

Armagh East Link

Route Assessment Report

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Version 4.0

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List of drawings not included in the main body of the Report text:-

Drawing No.	Version	Drawing Title
<i><u>Included in Appendix B:</u></i>		
1064968-A-D-0810	A	Proposed Options
1064968-A-D-0811	A	Alignment 10 (Sheets 1 to 3 of 3)
1064968-A-D-0812	A	Alignment 11 (Sheets 1 to 2 of 2)
1064968-A-D-0813	A	Alignment 12 (Sheets 1 to 2 of 2)
1064968-A-D-0814	A	Alignment 13 (Sheets 1 to 4 of 4)
1064968-A-D-0815	A	Alignment 14 (Sheets 1 to 2 of 2)
1064968-A-D-0816	A	Alignments 15 & 16 (Sheets 1 to 2 of 2)
1064968-A-D-0817	A	Alignment 20 (Sheets 1 to 3 of 3)
1064968-A-D-0818	A	Alignment 40
1064968-A-D-0819	A	Alignment 50 (Sheets 1 to 3 of 3)
1064968-A-D-0820	A	Scheme Constraints
<i><u>Included in Appendix C:</u></i>		
1064968-A-D-0821	A	Scheme Study Area
1064968-A-D-0822	A	Scheme Constraints
1064968-A-D-0827	A	Drift Geology Map
1064968-A-D-0828	A	Solid Geology Map
1064968-A-D-0829	A	Landscape and Townscape Character Areas
<i><u>Included in Appendix D:</u></i>		
1064968-A-D-0828	A	Option Overview
1064968-A-D-0823	A	Proposed Options: 2007 Preferred Option (Sheet 1 to 2 of 2)
1064968-A-D-0824	A	Proposed Options: Alignment 12 (Sheet 1 to 3 of 3)

1064968-A-D-0825	A	Proposed Options: Alignment 16 (Sheet 1 to 3 of 3)
1064968-A-D-0826	A	Proposed Options: Alignment 50 (Sheet 1 to 3 of 3)

1 Introduction

An integral feature of the Regional Development Strategy 2025 (RDS) was the requirement to develop a Regional Transportation Strategy having a vision of “a modern, integrated and sustainable transportation system which benefits society, the economy and the environment and which actively contributes to social inclusion and everyone’s quality of life”. In July 2002, the Assembly approved the strategic direction and underlying principles of the ‘Regional Transportation Strategy for Northern Ireland 2002-2012’ (RTS). The RTS identified strategic transportation investment priorities and considered potential funding sources over a 10 year period as well as setting down guidance as to how funding would be split between areas and transport modes.

Delivery of the RTS was to be progressed through 3 multi modal transport plans, one of which is the Regional Strategic Transport Network - Transport Plan (RSTN TP), published in March 2005.

The Regional Strategic Transport Network (RSTN) of Northern Ireland comprises the rail network, five Key Transport Corridors, four Link Corridors, the Belfast Metropolitan Transport Corridors and the remainder of the trunk road network. It was previously reported as comprising 5% of the total road network but carrying 37% of the traffic. A number of priority schemes to improve the RSTN were ongoing and appraisal work (based on the Government’s five key criteria of environment, safety, economy, accessibility and integration) was undertaken to identify further Strategic Road Improvement (SRI) schemes for inclusion in the RSTN TP. The RSTN TP followed the funding levels envisaged in the RTS, although they were extrapolated to match the longer period of the RSTN TP (2005 – 2015).

The proposed Armagh East Link was included within that ten-year Plan, with a recommendation that it be constructed towards the end of that period.

Also included in the RSTN TP, to improve the road network around Armagh, was the Armagh North–West Link, which is proposed to connect the A3 round the north of the city to the A28 west of Armagh.

Mouchel was commissioned to assist TransportNI (Southern Division) with the delivery of the proposed Armagh East Link. The scheme involves the provision of a new single carriageway road, with associated environmental mitigation and ancillary

works. The proposed Armagh East Link is intended to link the A28 Markethill Road to the A3 Portadown Road, incorporating a proposed junction with the A51 Hamiltonsbawn Road.

2 Project History

2.1 Introduction

The proposed Armagh East Link is intended to run from the A28 Markethill Road in the south to the A3 Portadown Road in the north, incorporating a proposed junction with the A51 Hamiltonsbawn Road.

The perceived project benefits include:-

- Improving traffic movement in and around the city;
- Relieving congestion on associated key routes to improve the environment of the historic city centre;
- Improving road safety;
- Facilitating future development in and around the city of Armagh; and,
- Improving the road network between the North and South of the Province

2.2 Scheme Background

In 2004 Roads Service commissioned Mouchel (formerly Mouchel Parkman) to investigate options for the proposed Armagh East Link Road. The commission would take the scheme through Public Consultation to the announcement of the Preferred Route, followed by the development of the Preferred Route to a stage sufficient to enable draft orders to be published, procurement of a contractor, administration of the contract and supervision of construction.

A joint Public Information Day to explain the principles behind the various options for the East Link and the North-West Link was held on Monday 13th March 2006, at the Armagh City Hotel. A further Public Exhibition Day for the Armagh East Link scheme was held on the 20th March 2007 to present the alignment and junction options for what, at that time, had been identified as the preferred route and update the public on scheme developments.

Due to the economic downturn, progress on a number of schemes was slowed down as public expenditure decreased. The Armagh East Link was one of those schemes. In 2014 a decision was taken to update members of public on the status of the scheme and gain feedback from the public, elected members and other interested parties on the proposals since the last information day. Subsequent to this decision a

Public Information Day was held on the 11th June 2014 to seek more recent views on the 2007 Preferred Option. Exhibition boards displaying an “Introduction”, the “Preferred Scheme Option” (2007), “Proposed Junction Layouts”, “Environmental Assessment Information”, “Land Issues Information” and “Statutory Procedures” were prepared along with advertisement posters and information leaflets. An increased level of public concern in relation to integration, accessibility and safety from the time of publishing the Stage 2 Scheme Assessment Report was noted at the southern/A28 end of the scheme. Queries were also raised regarding the development of Edenaveys Industrial Estate between 2007 and 2014, and whether a tie in to the A28 in that vicinity would now be preferable.

In light of the information gleaned from the event it was deemed prudent to reassess the validity of the 2007 Preferred Option and consider whether other options are now worthy of consideration given the changes in land use and potential traffic flows and patterns of movement within the study area.

A Summary of the *Stage 1* and *Stage 2 Assessment Reports* is presented in *Appendix A*.

Following on from the Public Information Day and development of alternative route options a workshop was held on Friday 27th February 2015 to review the potential route options to the East of Armagh. A copy of the text of the *Proposed Options Workshop Report* is provided in *Appendix B* together with the associated appendices.

From the workshop, four route options were brought forward to the next stage of the project for further review/design. It was recognised during the workshop that traffic transference to the new link would generally be in proportion with the distance from the centre of Armagh, i.e. a more “inner urban” link was considered to provide greater traffic relief than a more remote rural link due to the volume of traffic that would be predisposed to using a link closer to the city. However, the proposed Armagh North-West Link Road may also have an effect on the transference of traffic and this too could have an impact on the traffic and the Benefit to Cost Ratio (BCR) results for the Armagh East Link. Given the above, it was considered that, at that time, the routes described below were likely to prove the most favourable for further consideration, although this would only be confirmed following more detailed review including preparations of cost estimates and traffic modelling (with and without the

Armagh North-West Link in operation). The routes which were considered to fulfil the brief and were to be taken forward for further detailed assessment were:-

- 2007 Preferred Option - This option runs along the existing Ardmore Road and would extend northwards from the junction at the A28 Markethill Road to the junction at the A3 Portadown Road at Linsey's Hill.
- Option 12 - This option runs from the existing junction of the Edenaveys Industrial Estate and ties in to the existing roundabout on the A3 Portadown Road with connection to Killuney Road and Drumman Heights. The route would require realignment of the A51 Hamiltonsbawn Road to facilitate a new junction with the A51.
- Option 16 - This option is an alternative to the "2007 Preferred Option" which bypasses the existing Ardmore housing estate at the southern end by utilising Edenaveys Industrial Estate Road and existing junction location as a tie-in point to the A28 Markethill Road.
- Option 50 - This option runs from the existing junction of Edenaveys Industrial Estate and ties in at the north end of the scheme to the A3 Portadown Road, to the east of Killuney Road. The route would require realignment of the A51 Hamiltonsbawn Road to facilitate a new junction with the A51

From the workshop the following recommendations for action were identified and have been included in this report:-

- i) Traffic modelling to be finalised for each option;
- ii) Cost estimates to be further developed for the four remaining options;
- iii) BCRs to be determined for the four remaining options;
- iv) A51 Hamiltonsbawn Road to be further designed/developed for Option 12 and Option 50 to consider further improvement of the approach to the proposed junction;
- v) Development of the roundabout at Drumman Heights (A3); and,
- vi) A compact grade separated junction to be considered to connect Option 50 to the existing A51 Hamiltonsbawn Road.

