Wicklow County Council

N11/M11 Junction 4 to Junction 14 Improvement Scheme

Option Selection Report Appendix C12 – Engineering Assessment

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Contents

1 Engineering assessment

1.1 Introduction

This report details the Engineering assessment of the Stage 1 Preliminary Options Assessment for the N11/M11 Scheme with respect to the Engineering constraints identified in **Section 11** (Engineering) of **Volume B**.

For the corridor assessment, the overall scheme has been split into two sections, i.e. the Northern Section and the Southern Section and the corridor options assessed are those discussed in **Section 6.1** of **Volume A**.

There are two zones associated with each corridor option referred to in this assessment:

- The potential road "footprint" which is the potential land take required to construct or improve the road; and
- The road "corridor" which is a 200m wide corridor centred around the alignment centre line for all off-line corridors. For the on-line Corridor Options 1 (North), 1 (South) and 5 (South), the width is variable, but is typically narrower than the width of the off-line corridors. The "footprint" sits inside the "corridor" boundary.

As part of the Option Selection process, an assessment of the preliminary design of each corridor option against a number of engineering parameters is required, with the principle objective of narrowing the number of options and if possible, establishing the preferred option from a purely engineering perspective.

Section 1.2 outlines the methodology that was used to carry out the study, and **Section 1.3** outlines the assessment criteria which were used. The Stage 1 assessment is presented in **Section 1.4**, the road safety impact assessment in **Section 1.5**, summary in **Section 1.6**, and references in **Section 1.7.**

1.2 Methodology

For the engineering assessment, the corridors in the Northern Section have been assessed independently from the corridors in the Southern Section, on the basis that any corridor in the Northern Section could be combined with any corridor in the Southern Section to form an overall preferred corridor for the scheme.

For the purposes of undertaking the Stage 1 Preliminary Options Assessment for engineering, a preliminary mainline alignment has been designed for each of the corridor options. The geometric design of each corridor alignment is presented on **Figures A6.1.1** through **A6.10.4**. With reference to these preliminary designs and relevant TII Standards documents, comparative assessments have been undertaken for each corridor option (north and south) across a range of engineering sub-criteria.

Where possible, the assessment of each corridor is expressed quantitatively, by evaluation of adherence to geometric standards or direct comparison of corridor elements.

Based on this and professional judgement, a preference ranking has been assigned against each criterion using the scale; 'Preferred', 'Intermediate' or 'Least Preferred'.

1.3 Assessment criteria

The comparative assessment of each corridor with respect to engineering constraints considers the following engineering assessment sub-criteria:

- Technical Standards;
- Corridor Length;
- Junction Strategy;
- Traffic Assessment and Cross Section;
- Structures; and
- Topography and Earthworks.

1.4 Stage 1 corridor options assessment

1.4.1 Technical standards

In order to comparatively assess each corridor option for compliance with technical standards, the preliminary mainline alignments as presented on **Figures A6.3.2** through **A6.10.4** have been assessed against the geometric design requirements stipulated within current TII Standards documents[1]. Specifically, the following components of the geometric design have been evaluated:

- **Horizontal curvature** has been assessed by calculation of the percentage of each option that fails to achieve at least desirable minimum curvature.
- **Vertical curvature** has been assessed by calculation of the percentage of each option that fails to achieve at least desirable minimum curvature.
- **Gradient** has been assessed by calculation of the percentage of each option which exceeds the desirable maximum gradient. However, the gradient assessment has further split the percentage of corridor length exceeding desirable maximum gradient into bands of 3% - 4% (considered a relaxation from standards) and 4% - 5% (considered a departure from standards). Corridor gradients in the range 4% - 5% have been assigned a negative rating twice that of corridor gradients in the range 3% - 4%, in recognition of the progressive decrease in safety with increasingly steeper gradients.

[1] Transport Infrastructure Ireland (TII) Rural Road Link Design DN-GEO-03031. Available from https://www.tiipublications.ie/library/DN-GEO-03031-11.pdf

The results of the assessment for compliance with technical standards are presented in **Table 1.1** and **Table 1.2**.

