
Appendix 3.5

Bridge Form Assessment Tables

Boyne Bridge Viable Options Evaluation

Viable Option	Technical Evaluation	Environmental Evaluation	Aesthetic Evaluation	Economic Evaluation
Option 1 Four span constant depth steel box girders	<p>Advantages</p> <p>Span arrangement provides good overall symmetry and a structurally efficient ratio of end span to main span is achieved.</p> <p>Box girders would be fabricated from weathering steel which means the maintenance requirements and future works within the SAC are reduced compared to painted carbon steel.</p> <p>Site activities within the Boyne Valley would be minimised as the majority of the deck superstructure steelwork can be fabricated off site in factory conditions and launched incrementally into position.</p> <p>Increased speed of construction as multiple setups associated with crane lifting or balanced cantilever construction are not required.</p> <p>Launching operations being carried out predominantly from the northern side of the Boyne Valley would minimise disruption to Rosnaree road compared to the other options.</p> <p>Disadvantages</p> <p>Temporary intermediate supports are not possible within the River Boyne and setback zones to support the launch nose of the superstructure over a length of approximately 65m therefore likely that temporary intermediate supports would not be used within any of the spans during the launch.</p> <p>A king post system can be used to facilitate launching over these span lengths without temporary supports by supporting the tip of the launch nose and limiting deflections. The launching construction method has greater risks associated with the accuracy required for the position and alignment of the supports and the temporary launch bearings.</p>	<p>Advantages</p> <p>Site activities within the Boyne Valley will be minimised compared to the other options as the majority of the deck superstructure will be fabricated off site in factory conditions and launched into position.</p> <p>Launching operations being carried out predominantly from the northern side of the Boyne Valley would minimise disruption to Valley and Rosnaree road compared to the other options.</p> <p>Disadvantages</p> <p>Additional filling in of northern end of valley potentially blocking mammal routes</p> <p>Potential additional disruption of badger sett to northern end of valley</p> <p>Piers located close to edge of 10m setback zones</p>	<p>Advantages</p> <p>Architecturally, the merit of this option lies in the symmetry of its spans and uncomplicated form. Structurally efficient and architecturally pleasing ratios of side spans to main span are achieved. The required clearances to the canal, towpath and set-back zones are all satisfactory.</p> <p>Disadvantages</p> <p>Transverse deck cantilevers will overhang and shadow the main structural members, disguising the structural depth of the bridge, giving a slimmer, less intrusive appearance however the aesthetic limitations of this option are that the overall elevation will still be a 3.2m constant depth angular form across the valley. The constant depth means that the structure has a heavy appearance in the midspan regions.</p> <p>The box girders fabricated from weathering steel provide a rustic appearance. The clean lines of a box girder are well known to be aesthetically pleasing when viewed from close by or from underneath when compared to a multi-girder deck.</p>	<p>Out-turn Cost Certainty: Medium</p> <p>Options 1 and 2 have medium cost certainty. Although relatively uncomplicated structures are proposed for each, the specialist nature of bridge launching has an element of cost uncertainty associated with it.</p> <p>Estimated Cost Ex. Vat: €19.3m</p>

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Viable Option	Technical Evaluation	Environmental Evaluation	Aesthetic Evaluation	Economic Evaluation
	<p>The intermediate pier foundation locations are in proximity to the 10m setback zones on both sides of the River Boyne. Temporary works may be required to ensure excavations for the foundations do not encroach on the setback zones.</p> <p>The constant depth box girders mean the structure is quite deep at the midspan regions and is not as aesthetically pleasing as the varying depth girder options.</p>			
<p>Option 1A Four span varying depth steel plate girders</p>	<p>Advantages</p> <p>The span arrangement provides good overall symmetry and a structurally efficient ratio of end span to main span is achieved.</p> <p>The varying depth girder mean a reduced depth of structure at the midspan regions, improving aesthetics and increasing headroom clearance.</p> <p>The plate girders would be fabricated from weathering steel which means the maintenance requirements and future works within the SAC are reduced compared to painted carbon steel.</p> <p>The construction of steel plate girders is relatively straight-forward, and although the steel girders are large and a very large crane will be required, it is a relatively well understood construction methodology.</p> <p>Disadvantages</p> <p>A very large crane (approx. 1,200 tonnes) will be required to allow the central sections of the main span over the River Boyne to be lifted into position without temporary intermediate supports. It is assumed that girders will be lifted in braced pairs. The crane could be located on either side of the Boyne but another crane will also be required on the other side to lift in the remaining sections.</p> <p>It is likely that some intermediate temporary supports will be required (outside of the Boyne exclusion zone) during the lifting operation, to support one end of the pier sections prior to lifting in the central sections.</p>	<p>Advantages</p> <p>No obvious advantages over Option 1; varying depth girders included for aesthetic reasons and to improve headroom in middle of each span.</p> <p>Disadvantages</p> <p>Very large crane required to operate in the valley for lifting operation, greater hardstanding areas required. Additional temporary supports may be required (outside of the setback zones) to support the section while lifting them into place</p> <p>Additional filling in of northern end of valley potentially blocking mammal routes.</p> <p>Potential additional disruption of badger set to northern end of valley.</p> <p>Piers located close to edge of 10m setback zones.</p>	<p>Advantages</p> <p>Option 1A benefits from the same symmetry and span ratios as Option 1. The varying depth girders have a curved bottom flange which form an appealing arched elevation on both the main spans and side spans. This improves the aesthetics of this option compared to Option 1 by removing the angular elevation of the structure. The varying depth also allows the depth of the beams to be reduced at midspan to 2.15m, the most slender of the options proposed, further improving the open aspect nature of the structure.</p> <p>Disadvantages</p> <p>Transverse deck cantilevers will again overhang and shadow the main structural members, disguising the structural depth of the bridge, giving a slimmer, less intrusive appearance.</p> <p>The plate girders fabricated from weathering steel provide a rustic appearance. Although the appearance of a multi-girder bridge is not as neat as a box girder when viewed up close or from underneath, there is also some architectural merit in a structure</p>	<p>Out-turn Cost Certainty: High</p> <p>Option 1A and 2A have higher cost certainty as steel plate girders are a relatively well known form of structure and there is considerable experience of this form of construction particularly in the UK.</p> <p>Estimated Cost Ex. Vat: €15.8m</p>