Post Workshop Note: Following a review of agreed actions from the workshop it was decided not to assess a Compact Grade Separated Junction

Option for Option 50 due to the size of the junction that would be required and the considered view that a less complex and smaller junction would be viable.

This report aims to set out the key findings for each proposed route option for the four main assessment criteria in line with The Department for Transport (DFT) WebTAG:-

1. Economy;
2. Environmental;
3. Social; and,
4. Public Accounts

An engineering assessment is not set out as part of the Transport Analysis Guidance process, however it is deemed that inclusion of an engineering assessment would provide a more comprehensive review of the four proposed options under consideration alongside the WebTAG assessment areas above.

This report is structured as follows:-

- Chapter 1 – Introduction;
- Chapter 2 – Project History;
- Chapter 3 – Existing Conditions;
- Chapter 4 – Scheme Options Overview;
- Chapter 5 – Engineering Assessment;
- Chapter 6 – Economic Assessment;
- Chapter 7 – Environmental Assessment;
- Chapter 8 – Social Assessment;
- Chapter 9 – Public Accounts;
- Chapter 10 – Summary of Findings;
- Chapter 11 – Conclusions; and,
- Chapter 12 – Recommendations.

3 Existing Conditions

3.1 Highway Network & Public Transport

Armagh City is the administrative centre of Armagh District, which is an essentially rural district with a population of around 59,340 residents according to the 2011 Northern Ireland census and lies around 35 miles south west of Belfast (see Figure 2.1 below). Armagh City is the commercial and retail hub of the area, and accounts for around 30% of the district's population.

The city lies at the intersection of two Link Corridors that form part of the Regional Strategic Transport Network, namely the A3 linking Portadown, Armagh and on Monaghan, and, the A28/A29 linking Newry, Armagh, Dungannon, Cookstown and Maghera to Coleraine. Belfast can be reached from the north-east of the city via the A3 and on to the M1, while the port of Warrenpoint can be reached from the south of the city via the A28 and the A2.

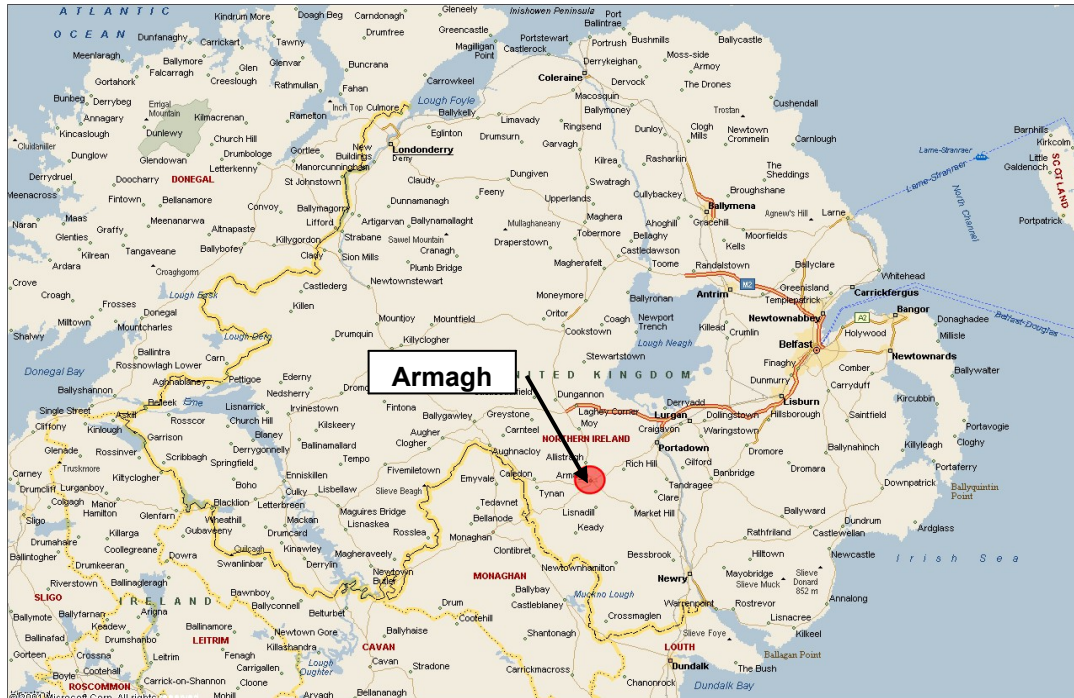


Figure 3.1 - Armagh Location Plan

Any line of the Armagh East Link would commence at the A28, travel due north, crossing the A51 and terminate at the A3. These three primary routes would form the

main access points to the scheme. Other roads will be accessed off the proposed link where possible and where an alternative is diversion is deemed too long. Some roads would be over/under bridged or stopped up.

A28 Markethill Road

The A28 Markethill Road is a 7.3m wide single carriageway road with pedestrian footways along each side past the existing junction with Ardmore Road up to the nearby car dealership. From there the road has pedestrian footway on one side only and a hard shoulder on the other side for breakdowns and emergencies. The junctions in this area are mainly ghost island priority junctions, including the existing junction with Ardmore Road, with the carriageway widened to approximately 10m in these locations to accommodate the right turn lanes.



Figure 3.2 – Photograph of existing A28 Markethill Road at Ardmore Road Junction (Looking northwest towards Armagh City Centre)



Figure 3.3 – Photograph of existing A28 Markethill Road at Ardmore Road Junction (Looking northwest towards Armagh City Centre)



Figure 3.4 – Photograph of existing A28 Markethill Road at Edenaveys Industrial Estate Junction (Looking northwest towards Armagh City Centre)



Figure 3.5 – Photograph of existing A28 Markethill Road at Edenaveys Industrial Estate Junction (Looking northwest towards Armagh City Centre)

A51 Hamiltonsbawn Road

The A51 Hamiltonsbawn Road is a 7.3m wide single carriageway road with simple priority side road junctions. It links Armagh with the towns of Tandragee and Gilford to the east. The A51 has pedestrian facilities along the North side of the carriageway. The existing horizontal and vertical alignment of this road does not meet current design standards.



Figure 3.6 – Photograph of existing A51 Hamiltonsbawn Road (Looking west towards Armagh City Centre)

A3 Portadown Road

From Armagh City Centre the A3 Portadown Road is a 7.3m (minimum) single carriageway with footway either side up until the existing junction with Linsey's Hill. From Linsey's Hill there are hard shoulders and footways until the A3 Drumman Heights roundabout. Towards the city centre from Linsey's Hill is a mini-roundabout at Drumadd Road, which links the A3 and A51 Hamiltonsbawn Road east of the decommissioned army barracks.



Figure 3.7 – Photograph of existing A3 Portadown Road (Looking west towards Armagh City Centre)



Figure 3.8 – Photograph of existing roundabout linking the A3 Portadown Road with the housing estates at Killuney Road and Drumman Heights (Looking west towards Armagh City Centre)

Public Transport

There is no rail service to Armagh but there is a network of cross-country bus routes linking Armagh to most major towns and cities in Northern Ireland provided by Translink. The network also provides cross border services to the Republic of Ireland (ROI). Within the city itself, there are a number of local bus services serving the Ardmore Estate via A51 Hamiltonsbawn Road and Ballynahonemore Road. This is presented below in *Figure 3.9*.