Table 1.1: Summary of technical standards assessment for the Northern Section

Technical Standards (Sub-Criteria)		**Corridor Option 1 (North)**	**Corridor Option 2 (North)**	**Corridor Option 3 (North)**	**Corridor Option 4 (North)**
Horizontal Alignment	% of Each Corridor below DM Standard	49.5%	24.3%	24.7%	29.7%
	Preference	Least Preferred	Preferred	Preferred	Intermediate
Vertical Alignment	% of Each Corridor below DM Standard	18.4%	10.0%	9.2%	7.7%
	Preference	Least Preferred	Intermediate	Intermediate	Preferred
Gradient	% of Each Corridor between 3% - 4%	6.4%	23.5%	23.2%	28.8%
	% of Each Corridor between 4% - 4%	10.5%	0%	0%	2.2%
	Preference	Intermediate	Preferred	Preferred	Least Preferred
Overall Preference Ranking (Technical Standards)		Least Preferred	Preferred	Preferred	Intermediate

Table 1.2: Summary of technical standards assessment for the Southern Section

Technical Standards (Sub-Criteria)		**Corridor Option 1 (South)**	**Corridor Option 2 (South)**	**Corridor Option 3 (South)**	**Corridor Option 4 (South)**	**Corridor Option 5 (South)**
Horizontal **Alignment**	% of Each Corridor below DM Standard	13.5%	0%	1.7%	1.6%	13.5%
	Preference	Least preferred	Preferred	Intermediate	Intermediate	Least preferred
Vertical Alignment	% of Each Corridor below DM Standard	11.9%	9.7%	9.5%	9.2%	11.9%
	Preference	Least preferred	Intermediate	Intermediate	Preferred	Least preferred
Gradient	% of Each Corridor between 3% - 4%	20.8%	36.0%	59.5%	60.6%	20.8%
	% of Each Corridor between 4% - 4%	0%	0%	0%	0%	0%
	Preference	Preferred	Intermediate	Least preferred	Least preferred	Preferred
Overall Preference Ranking (Technical Standards)		Least preferred	Preferred	Intermediate	Intermediate	Least preferred

In the Northern Section, Corridor Options 2 (North) and 3 (North) are preferred when assessed against compliance with technical standards. In the Southern Section, Corridor Option 2 (South) is preferred.

1.4.2 Length

The length of each corridor option is assessed with the shortest lengths indicating the most preferred options and the longest corridors least preferred. At this stage of the assessment, lengths have been determined for the mainline only – lengths of link and side roads have not been considered under this sub-criterion. The results of this assessment are presented in **Table 1.3** and **Table 1.4**.

Table 1.3: Summary of corridor lengths for the Northern Section

	Corridor Option 1 (North)	**Corridor Option 2 (North)**	**Corridor Option 3 (North)**	**Corridor Option 4 (North)**
Mainline Alignment Length (m)	8,969	9,069	9,686	9,720
Preference	Preferred	Intermediate	Least Preferred	Least Preferred

Table 1.4: Summary of corridor lengths for the Southern Section

	Corridor Option 1 (South)	**Corridor Option 2 (South)**	**Corridor Option 3 (South)**	**Corridor Option 4 (South)**	**Corridor Option 5 (South)**
Mainline Alignment Length (m)	14,413	14,838	14,730	14,907	14,413
Preference	Preferred	Least Preferred	Intermediate	Least Preferred	Preferred

In the Northern Section, Corridor Option 1 (North) is the shortest in overall length and Corridor Option 4 (North) is the longest. In the Southern Section, Corridor Options 1 (South) and 5 (South) are the shortest while Corridor Option 4 (South) is the longest.

1.4.3 Junction strategy

As discussed in **Appendix F2.2** (Existing road condition assessment report) of **Volume F**, the current junction provision on the N11/M11 is not entirely conducive to the safe and efficient operation of a strategic road. Few, if any, junctions along the scheme comply fully with current TII geometric standards. Furthermore, there is an absence of consistency in junction standard and design characteristics, which does not present drivers with intuitive and expected layouts. Moreover, many of the primary junctions are closely spaced, with insufficient weaving lengths contributing to flow instability and collision frequency.