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Viable Option	Technical Evaluation	Environmental Evaluation	Aesthetic Evaluation	Economic Evaluation
Option 2 Four span constant depth steel box girders with extended northern span	<p>The intermediate pier foundation locations are in close proximity to the 10m setback zones on both sides of the River Boyne. Temporary works may be required to ensure excavations for the foundations do not encroach on the setback zones.</p> <p>Advantages</p> <p>The box girders would be fabricated from weathering steel which means the maintenance requirements and future works within the SAC are reduced compared to painted carbon steel.</p> <p>Site activities within the Boyne Valley would be minimised as the majority of the deck superstructure steelwork can be fabricated off site in factory conditions and launched incrementally into position. An advantage of this method is the increased speed of construction as multiple setups associated with crane lifting or balanced cantilever construction are not required.</p> <p>Launching operations being carried out predominantly from the northern side of the Boyne Valley would minimise disruption to Rosnaree road compared to the other options.</p> <p>This option has an additional environmental benefit over Option 1 in that it does not require the filling in of the northern end of the Boyne Valley.</p> <p>Disadvantages</p> <p>This option has similar disadvantages to Option 1, however, a significant disadvantage when compared to Option 1 is the lengthening of the span at the northern end results in the ratio of end span to main span becoming structurally inefficient.</p> <p>The end span now dictates the depth of girder required and this increase in depth is then required for all 4-spans to maintain the constant depth of this option for the launching construction method. This will also increase the risk and difficulty of fabrication, transportation and the launching of this option as well as the scale of the foundations when compared to Option 1.</p>	<p>Advantages</p> <p>As per Option 1 with added benefit of avoiding filling in of northern end of valley.</p> <p>Disadvantages</p> <p>Piers located close to edge of 10m setback zones.</p> <p>Adjustment of the towpath required to achieve headroom clearance.</p>	<p>that doesn't hide its load carrying members and these are fully on display in a multi-girder bridge.</p> <p>Disadvantages</p> <p>Option 2 is similar in form to Option 1 with the northern end extended 15m to the end of the northern section of the valley. This has the effect of increasing the overall cross-sectional depth thus reducing the vertical clearance of this option while also removing the symmetry and structural efficiency of the side spans.</p> <p>These are significant reductions in the aesthetic quality of this option when compared to Option 1.</p>	<p>Out-turn Cost Certainty:</p> <p>Medium</p> <p>Options 1 and 2 have medium cost certainty. Although relatively uncomplicated structures are proposed for each, the specialist nature of bridge launching has an element of cost uncertainty associated with it.</p> <p>Estimated Cost Ex. Vat: €20.4m</p>