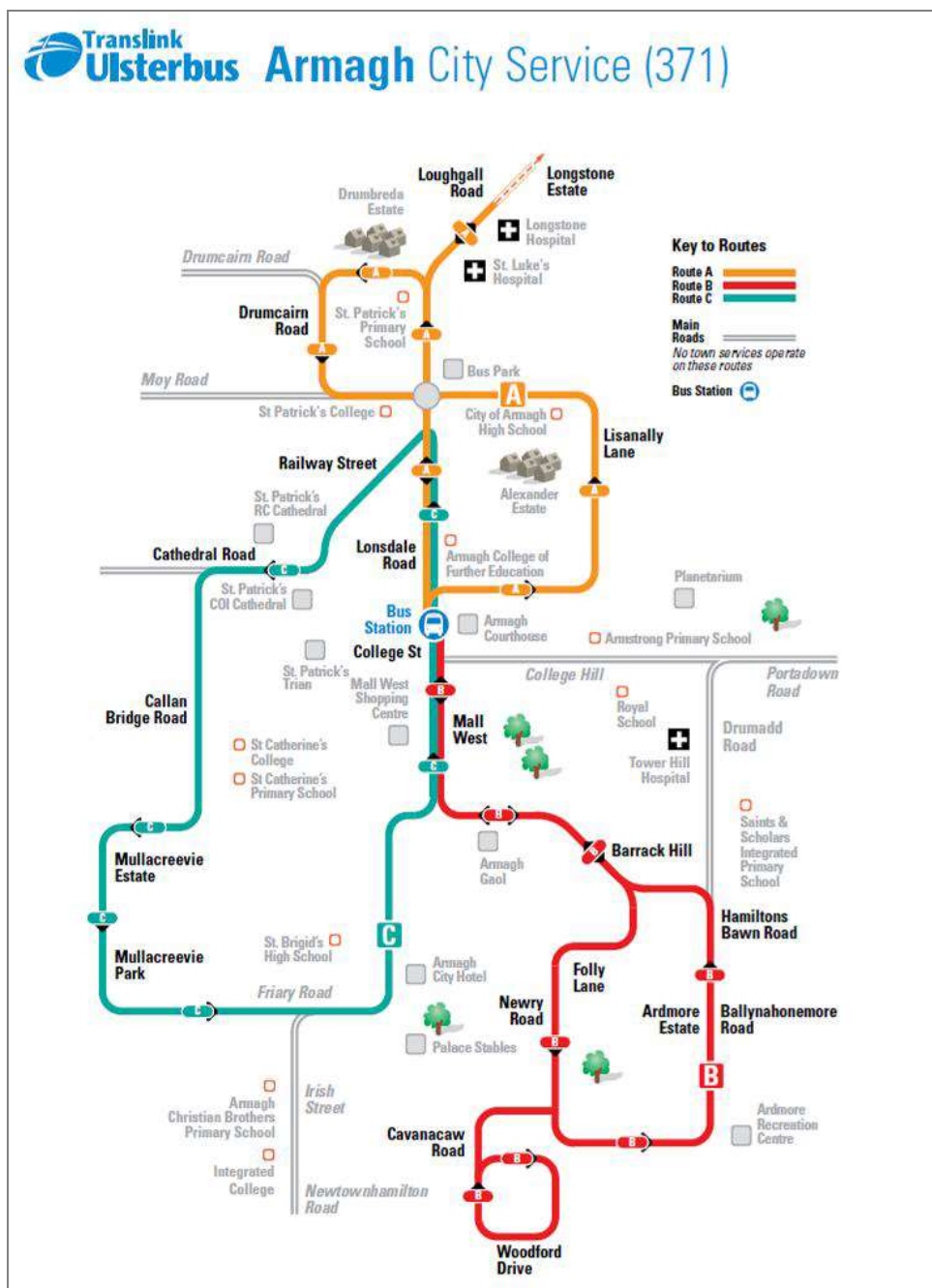


Figure 3.9 – Translink Local Bus Routes for Armagh City

3.2 Traffic Flows

One of the major regional flows of traffic passing through the City is from the A28 South East towards the A3 and then to Belfast and the north-east of the province. The currently signed north-south route on the eastern periphery of Armagh runs through the centre of the city, though anecdotal evidence suggests a well-used “rat run” via Ardmore Road (Bannvale Villas), Ballynahonemore Road and Drumadd Road. The routes through the city are constrained by the relatively narrow roads and busy residential areas through which they pass. Road users experience significant delays due to heavy congestion during the morning and evening peak periods.

Annual Average Daily Traffic (AADT) flows along the A3 Portadown Road to and from Armagh are in the region of 12,000 vehicles per day. Flows along the A29 Moy Road are in the region of 16,000 vehicles per day while the highest observed flows were recorded for the A29 Irish Street between Friary Road and A3 Monaghan Road.



Figure 3.10 – Bannvale Villas: rat run via the Ardmore Road (traffic calming features in place)

3.3 Topography and Surrounding Environment

Within the Environment & Heritage Service (EHS) Northern Ireland Landscape Character Assessment Series 1999 the proposed site falls within the Armagh 95/15 Series. The area has been characterised as the “Armagh Drumlins” Landscape Character Area No. 66 which can be seen in *Figure 3.11* below.

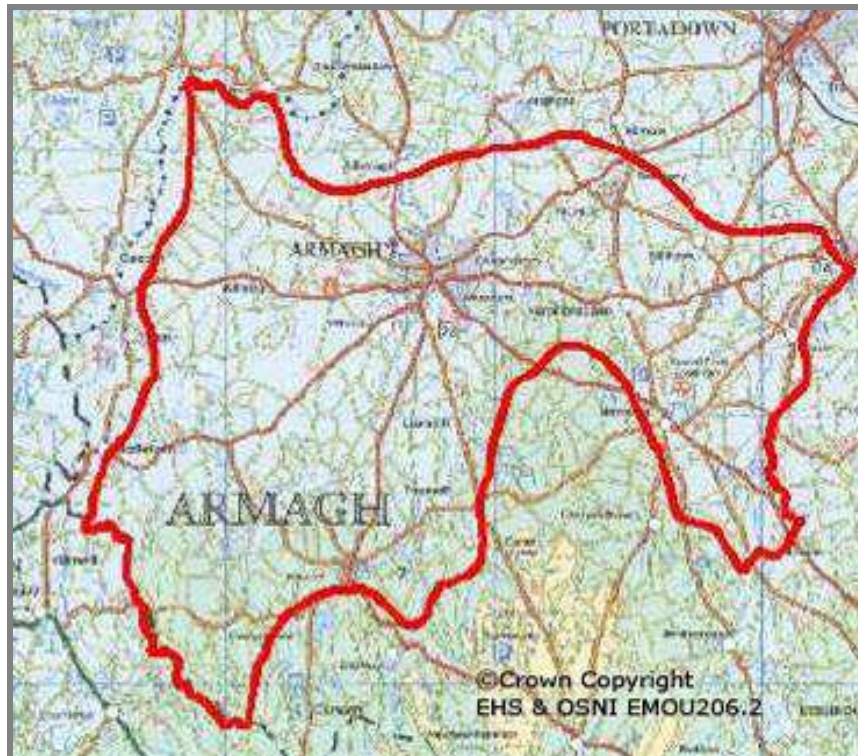


Figure 3.11 – Landscape Character Area Map No. 66

This landscape character area (excluding city centre) is characterised by the following:-

- Rolling drumlin landscape covering a large area and crossed by a large number of small river valleys;
- Hedgerow and tree belts separate field systems which consist of improved pasture and orchards;
- Scattered rural housing and farms;
- Wooded historic estates and parkland landscapes;
- Open views across the landscape from elevated locations while enclosed landscapes are found between drumlins; and,
- Significant archaeological sites.

The key characteristics of the Armagh Area are the extensive areas of rolling north-south orientated drumlins. The area is drained by numerous, small, winding watercourses; one of which, the Ballynahone River runs through the study area to the west. Land use is dominated by agricultural grassland of varying quality, separated by a network of hedges, trees and winding roads connecting numerous dwellings.



Figure 3.12 - Looking Northeast from Drumlins North of A51 Hamiltonsbawn Road



Figure 3.13 - Looking North from Drumlins South of A51 Hamiltonsbawn Road

The built environment surrounding the scheme is mainly residential with lands to the north (Linsey's Hill) and south (Ardmore Road) made up of residential developments, though there are some light industrial buildings north-east of the A51 Hamiltonsbawn Road, and the city's now decommissioned army barracks lies to the north-west.



Figure 3.14 - Looking northwest towards Linsey's Heights / Linsey's Hill from Drumlins north of A51 Hamiltonsbawn Road



Figure 3.15 - Looking west towards the decommissioned Army Barracks / Drumadd Road from Drumlins north of A51 Hamiltonsbawn Road

3.4 Geology

A plan illustrating the scheme study area is provided in *Appendix C*.

The majority of the superficial (Quaternary) soils within the scheme study area are Till-Diamicton (glacial stony clay) with areas of Alluvium consisting of clays, silts, sands and gravels. These areas of alluvium are mainly positioned in the vicinity of Ardmore Road and Edenaveys Industrial Estate, around A51 Hamiltonsbawn Road and in the vicinity of the scheme at Linsey's Hill / A3 Portadown Road. Peat deposits are found east of the study area northeast of A51 Hamiltonsbawn Road. This is presented in *Figure 3.16* below.