Problems also stem from the proliferation of direct accesses and minor road junctions, including residential accesses, with 39 such accesses located between Junction 6 (Bray/Fassaroe) and Junction 12 (Newtownmountkennedy/Roundwood) alone.

Improvements to the junctions along the N11/M11 corridor would support a number of the scheme objectives vis-à-vis enhancing connectivity, improving safety and efficiency and promoting a safer environment for non-motorised users.

The preliminary geometry designs developed and presented on **Figures A6.3.2** through **A6.10.4** illustrate potential junction locations for each corridor. However, it should be noted that a decision on any future junction provision will require more traffic modelling and appraisal. Any corridor option incorporating on-line sections may look to integrate existing primary junctions into the future scheme, perhaps with modification and improvement to better manage capacity and safety. However, a rationalisation of the number of existing junctions may also achieve benefits by extending weaving lengths and improving mainline journey time, subject to maintaining adequate connectivity with the regional road network and populated areas. These principles apply to all corridor options as each includes sub-sections of on-line improvement.

In addition, corridor options incorporating on-line sections would seek to remove or relocate junction types which do not comply with TII Standards for the major road type. On motorways, only grade separated junctions are permitted. On type 1 dual carriageways, only grade separation and priority junctions of the left in – left out form may be used. This principle can also be applied to all corridor options.

For corridor options incorporating off-line elements, it is not certain that additional, new, junctions would be needed. Many of the off-line segments are intended to facilitate short deviations off the existing corridor to avoid particular engineering and environmental constraints and occur in between existing junctions and population centres. As such, it is not considered that the overall junction strategy for the scheme would be radically different depending on the chosen combination of corridor options. The junction strategy objectives will seek to align with the following basic principles, irrespective of the corridor option:

- Provide junction layouts which are consistent, intuitive and better manage capacity needs;
- Provide junctions which are safer for non-motorised users;
- Ensure junction strategy provides good connectivity to the regional network and population centres; and
- Remove or re-locate non-standard junction types.

In summary, it is considered that each corridor option has the potential to align with the strategic objectives above. For these reasons, it is not considered possible to objectively differentiate between corridor options at this stage from a purely junction strategy perspective. Therefore, all corridor options are considered equal at this stage under this sub-criterion at this stage in the assessment.

1.4.4 Traffic assessment and cross section

As detailed in Chapter 3, the existing N11/M11 between Junction 4 (City Centre/Dún Laoghaire) and Junction 14 (Coyne's Cross) is essentially comprised of both standard 2-lane motorway and 2-lane type 1 dual carriageway cross-sections, with some slight variations in lane, hard shoulder, verge and median widths owing to piecemeal development of the existing route.

Ordinarily, a simple examination of traffic volumes would suggest that additional capacity is needed, with Annual Average Daily Traffic (AADT) flows exceeding the recommended capacity for the desired level of service on the mainline north of Junction 8 (Kilmacanoge / Roundwood). However, at this stage in the Option Selection process, a decision on the optimum future cross-section for the N11/M11 corridor has not been reached. This is predominantly due to the range of scenarios currently under consideration to best meet the scheme objectives, including public transport both on and off the N11/M11 corridor, demand management and road improvement measures. Each of these scenarios has the potential to significantly alter the future highway demand by, for example, promoting modal shift away from private car travel or encouraging off peak travel. The potential to improve the public transport carrying capacity of the N11/M11, through the provision of bus priority, could also influence the appropriate cross-section design. Full details on the chosen cross-section will not be available until the cost benefit analysis has been completed. However, for the purposes of the Stage 1 Preliminary Options Assessment, it is assumed that the cross-section necessary to implement the range of scenarios under consideration will be accommodated within any of the corridor options developed.

It should also be noted that the off-line corridors are generally confined to segments along the N11/M11 where specific deficiencies exist, warranting the consideration of an alternative corridor. A corollary of this is that an off-line corridor, if preferred, would become the new national route, with the residual N11/M11 at that location declassified to serve a regional / local purpose only. Moreover, the off-line corridors are closely focussed around the existing N11/M11 route, facilitating short deviations off the existing corridor to avoid particular engineering and environmental constraints. In this manner, the off-line corridors are not very geographically distinct relative to the wider study area, as may be the case for the assessment of an entirely new road in a greenfield setting. It is therefore assumed that the traffic carrying capacity and cross-section is essentially equivalent for each corridor option, with no particular preference at this stage in the assessment.