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	<p>A further disadvantage of the increase in cross-section depth is that the alignment and level of the towpath needs to be adjusted locally at the bridge to achieve the 5.1m headroom clearance required.</p>			
<p>Option 2A Four span varying depth steel plate girders with extended northern span</p>	<p>Advantages</p> <p>The varying depth girder mean a reduced depth of structure at the midspan regions, improving aesthetics and increasing headroom clearance.</p> <p>The box girders would be fabricated from weathering steel which means the maintenance requirements and future works within the SAC are reduced compared to painted carbon steel.</p> <p>The construction of steel plate girders is relatively straight-forward, and although the steel girders are large and a very large crane will be required, it is a relatively well understood construction methodology.</p> <p>This option has an additional environmental benefit over Option 1A in that it does not require the filling in of the northern end of the Boyne Valley.</p> <p>Disadvantages</p> <p>Has similar disadvantages to Option 1A, however, a significant disadvantage when compared to Option 1A is the lengthening of the span at the northern end results in the ratio of end span to main span becoming structurally inefficient. The northern span is therefore effectively acting almost as simply supported beam requiring greater structural depth at midspan than the continuous main 75m spans.</p> <p>This increase in depth locally at the northern end span further reduces the symmetry and aesthetics of this option compared to Option 1A as well as increasing the scale and difficulty of fabrication, transportation, lifting and foundations required.</p>	<p>Advantages</p> <p>Advantage over Option 1A as avoiding filling in of northern end of valley.</p> <p>No other obvious environmental advantages over Option 2, varying depth girders included for aesthetic reasons and to improve headroom in middle of each span.</p> <p>Disadvantages</p> <p>Very large crane required to operate in the valley for lifting operation Additional temporary supports may be required (outside of the setback zones) to support the sections while lifting them into place.</p> <p>Piers located close to edge of 10m setback zones.</p>	<p>Disadvantages</p> <p>Option 2A is similar in form to Option 1A with the northern end extended 15m to the end of the northern section of the valley. This has the effect of increasing the north back span cross-sectional depth while also removing the symmetry and structural efficiency of the side spans.</p> <p>These again are significant reductions in the aesthetic quality of this option when compared to Option 1A.</p>	<p>Out-turn Cost Certainty: High</p> <p>Option 1A and 2A have higher cost certainty as steel plate girders are a relatively well known form of structure and there is considerable experience of this form of construction particularly in the UK.</p> <p>Estimated Cost Ex. Vat: €16.7m</p>
<p>Option 3 Four span varying depth</p>	<p>Advantages</p> <p>The span arrangement provides good symmetry and a structurally efficient ratio of side span to main span is achieved.</p>	<p>Advantages</p> <p>Piers located further away from river and 10m setback zones.</p>	<p>Advantages</p> <p>Option 3 consists of 3 spans of varying depths spanning the majority of the Boyne Valley achieving good</p>	<p>Out-turn Cost Certainty: Medium</p> <p>Options 3 has medium cost certainty due to the scale of the</p>

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concrete box girder	<p>The varying depth girder means a reduced depth of structure at the midspan regions, improving aesthetics and increasing headroom clearance.</p> <p>The concrete deck structure means maintenance requirements are reduced compared to the steel options.</p> <p>The piers are situated further from the edge of the 10m setback zones than the other options, improving the open aspect aesthetic and reducing risk of potential negative impact on the watercourse.</p> <p>Disadvantages</p> <p>Northern pier positioned further north into the Boyne Valley SAC area compared to other options. This will be discussed further in Section 9.</p> <p>This option will require larger piled foundations and substructures for the two main piers than the other options.</p> <p>Balanced cantilever construction is a significant construction operation and is extremely specialised and not an everyday form of construction. Post tensioned concrete is also not a commonly used form of construction in Ireland so a very skilled and experienced Contractor will be required, most likely with international experience of similar forms of construction.</p> <p>Construction of the side spans beyond the balanced cantilevers and end span over the canal will most likely require conventional ground supported falsework as these cannot be constructed by cantilever methods. Indeed, it may be more economical to construct the full length of both side spans using conventional falsework with only the main span over the Boyne constructed using the cantilever method.</p>	<p>Full valley spanned.</p> <p>Disadvantages</p> <p>Significant amount of in-situ concrete works taking place across the valley and over the watercourse.</p> <p>Temporary supports in the form of ground supported falsework required for construction of box girder outside extent of balanced cantilever.</p>	<p>aesthetics and 1 shorter shallower constant depth span achieving good clearance to the towpath and the canal at the southern end of the bridge. This option spans the entire Boyne Valley. The piers are further removed from the back of the 10m setback zones compared to the other options further improving the open aspect of the bridge.</p> <p>Structurally efficient and architecturally pleasing ratios of side spans to main span are achieved and the structure has good symmetry, even with the additional constant depth south end span. The bridge deck's varying depth arched elevation on both the main and side spans has a satisfactory aspect ratio.</p> <p>Disadvantages</p> <p>Transverse deck cantilevers will again overhang and shadow the main structural members, disguising the structural depth of the bridge, giving a slimmer, less intrusive appearance in elevation. At 5.15m deep at the intermediate pier supports Option 3 has the deepest deck cross-section of the proposed options.</p> <p>A concrete box girder offers clean lines and is known to be aesthetically pleasing when viewed from close by or from underneath with no fussy details on display and a consistency of materials across the girder, deck slab and substructure.</p>	<p>bridge and the highly specialist nature of the balanced cantilever construction method.</p> <p>Estimated Cost Ex. Vat: €22.3</p>