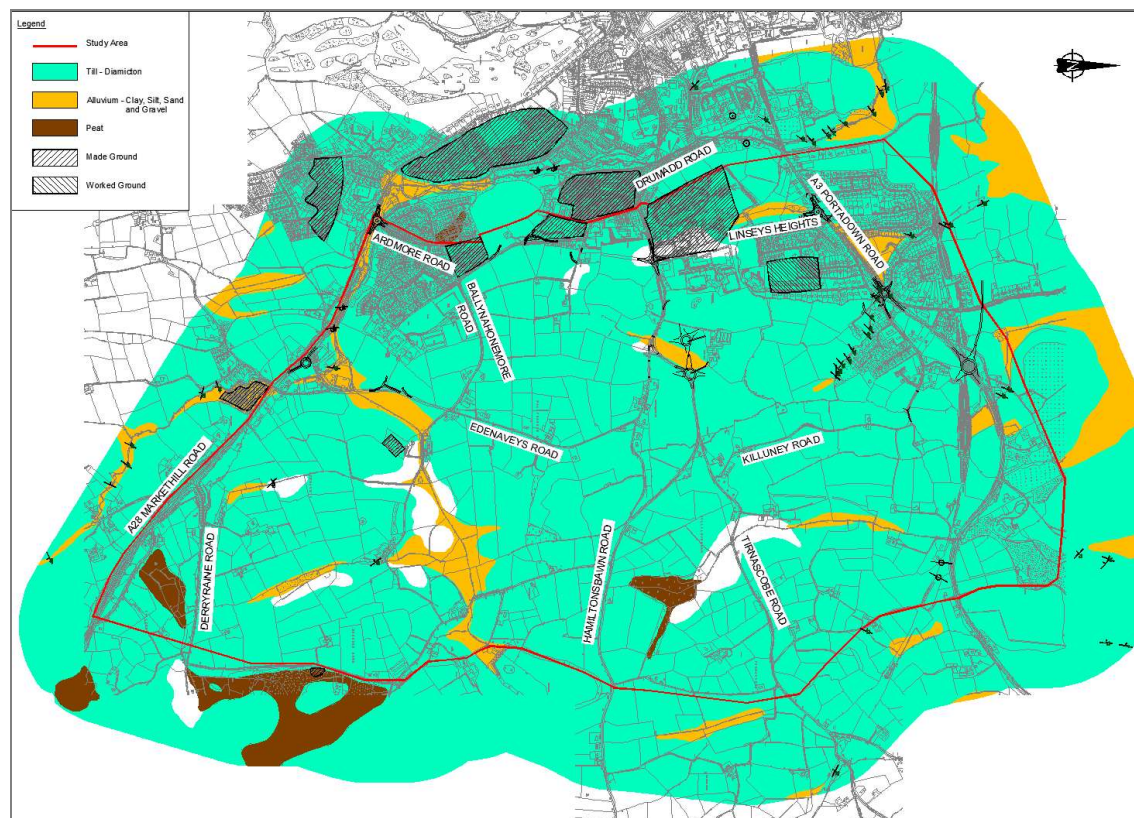


Figure 3.16 – Drift Geology within Scheme Study Area

The underlying rock within the study area, bar the far northern end, consists largely of the Leadhill Supergroup, Wacke and Sandstone (Ordovician Age). These are described as variably coloured mudstones and siltstones with occasional “greywacke” (poorly sorted, mixed sandstone, gritstone and mudstone). The northern end of the scheme towards Linsey's Hill / A3 Portadown Road is underlain by (Carboniferous age) rocks from the Killuney Conglomerate formation (Tournasian age) which consist of Conglomerate, Sandstone and Siltstone. The Killuney

Conglomerate Formation outcrop is bounded by a southwest-to-northeast trending fault, which is shifted to the north. The line of the fault is shown to locally coincide with the line of the existing A3. These are described as Purple-Red fine grained conglomerates, fine to coarse grained sandstones and banded siltstones. North of the fault lie limestone rocks of the Armagh Group (Visean Age), these can be described as argillaceous rocks and subordinate Sandstone, Interbedded. This can be seen in *Figure 3.17* below.

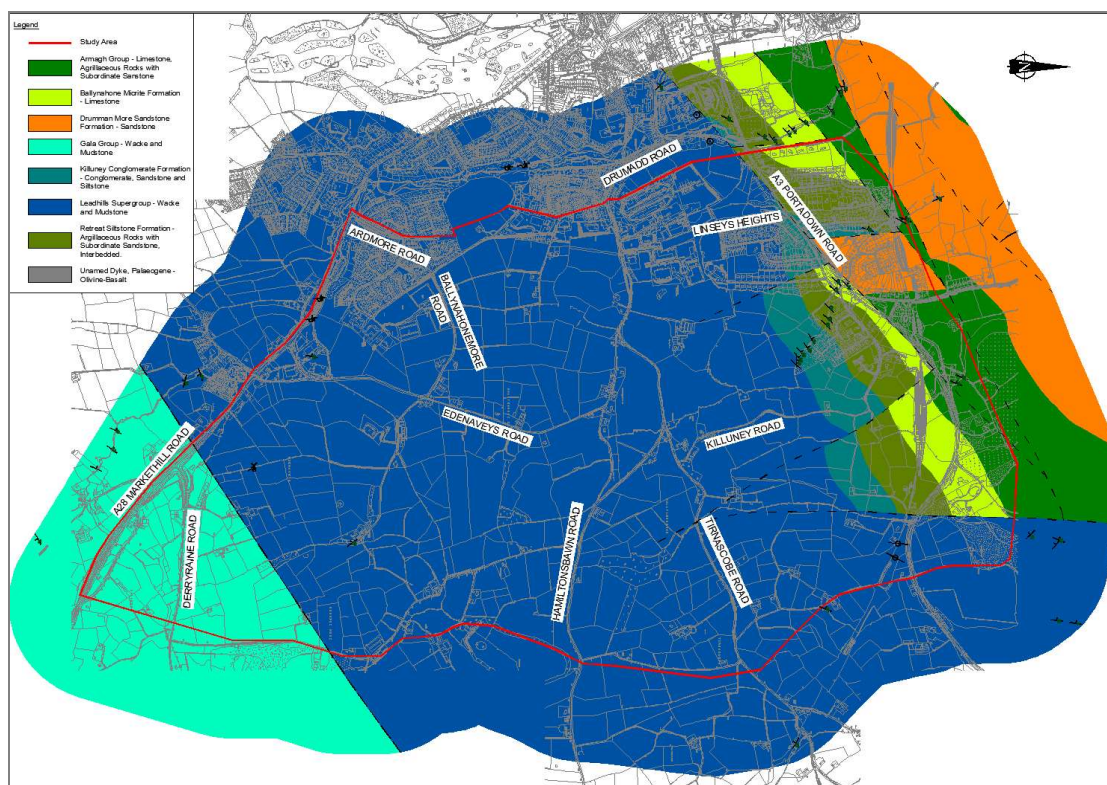


Figure 3.17 – Solid Geology within Scheme Study Area

Other rocks in the northern area comprise of:-

- Retreat Siltstone Formation – Argillaceous rocks with subordinate Sandstone and Limestone;
- Ballynahone Micrite Formation – Limestone;
- Drummanmore Sandstone Formation – Sandstone; and,
- Armagh Group – Limestone, Argillaceous rocks and subordinate Sandstone, Interbedded;

The southeast end of the scheme study area is where Palaeogene, Olivine-Basalt is found.

In recent years there have been no records of mining or mineral extraction in the area, though two historic (and now backfilled) quarries were recorded north of the A51 Hamiltonsbawn Road, one in the Drumadd site and one on the industrial estate site.

The terrain is a largely glacial landform with generally steep slopes of 1:10 – 1:5. Glacial action may have over steepened some of the slopes. Linsey's Hill in the north of the scheme is a drumlin feature. Conversely, the low lying ground between Drumadd and Linsey's Hill may be an interglacial hollow, where soft ground problems can manifest.



Figure 3.18 – Low lying poor ground (North of A51 Hamiltonsbawn Road)

Man-made slopes are present in the Ardmore Road Cutting (slope gradients of 1:2) and in the embankment that is the A51 Hamiltonsbawn Road Industrial Estate access.



Figure 3.19 – Ardmore Road Cutting



Figure 3.20 – A51 Hamiltonsbawn Road Industrial Estate Access Embankment

4 Scheme Options Overview

4.1 Study Area

In 2006 following a DMRB Stage 1 assessment, the centre corridor was chosen as the Preferred Option. The line of this route forms the most westerly limits of the current study area. The A3 Portadown Road and the A28 Markethill Road form the northern and southern limits of the study area. To the east a line was chosen that was deemed to be as far out as from the urban limits as was considered reasonable that may still achieve the scheme objectives.

4.2 Scheme Constraints

The major constraints within the scheme study can be seen below in *Figure 4.1* The constraints include, but are not limited to the following:-

- Potential archaeological constraints;
- Flooding Constraints;
- Residential dwellings;
- Poor ground;
- High ground; and
- Areas of woodland.