1.4.5 Structures

For the structure assessment, each corridor option (north and south) has been compared to determine both the number of existing structures which may be impacted – in the case of an on-line corridor, and the number of new structures likely to be required – in the case of an off-line corridor. In the case of existing structures, road (underbridge and overbridge), pedestrian and river bridges have been counted.

While the ability to retain existing structures as part of an on-line solution would be positive from a cost and construction perspective, it is likely that certain existing structures would require a degree of improvement, ranging from minor repairs to potential bridge widening if necessitated by a change in cross-section. New structures have been counted where off-line corridors cross side roads or major rivers. For the purposes of making a comparative assessment, it is recognised that new structures would likely require a greater investment than the retention/improvement of existing. As such, a structure score for each corridor option has been determined by counting the number of new and existing and assigning a weighting of '2' against any new structures.

The corridor option with the lowest score is deemed preferred, on the basis that it is likely to have the fewest new structures and comparatively more existing structures which can be retained and improved.

The results of this assessment are presented in **Tables 1.5** and **1.6**.

Table 1.5: Summary of structures assessment for the Northern Section

	Corridor Option 1 (North)	**Corridor Option 2 (North)**	**Corridor Option 3 (North)**	**Corridor Option 4 (North)**
Existing Road Structures (Road & River Bridge)	9	7	5	6
New Road Crossings	0	5	5	3
Total	9	17	15	12
Preference	Preferred	Least Preferred	Least Preferred	Intermediate

Table 1.6: Summary of structures assessment for the Southern Section

	Corridor Option 1 (South)	**Corridor Option 2 (South)**	**Corridor Option 3 (South)**	**Corridor Option 4 (South)**	**Corridor Option 5 (South)**
Existing Road Structures (Road & River Bridge)	12	8	9	9	12
New Road Crossings	0	3	6	6	0

	Corridor Option 1 (South)	Corridor Option 2 (South)	Corridor Option 3 (South)	Corridor Option 4 (South)	Corridor Option 5 (South)
Total	12	14	21	21	12
Preference	Preferred	Intermediate	Least Preferred	Least Preferred	Preferred

In the Northern Section, Corridor Option 1 (North) is preferred from a structure perspective and Corridor Options 2 (North) and 3 (North) are least preferred. In the Southern Section, Corridor Options 1 (South) and 5 (South) are preferred and Corridor Options 3 (South) and 4 (South) are least preferred.

1.4.6 Topography and earthworks

In order to comparatively assess each corridor option under the criterion of Topography and Earthworks, a preliminary assessment of the earthworks quantities has been undertaken for the mainline alignments as presented on **Figures A6.3.2** to **A6.10.4** to ascertain the overall cut / fill balance for each option in the northern and southern sections. The results of this assessment are presented in **Tables 1.7** and **1.8.**

Table 1.7: Summary of cut / fill balance for the Northern Section

	Corridor Option 1 (North)	Corridor Option 2 (North)	Corridor Option 3 (North)	Corridor Option 4 (North)
Mainline Cut (m3)	129,005	2,564,669	2,494,274	2,182,963
Mainline Fill (m3)	0	-43,788	-94,695	24,654
Cut / Fill Balance (m3)	+129,005 (Surplus)	+2,520,882 (Surplus)	+2,399,580 (Surplus)	+2,158,309 (Surplus)
Preference	Preferred	Least Preferred	Least Preferred	Least Preferred

Table 1.8: Summary of cut / fill balance for the Southern Section

	Corridor Option 1 (South)	Corridor Option 2 (South)	Corridor Option 3 (South)	Corridor Option 4 (South)	Corridor Option 5 (South)
Mainline Cut (m3)	0	3,057,997	3,114,144	7,949,947	67,000
Mainline Fill (m3)	0	-1,136,437	-1,558,555	-2,017,181	-7,000
Cut / Fill Balance (m3)	0	+1,292,156	+1,555,590	+5,932,765	+60,000
Preference	Preferred	Intermediate	Intermediate	Least Preferred	Preferred

In the Northern Section, Corridor Option 1 (North) is preferred, with all other corridors resulting in a significant cut / fill surplus. In the Southern Section, Corridor Options 1 (South) and 5 (South) are preferred with all other corridors resulting in a significant cut / fill surplus.

