are necessary to limit contact with any potentially harmful substances and reduce the risk of falls during application. Others should be kept clear of such areas when this work is in progress. Painting of structural steelwork should be applied in a controlled environment.	2	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, In what form has information been passed to PSDP or PSCS?
(5) Erecting/ maintenance and removal of temporary works and scaffolding required for the construction.	Risk of falling from height;	3	(a) Yes, risk rating >1. (b) No – construction for the deck requires significant temporary works and scaffolding. (c) Yes – The deck for the main span will be constructed using a fabricated steel box. This reduces the requirement for temporary works over the river channel. Specify requirements for independent check certificates for temporary works. (d) Residual risk remains because it is not reasonably practicable to eliminate the use of temporary works and scaffolding. The contractor should ensure suitability qualified personnel are in place for all stages of erection and for the erection of all false work and scaffolding. The Temporary works will require approval by the designer. Temporary works require Design Check Certificates.	3	Copy Risk Assessment to PSDP
(6) Post-tensioning operations	Risk of falls; Cable rupture.	3 3	(a) Yes, risk rating >1 (b) No – the design requires the use of post-tensioned concrete; (c) Yes – tensioning operations will be carried out by competent contractor using appropriately trained operatives. Clearly specify and describe the post tensioning requirements and assumed stressing sequence. (d) A residual risk remains in relation to this hazard. Cable tensioning equipment must have a current test certificate. Others should be kept clear of such areas when this work is in progress. Method statements for stressing operations to be provided. Experienced personal to complete stressing. Appropriate PPE to be used. Design Check Certificates for temporary works required.	3 2	Copy Risk Assessment to PSDP
(7) Placing of prefabricated steel unit.	Risk of falls; Being struck by machinery/ crane; Drowning; Crushed or struck during lifting.	3 3 3 3	(a) Yes, risk rating >1 (b) No – the design requires the use of prefabricated steel elements. The use of prefabricated elements reduces construction time, site welding and the number of staff working in the vicinity of water and therefore reduces the health and safety risks. (c) Yes – The steel main span will be prefabricated prior to lifting. Specify requirements for independent check certificates for temporary works. (d) A residual risk remains in relation to this hazard. The lifting apparatus must have a current test certificate. The lifting arrangement must ensure that the load is evenly carried. Appropriately trained operatives should carry out the lifting into place of the main unit. Design Check Certificates required for temporary works.	3 3 3 3	Copy Risk Assessment to PSDP

Table 1.6 Detailed Design Risk Assessment for Option 5 – 3 Span Asymmetric Stay Bridge

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, in what form has information been passed to PSDP or PSCS?
(1) Construction of in-situ concrete for intermediate supports, deck and pylon.	Risk of falls; Being struck by machinery/ crane; Drowning; Crushed or struck during operations.	3 3 3 3	(a) Yes, risk rating >1 (b) No – the design requires the use of in-situ concrete deck and pylon. (c) Yes – clearly describe the assumed indicative construction sequence and specify requirements for independent check certificates for temporary works. (d) A residual risk remains in relation to this hazard. Temporary works required to ensure stability of formwork, access and stability of foundation. Life jackets, emergency vessel and trained boatsman to be provided, PPE to be used when handling concrete and reinforcement, protection caps should be provided on the ends of reinforcement. Temporary works require design and check certificates.	3 3 3 3	Copy Risk Assessment to PSDP
(2) Access for maintenance and repairs to superstructure	Falling from heights; Manual handling; Drowning.	3 2 3	(a) Yes, risk rating >1. (b) No – all structures require maintenance and repair. (c) Yes – adequate cover is given to reinforcement for the purpose of durability in accordance with the provisions of NRA BD 57/01. Adequate headroom and provision for lighting will be provided within the box for inspection / maintenance. (d) Residual risk remains as it is impossible to eliminate the eventual need for maintenance and repair; experienced maintenance Contractors to be used, proper planning and PPE is required for personnel involved with maintenance and repair; any temporary works used must be approved by the Authority. Traffic management proposals to be provided in the event of works required.	3 2 3	Copy Risk Assessment to PSDP
(3) Application of finishes – waterproofing, concrete impregnation, Anti-graffiti coating	Risk from Chemical or biological substances.	3	(a) Yes, risk rating >1. (b) No – for durability reasons structural elements must be waterproofed/painted and concrete impregnation will be required for durability. (c) Yes – Waterproofing is to be provided to the relevant concrete deck areas. Specify BBA / IIAB approval system for concrete waterproofing. (d) Individual protective measures of persons applying waterproofing and impregnation are necessary to limit contact with any potentially harmful substances and reduce the risk of falls during application. Others should be kept clear of such areas when this work is in progress.	2	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, In what form has information been passed to PSDP or PSCS?
(4) Erecting/ maintenance and removal of temporary works and scaffolding required for the construction.	Risk of falling from height;	3	(a) Yes, risk rating >1. (b) No – construction for the deck back spans require significant temporary works and scaffolding. (c) Yes – The deck for the main span will be constructed using travelling formwork in two stages (concrete box and propped cantilever). This reduces the requirement for temporary works over the river channel. Temporary works will be required to construct the pylon. Specify requirements for independent check certificates for temporary works. (d) Residual risk remains because it is not reasonably practicable to eliminate the use of temporary works and scaffolding. The contractor should ensure suitability qualified personnel are in place for all erection operations, and for the erection of all false work and scaffolding. The Temporary works will require approval by the designer. Temporary works require Design and Check Certificates.	2	Copy Risk Assessment to PSDP
(5) Cable Stressing operations	Risk of falls; Cable Rupture;	3 3	(a) Yes, risk rating >1 (b) No – the design and construction sequence requires the use of Tension System at this structure; (c) Yes – specify requirements for tension system and clearly describe the required stressing sequence on the drawings. Specify requirements for independent check certificates for temporary works. (d) A residual risk remains in relation to this hazard. Cable tensioning equipment must have a current test certificate. Others should be kept clear of such areas when this work is in progress. Detailed method statements will be required. Adequate PPE, check certificates for temporary works.	2 2	Copy Risk Assessment to PSDP