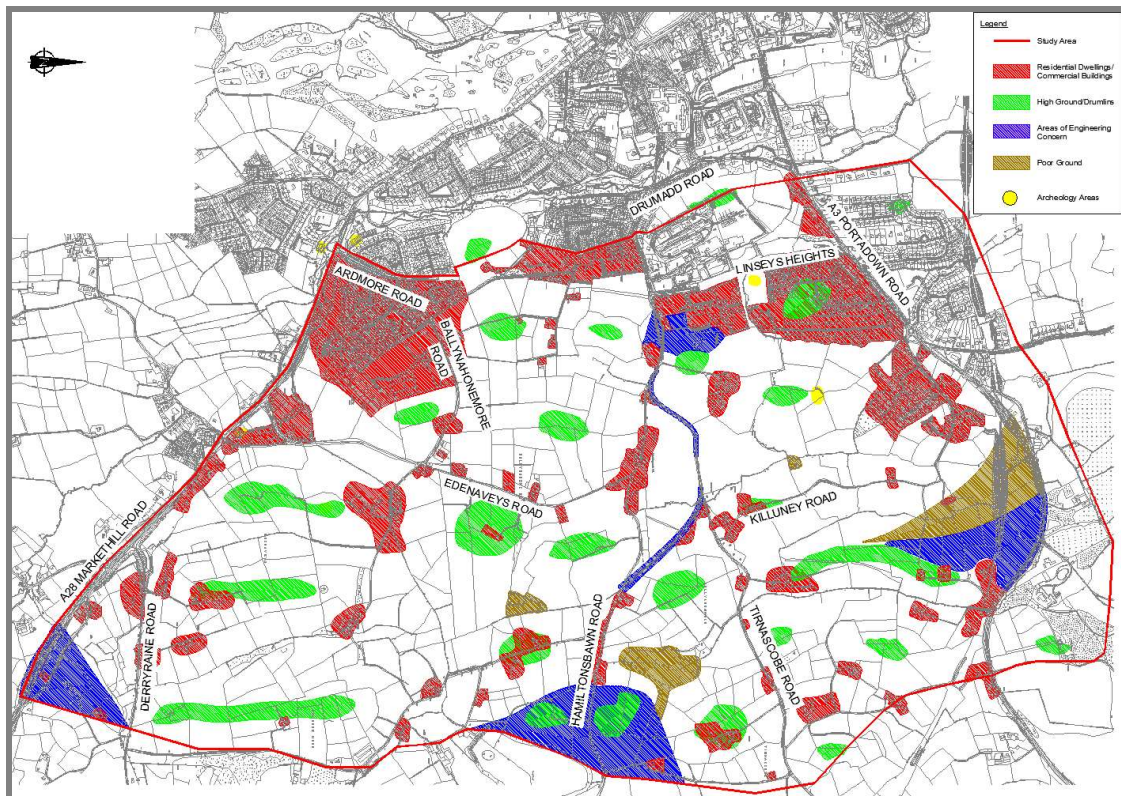


Figure 4.1 – Major Scheme Constraints

Plans illustrating the study area, the major constraints identified at this time, and the landscape and townscape character areas in the vicinity of the proposed routes are presented in *Appendix C*.

4.3 2007 Preferred Option

This option (which includes approximately 1.55km of new carriageway; 2.23km in total), starts at the junction of A28 Markethill Road and Ardmore Road, and extends northwards from the junction at the A28 Markethill Road to its junction with the A3 Portadown Road to the west of Linsey's Hill. This option would be likely to incorporate a staggered junction to facilitate access to Ballynahonemore Road. This option also makes use of the road through the Hamiltonsbawn Road Industrial Estate and Linsey's Heights Road. The option terminates approximately 1km west of the proposed Armagh North-West Link junction with the A3.

An overview of this option is shown in *Figure 4.2* below.

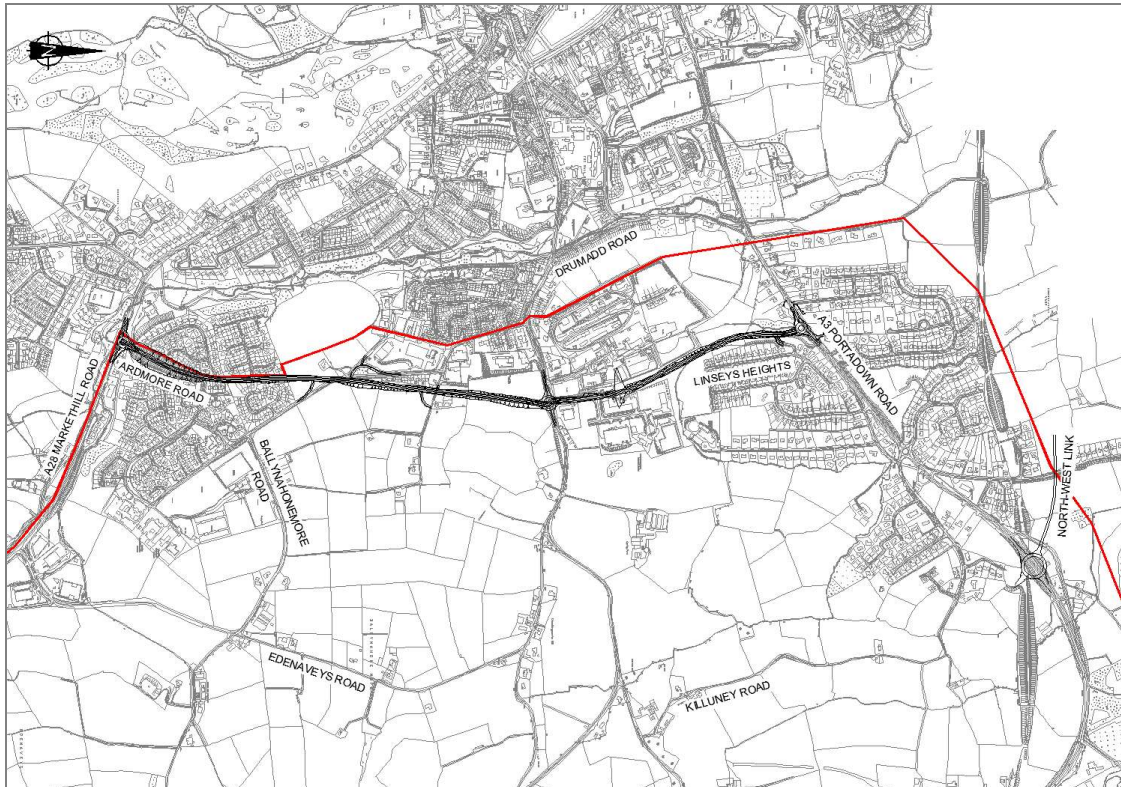


Figure 4.2 – 2007 Preferred Option

More detailed plans and long section drawings are presented in *Appendix D*.

4.4 Option 12

This option (which includes approximately 2.51km of new carriageway, 2.96km in total) runs from the existing junction of the Edenaveys Industrial Estate, making use of the newly constructed road in the industrial estate and ties in to the existing roundabout on the A3 Portadown Road at Drumman Heights. The route would require realignment of the A51 Hamiltonsbawn Road to facilitate a new junction with the A51. The option terminates approximately 0.45km west of the proposed Armagh North-West Link junction with the A3.

An overview of this route can be seen in *Figure 4.3* below.

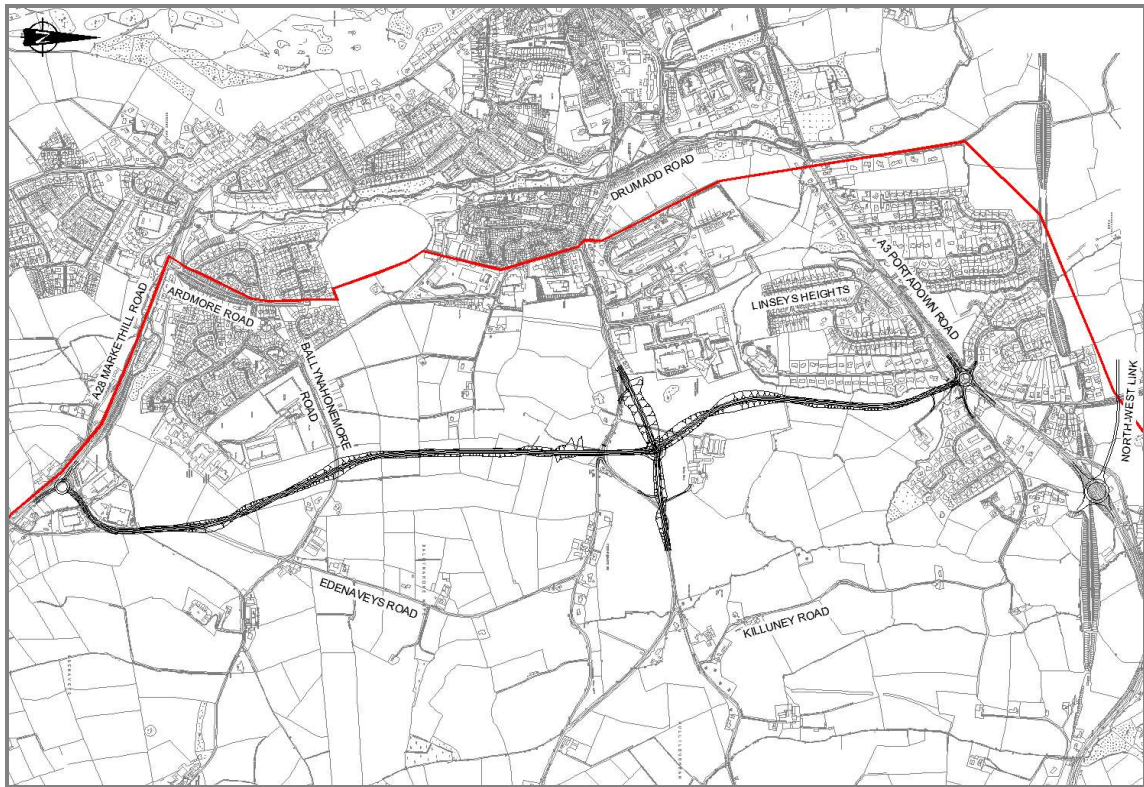


Figure 4.3 – Option 12

More detailed plans and long section drawings are presented in *Appendix D*.