1.5 Road safety impact assessment

A Stage F1 Road Safety Audit was carried out as part of this Stage 1 Preliminary Options Assessment. This is included in **Appendix C14** Road Safety Impact Assessment) of **Volume C.**

1.5.1 Northern Section

The road safety assessment is summarised in **Table 6.34** for the Northern Section.

Table 6.1: Road safety summary assessment table Northern Section

Corridor option	Preference
Corridor Option 1 (North)	Intermediate
Corridor Option 2 (North)	Least Preferred
Corridor Option 3 (North)	Preferred
Corridor Option4 (North)	Intermediate

Corridor Options 3 (North) and 4 (North) are ranked high because they have fewer junctions than the other corridor options. Corridor Option 3 (North) is ranked preferred over Corridor Option 4 (North) because it has a slightly higher standard horizontal alignment, and Corridor Option 1 (North) is more preferred to Corridor Option 2 (North) which is least preferred because it has fewer junctions.

1.5.2 Southern Section

The road safety assessment is summarised in **Table 6.35** for the Southern Section.

Table 2: Road safety summary assessment table Southern Section

Corridor option	**Preference**
Corridor Option 1 (South)	Least Preferred
Corridor Option 2 (South)	Preferred
Corridor Option 3 (South)	Intermediate
Corridor Option 4 (South)	Intermediate
Corridor Option 5 (South)	Least Preferred

Corridor Option 2 (South) is preferred because it has fewer junctions than the other corridor options. Corridor Option 3 (South) and Corridor Option 4 (South) are comparable in terms of road safety. Corridor Option 1 (South) and Corridor Option 5 (South) are least preferred because they have more junctions than the other corridor options and have a lower standard horizontal alignment. Corridor Option 1 (South) is slightly preferred over Corridor Option 5 (South) because the potential provision of an additional lane through Glen of the Downs may lead to higher speeds in a location where there is a low standard of horizontal alignment, but it is considered least preferred comparative to the other corridor options considered.

1.6 Summary

The above assessments under the various engineering sub-criteria are summarised in **Tables 1.9** and **1.10**. An overall preference for each corridor option has been determined, indicating that Corridor Option 1 (North) is preferred in the Northern Section and Corridor Option 1 (South) is preferred in the Southern Section.

Table 1.9: Summary of engineering assessment for the Northern Section

	Corridor Option 1 (North)	**Corridor Option 2 (North)**	**Corridor Option 3 (North)**	**Corridor Option 4 (North)**
Technical Standards	Least Preferred	Preferred	Preferred	Intermediate
Corridor Length	Preferred	Intermediate	Least Preferred	Least Preferred
Junction Strategy	All Corridors Equal			
Structures	Preferred	Least Preferred	Least Preferred	Intermediate
Topography & Earthworks	Preferred	Least Preferred	Least Preferred	Least Preferred

Table 1.10: Summary of engineering assessment for the Southern Section

	Corridor Option 1 (South)	**Corridor Option 2 (South)**	**Corridor Option 3 (South)**	**Corridor Option 4 (South)**	**Corridor Option 5 (South)**
Technical Standards	Least preferred	Preferred	Intermediate	Intermediate	Least Preferred
Corridor Length	Preferred	Least Preferred	Intermediate	Least Preferred	Preferred
Junction Strategy	All Corridors Equal				
Structures	Preferred	Intermediate	Least Preferred	Least Preferred	Preferred
Topography & Earthworks	Preferred	Intermediate	Intermediate	Least Preferred	Preferred

1.7 References

Transport Infrastructure Ireland (TII) Project Appraisal Guidelines for National Roads Unit 7.0 - Multi-Criteria Analysis, 2016. Available from: https://www.tiipublications.ie/library/PE-PAG-02031-01.pdf

Transport Infrastructure Ireland (TII) Rural Road Link Design DN-GEO-03031. Available from: https://www.tiipublications.ie/library/DN-GEO-03031-11.pdf