Activity, Design, Process, Material	Hazard	Initial Risk Rating	Actions by Designer to Reduce Risk Rating	Final Risk Rating	Is Final Risk Rating 2 or 3? If so, In what form has information been passed to PSDP or PSCS?
(6) Construction of Pylon	Falling from height; Concrete handling.	3 2	(a) Yes, risk rating >1 (b) No - intermediate pylon support is required on cable stay structure. Cable stay span is optimised within constraints, to reduce the number of support points. (c) Yes – specify and clearly describe the assumed construction sequence and requirements for independent check certificates for temporary works. (d) Residual risk remains, temporary works will be required to ensure: safety against falling from heights, access and stability of formwork. PPE should be used when handling concrete and reinforcement; protective caps should be used on the exposed ends of reinforcement. Temporary works Design and Check Certificates are required.	3 2	Copy Risk Assessment to PSDP
(7) Members of the public climbing the pylon	Falling from height; Drowning.	3 3	(a) Yes, risk rating >1 (b) No – Cable stay option proposed to span the river and floodplain and reduce the impact on existing watercourse/floodplain (c) Yes – provide vertical surfaces with no hand or foot holes. (d) Residual risk remains, climbing deterrents to be provided if necessary.	1 1	
(8) Post-tensioning operations	Risk of falls; Cable rupture.	3 3	(a) Yes, risk rating >1 (b) No – the design requires the use post-tensioning concrete; (c) Yes – tensioning operations will be carried out by competent contractor using appropriately trained operatives. Clearly specify and describe the post tensioning requirements and assumed stressing sequence. (d) A residual risk remains in relation to this hazard. Cable tensioning equipment must have a current test certificate. Others should be kept clear of such areas when this work is in progress. Method statements for stressing operations to be provided. Experienced personnel to complete stressing. Appropriate PPE to be used. Design Check Certificates for temporary works required.	3 2	Copy Risk Assessment to PSDP

From the above risk assessment it can be determined that;

Option 1 and 2: Additional risk due to requirement to; Fabrication, transportation and erect by crane significant prefabricated steel elements, maintenance painting of steel elements if weathering steel is not adopted.

Option 3: Additional risk due to requirements to; Fabricate, transport and erect significant prefabricated steel elements; the weight of the arch is reduced by providing steel/concrete composite section, however, additional risk due to pouring concrete into arch elements, carry out maintenance of steel arch and tension system above live carriageway, provide temporary works to support superstructure during construction, risks associated with deck launching and cable stressing operations, maintenance painting of structural steel elements.

Option 4: Additional risk due to requirements to; Fabricate, transport and erect significant prefabricated steel elements, temporary works associated with support of the superstructure and inclined supports during construction, post tensioning operations; maintenance painting of steel elements.

Option 5: Additional risk due to requirements to; construction of reinforced concrete pylon, carry out maintenance of pylon and tension system above the carriageway, temporary works associated with construction of the pylon and superstructure, cable stressing operations and post tensioning operations.