4.5 Option 16

This option with an approximate construction length of 2.78km is a variation of the “2007 Preferred Option” which bypasses the Ardmore Road at the southern end of the scheme by utilising the Edenaveys Industrial Estate Road and existing junction location as a tie-in point to the A28 Markethill Road. The option terminates approximately 1km west of the proposed Armagh North-West Link junction, tying into the A3 to the west of Linsey’s Hill.

An overview of this route can be seen in *Figure 4.4* below.

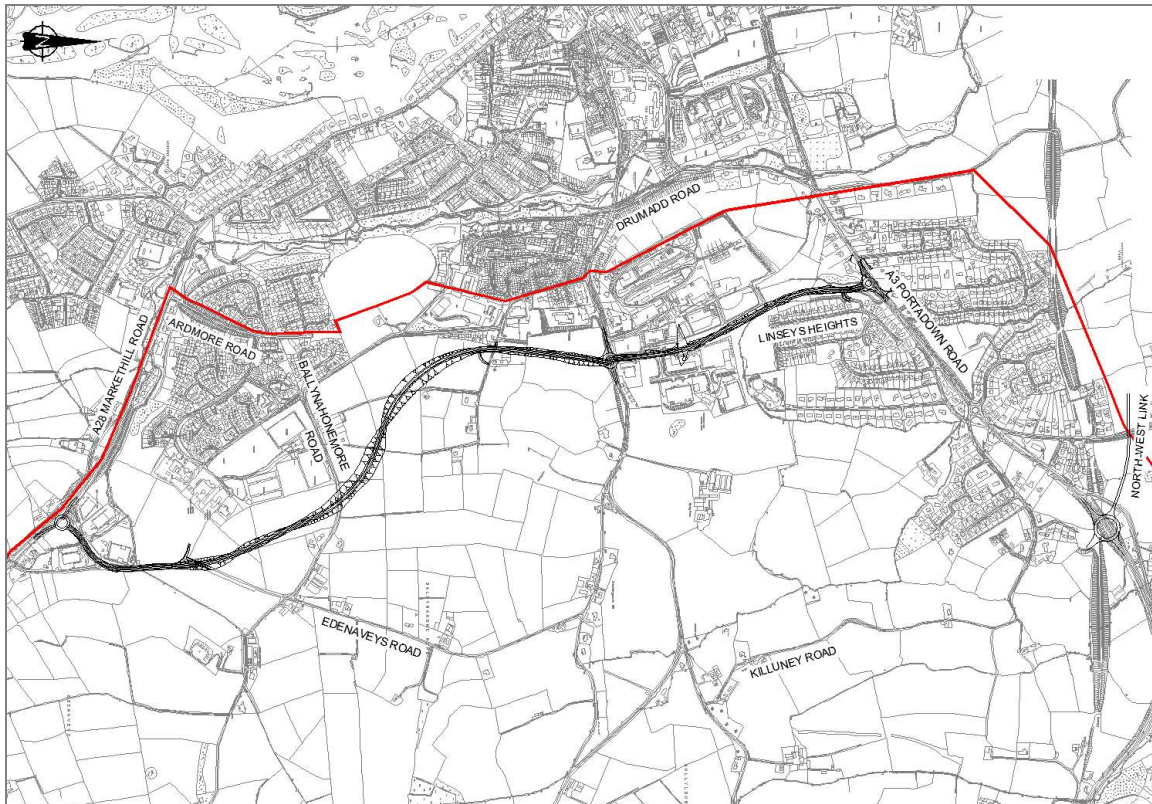


Figure 4.4 – Option 16

More detailed plans and long section drawings are presented in *Appendix D*.

4.6 Option 50

This option with an approximate construction length of 2.94km (3.39km in total) runs from the existing junction of Edenaveys Industrial Estate, utilising the newly constructed road in the industrial estate and ties in at the north end of the scheme to the A3 Portadown Road. The route would require realignment of the A51 Hamiltonsbawn Road to facilitate a new junction with the A51. This option would provide a direct connection with the proposed Armagh North-West Link Junction with the A3.

An overview of this route can be seen in *Figure 4.5* below.

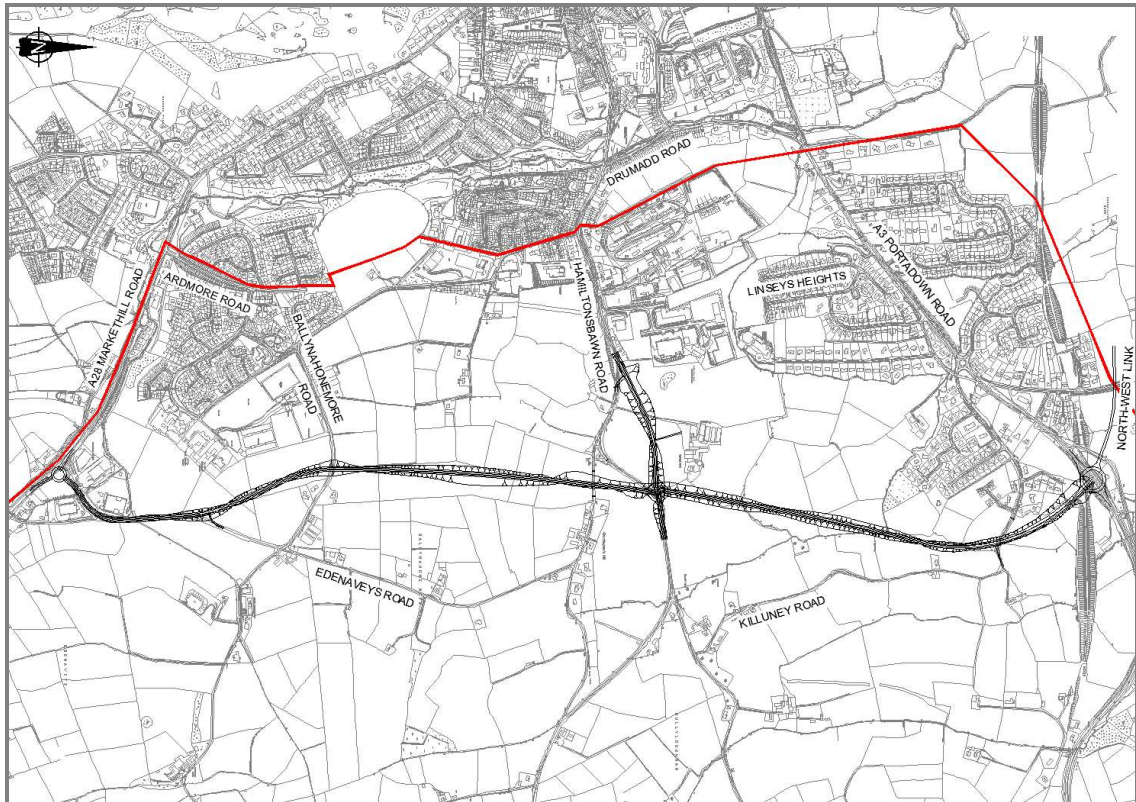


Figure 4.5 – Option 50

More detailed plans and long section drawings are presented in *Appendix D*.

5 Engineering Assessment

5.1 Introduction

This section presents a high level assessment of the options presented in *Section 4* against engineering constraints within the proposed study area. Headings under which assessments were made are listed below:-

- Engineering Standards;
- Cross-Section Design Criteria;
- Departures from Standard;
- Relaxations from Standard;
- Speed Restrictions;
- Structures;
- Roads Stopped Up;
- No. of Proposed Junctions;
- Landtake;
- Overtaking;
- Geotechnical;
- Vehicle Restraint System;
- Climate;
- Topography;
- Hydrology;
- Hydrogeology; and
- Drainage.

5.2 Engineering Standards

The standard of road and cross-section appropriate to this proposal have been selected in accordance with TD 27/05 *Cross-sections and Headrooms* (DMRB 6.1.2) and TA 30/82 *Choice between Options for Trunk Road Schemes* (DMRB 5.1.4).

The horizontal and vertical geometry of the scheme has been designed in accordance with TD 9/93 *Highway Link Design* (DMRB 6.1.1), and also designed in accordance with TD 70/08 *Design of wide single 2+1 Roads* (DMRB 6.1.4).

In addition to the above standards, the scheme would be developed with reference to DMRB Volume 10 – Environmental Design. This volume sets out the best practice with regard to the integration of a road scheme into the existing landscape and the provision of appropriate environmental measures.

5.3 Cross-Section Design Criteria

The proposed route options have the following criteria as standard from the DMRB. *Table 5.1* below outlines road type, carriageway widths, footway widths, combined footway/cycleway widths and street lighting elements of each route option.

Table 5.1 – Cross-Section Assessment Criteria

Route Option	Road Type	Carriageway Width	Shared Use Cycleway/Footway	Street Lighting
2007 Preferred Option	S2*	7.3m	3m	Fully Lit**
Option 12	S2*	7.3m	3.5m	Junctions*** Only
Option 16	S2*	7.3m	3m	Fully Lit**
Option 50	S2*	7.3m	3.5m	Junctions*** Only

*S2 is a 2 lane single carriageway.

**Route options in an urban environment would have street lighting over the entire length.

***Route options in a rural environment would have street lighting present at junctions only.

From the *Table 5.1* above it can be seen that it is proposed to provide both urban and rural environments with shared use cycleways and footways. Urban environment schemes would typically have street lighting along the entire length of the proposed works. Rural environments typically have street lighting proposed at junction locations only. All route options are 2 lane single carriageway.

A roundabout junction type was used for consistent assessment across all of the proposed options, however, a more detailed junction strategy would be developed for the final proposals.

5.4 Departures from Standard

Departures and Relaxations from the Design Manual for Roads and Bridges (DMRB) generally relate to reductions to prescribed desirable minimum guidance for highway design. Any departures from standard associated with the design would be subject to a formal sign off procedure through Transport NI's Technical Approval Authority (TAA). At this stage only potential Departures from the DMRB guidance for the mainline were considered, although the number of departures are small. Departures identified at this time are outlined in *Table 5.2* below.

Table 5.2 – Potential Departures from Standard

Route Option	Description of Departures
2007 Preferred Option	<ul style="list-style-type: none"> • No departures from standard at this stage
Option 12	<ul style="list-style-type: none"> • No departures from standard at this stage
Option 16	<ul style="list-style-type: none"> • No departures from standard at this stage
Option 50	<ul style="list-style-type: none"> • Combination – 2 step horizontal, 2 step vertical crest and 2 step stopping sight distance at ch800m; <ul style="list-style-type: none"> ○ This departure is required to generate a level section for overtaking at Ch940m onwards. This also provides a definitive end of overtaking section and a staged reduction in design provision for the proposed 30mph zone approaching Edenaveys Industrial Estate. • Combination – 1 step horizontal, 2 step vertical crest and stopping sight distance at Ch1650m; <ul style="list-style-type: none"> ○ This departure is required to generate a level section for overtaking from Ch1600m backwards. This also provides a definitive end of overtaking section and a staged reduction in design provision on the approach to the proposed roundabout, although no reduction in stopping sight distance is proposed on the approach.

Across all of the proposed route options, only Option 50 has at present any identified potential departures, these being two combination departures. Further detailed design may or may not remove these departures.

Departures for side roads and private / field access have not been assessed at this stage. This would be assessed at a further detailed design stage.

5.5 Relaxations from Standard

At this stage Relaxations from standard for the mainline are being considered. *Table 5.3* below sets out the potential relaxations on the mainline for each of the route options.

Table 5.3 – Potential Relaxations from Standard

Route Option	Description of Relaxations
2007 Preferred Option	<ul style="list-style-type: none"> • 2 step horizontal relaxation on approach to roundabout at the A3 Portadown Road.
Option 12	<ul style="list-style-type: none"> • 2 step horizontal at 30mph; <ul style="list-style-type: none"> ○ This relaxation is in the existing road at the newly constructed industrial estate (127mR), although 120m stopping sight distance is available. • 1 step relaxation in vertical gradient no greater than 7.5% maximum at Ch650m and Ch2750m.
Option 16	<ul style="list-style-type: none"> • 2 step horizontal at 30mph; <ul style="list-style-type: none"> ○ This relaxation is in the existing road at the newly constructed industrial estate (127mR), although 120m stopping sight distance is available. • 2 step horizontal relaxation on approach to roundabout at the A3 Portadown Road; • Gradient relaxations at Ch600 and Ch1450m.
Option 50	<ul style="list-style-type: none"> • 2 step horizontal at 30mph; <ul style="list-style-type: none"> ○ This relaxation is in the existing road at the newly constructed industrial estate (127mR), although 120m stopping sight distance is available. • 1 step relaxation in vertical gradient no greater than 7.5% maximum; • 2 step existing horizontal relaxation on newly constructed road in Edenaveys Industrial Estate; • 2 step horizontal relaxation Ch550m; • 1 step horizontal and stopping sight distance at Ch2800m, no reduction on approach to junction.

Option 50 has the most relaxations from standard at five in total compared to Option 16 which has three, Option 12 which has two and the 2007 Preferred Option has only one. Further detailed design may or may not remove these relaxations.

Relaxations for side roads and private / field access have not been assessed at this stage. This would be assessed at a further detailed design stage.

Any relaxations from standard would require to undergo a formal sign off procedure through TransportNI's Technical Approval Authority.

5.6 Speed Restrictions

Appropriate speed limits are important for safety and environmental reasons. Speed limits vary according to the type of vehicle and the nature of the road. *Table 5.4* sets out the speed restrictions set for each of the proposed route options.

Table 5.4 – Speed Restrictions

Route Option	Speed Restrictions	Area / Environment
2007 Preferred Option	30 mph	Urban
Option 12	30 mph / 40 mph	Urban / Rural
Option 16	30 mph / 40 mph	Urban / Rural
Option 50	30 mph / 60mph	Urban / Rural

It can be seen from *Table 5.4* above that as the route options move away from the City centre that the speed restriction increases to match that of the environment that it is in.

Although previously assessed as a 40mph speed limit, the 2007 Preferred Option has now been assessed as a 30mph zone throughout the design given the urban constraints and residential and commercial properties in close proximity to the alignment.

Option 12 would have a posted speed limit of 40mph on the mainline alignment and A51 Hamiltonsbawn Road realignment with Edenaveys Industrial Estate restricted to 30mph.

Option 16 is both urban and rural environment, and as such it would have a posted speed limit of 40mph from A28 Edenaveys Industrial Estate up to A51 Hamiltonsbawn Road and a 30mph speed limit from the A51 to the A3 Portadown Road at the northern end of the scheme.

Option 50 would have a posted speed limit of 60mph on the mainline alignment with the section through Edenaveys Industrial Estate to be restricted to 30mph.

5.7 Major Structures

Major structures for highway works applicable to this scheme would be in the form of either an overbridge, underbridge or culvert crossing. From *Table 5.5* below it can be seen the number of potential major structures required for each option.

Table 5.5 – Number of Potential Major Structures

Route Option	No. of Potential Major Structures
2007 Preferred Option	3
Option 12	1
Option 16	3
Option 50	1

The 2007 Preferred Option has three major structures. Two culverts crossing the line of the tributary of the Ballynahone River, both at the north end of the scheme between the barracks and the Linsey's Hill housing estate. In order to minimise land take along Ardmore Road a retaining wall would also be required along the western toe of the existing cutting slope. Retaining walls were deemed necessary in the assessment of the 2007 Preferred Option, and this would still be the case should the scheme be chosen to be taken forward. These structures have however not been

included in the table above as retaining walls may be necessary to facilitate any or all of the routes whilst refining the detail.

Option 16 has three major structures required: the culverts at the north end of the route similar to 2007 Preferred Option and one further structure comprising an overbridge where the mainline alignment crosses the existing Ballynahonemore Road at the southern end of the scheme.

Option 12 and Option 50 only require 1 major structure comprising of an overbridge crossing the Ballynahonemore Road at the southern end of the scheme.

Accommodation works structures have not been considered at this stage, however it is likely that more rural options would require provision for mitigating severance issues.

5.8 Roads Stopped Up

Table 5.6 below outlines the number of roads/accesses, if applicable, for each proposed option that potentially may be required to be stopped up.

Table 5.6 – Number of Potential Roads to be stopped up

Route Option	No. of Potential Roads to be Stopped Up
2007 Preferred Option	0
Option 12	2
Option 16	0
Option 50	2

From the table above it can be seen that the 2007 Preferred Option and Option 16 do not have any potential roads to be stopped up. However, Option 12 and Option 50 both have two roads that potentially need to be stopped up. The roads are:-

- Stockingmans Road; and,
- Killuney Road (after Killuney Park Road).

It is proposed that Stockingmans Road would be stopped up adjacent to the alignment and the remainder of Killuney Road has the potential to be accessed by a direct access onto the mainline alignment.

5.9 Number of Proposed Junctions

During the Stage 2 Assessment in 2007 a signalised junction was proposed for the junction with the A28 and A51 Hamiltonsbawn Road. However in order to assess the current options on a consistent basis, roundabouts were assessed at all major junction locations. Further assessment of the most suitable junction type will be carried out on the scheme to be taken forward. *Table 5.7* below sets out number of major junctions and priority junctions that each route will potentially require to be incorporated within the design. The major junctions are assessed through consistency of junction type (roundabout). Any further refinements of a preferred option may lead to an increase or decrease in the number of junctions. For the purposes of this report junction type is not a key consideration or deciding factor.

Table 5.7 – Number of Proposed Junctions

Route Option	No. of Major Junctions	No of Priority Junctions
2007 Preferred Option	3	7
Option 12	3	1
Option 16	3	4
Option 50	3	2

From *Table 5.7* above it can be seen that the proposed options have three proposed major junctions along the length of each alignment. For each of the four proposed options the three major junctions would be situated at:-

- A28 Markethill Road;
- A51 Hamiltonsbawn Road; and,
- A3 Portadown Road.

Further to the above major junction locations, there are a number of priority junctions that would be incorporated into the design to facilitate residential access and realignment of existing roads or roads that potentially require to be stopped up.

2007 Preferred Option

No one particular junction type presents itself as preferable from an alignment perspective for the 2007 Preferred Option on the A28 Markethill Road. However a roundabout arrangement does currently seem to lend itself to the A51 Hamiltonsbawn Road in terms of integration into the exiting road network. At the A3 Portadown Road tie-in, a roundabout would be consistent with existing junctions along the A3 Portadown Road and therefore, currently, would seem the preferable junction option at this location. The proposed priority junctions are situated at the following approximate chainages along the mainline alignment (Chainage references refer to the proposed alignment):-

- Ch300m East Side (Ardmore Drive);
- Ch320m West Side (Thornleigh);
- Ch450m (Greenfield Close);
- Ch640m (Bannvale Villas East);
- Ch760m (Bannvale Villas West);
- Ch1000m (Access road off Cul-De-Sac off Bannvale Villas);
- Ch1550m (Industrial Estate); and,
- Ch2170m (Linsey's Hill/Heights).

Option 16

No one particular junction type presents itself as preferable from an alignment perspective for Option 16 on the A28 Markethill Road. However, currently, a roundabout solution is currently considered to lend itself to suit the existing conditions on both the A51 and the A3, which would also be consistent with other existing junctions along the A3 Portadown Road. The proposed priority junctions are situated at the following approximate chainages along the mainline alignment:-

- Ch0m to 160m (Edenaveys Industrial Accesses);
- Ch280m (Private Access);
- Ch510m (Edenaveys Road);
- Ch1620m (Access road off Cul-De-Sac off Bannvale Villas);

- Ch1670m (Access road off Cul-De-Sac off Bannvale Villas);
- Ch2110 (Industrial Access);
- Ch2180 (Hamiltonsbawn Road Industrial Estate Access); and,
- Ch2800m (Linsey's Hill/Heights).

Option 12

For Option 12 a roundabout is possible from the mainline connecting with A28 Markethill Road although the approach is sub-standard. Option 12 includes for the potential realignment of the A51 Hamiltonsbawn Road and a roundabout at the intersection of the two roads. Option 12 ties into the existing A3 Drumman Heights Roundabout that would need to be reconfigured to accommodate a fifth arm for the link road. The proposed priority junctions are situated at the following approximate chainages along the mainline alignment:-

- Ch0m to 160m (Edenaveys Industrial Accesses);
- Ch280m (Private Access);
- Ch510m (Edenaveys Road); and,
- Ch2860m (Private Access).

Option 50

For Option 50 a roundabout is possible from the mainline connecting with A28 Markethill Road although the approach is sub-standard. The option has an acceptable approach to the potential realignment of A51 Hamiltonsbawn Road, and the route option allows for a direct connection with the A3 Portadown Road and the Armagh North-West Link. The proposed priority junctions are situated at the following approximate chainages along the mainline alignment:-

- Ch0m to 160m (Edenaveys Industrial Accesses);
- Ch280m (Private Access);
- Ch510m (Edenaveys Road); and,
- Ch3025m (Killuney Road).

At this stage no detailed design work has been carried out on junction design or junction type. However, a more detailed junction strategy would be developed for the final proposal.

5.10 Landtake

Table 5.8 below outlines the approximate total land take required for each of the proposed options and the approximate split, where applicable, in relation to residential, agricultural, industrial and commercial.

Table 5.8 –Approximate Total Landtake requirements

Route Option	Landtake (hectares)	Urban (Residential)	Rural (Agricultural)	Industrial / Commercial
2007 Preferred Option	11.2 ha*	69 %	0 %	31 %
Option 12	23.67 ha	0 %	90 %	10 %
Option 16	13.50 ha**	22 %	36 %	42 %
Option 50	29.14 ha	0 %	89 %	11 %

*Approx. 48% of the 11.2 hectares of land required for the 2007 Preferred Option is already owned by TransportNI.

**Approx. 3% of the 13.5 hectares of land required for Option 16 is already owned by TransportNI.

It can be seen from *Table 5.8* above that the highest landtake figures are that of Options 12 and 50 at approximately 23 and 29 hectares respectively.

Option 16 is a mix between rural and urban areas of totalling approximately 14 hectares of land.

The 2007 Preferred Option, at 11 hectares, is the lowest of all four options with regard to landtake.

Table 5.9 below shows the potential properties that would be required to be demolished and the number of gardens that would be affected on each route due to landtake requirements.

Table 5.9 – Potential Known Properties Affected

Route Option	No. of Properties to be Demolished	No. of Gardens of Affected Properties
2007 Preferred Option	0	2
Option 12	0	3
Option 16	0	2
Option 50	1	1

2007 Preferred Option

Two properties would potentially be affected, one on Orangefield Drive and one property on the A3 Portadown Road. This option would require alternative access arrangements to the private dwellings on the north side of the A3 in the vicinity of the proposed junction.

Option 12

Three gardens could potentially be affected at the Drumman Heights Roundabout tie-in on Option 12. Further design work on the proposed roundabout junction with the link and the A3 would be required to determine if private accesses in the vicinity of the junction would be affected.

Option 16

Option 16 utilises part of the land already in the ownership of TNI from the A51 Hamiltonsbawn Road to the tie-in point at Linsey's Hill. Two properties could potentially be affected on Orangefield Drive and one property on the A3 Portadown Road. This option would require alternative access arrangements to be provided for the private dwellings on the north side of the A3 in the vicinity of the proposed junction.

Option 50

Option 50 has one affected property at Ch3300m, and a property on the western verge at the location of the proposed A3 junction could potentially be required to be demolished. Further design work on the proposed roundabout junction with the

link and the A3 would be required to determine if private accesses in the vicinity of the junction would be affected.

There is the potential with all routes for private accesses to require realigning or combining. Suitable engineering mitigation would be investigated at a later date where residential properties are affected

5.11 Overtaking

Table 5.10 below sets out the overtaking provisions for each of the proposed options including requirements for hard strips.

Table 5.10 – Overtaking Provisions

Route Option	Overtaking Provisions Northbound	Distance Northbound	Overtaking Provisions Southbound	Distance Southbound	Hard strips
2007 Preferred Option	0%	n/a	0%	n/a	Category 1 – Without Hard strips
Option 12	17%	503.2m	17%	503.2m	Category 1 or 2 – With or Without Hard strips
Option 16	0%	n/a	0%	n/a	Category 1 – Without Hard strips
Option 50	32%	1084.8m	32%	1084.8m	Category 1 or 2 – With or Without Hard strips

It can be seen from Table 5.10 above that the 2007 Preferred Option and Option 16 have no overtaking provision northbound or southbound. This is due to the urban environment and the speed restrictions appropriate to the design. Option 12 and Option 50 are in a rural environment and therefore overtaking provision has been included.

Based on TD 9/93 *Highway Link Design*, the above values are above the minimum required in order to provide overtaking within a scheme, which is 500m minimum. At this stage Full Overtaking Sight Distance (FOSD) cannot be commented on as no detailed design has been carried out.

The values above for each of the route options are classed under two categories for hard strips, these are:-

- Category 1: without hard strips;
 - Minimum Overtaking Length of 15%;
- Category 2: with hard strips;
 - Minimum Overtaking Length of 30%;

Option 50 can be designed and constructed under Category 2, with hard strips, as the overtaking provision is more than the minimum required of 30%.

Option 12 can be designed and constructed under Category 1, without hard strips, as the overtaking provision is more than the minimum required of 15%.

The remainder of the proposed route options fall under Category 1, without hard strips. No overtaking has been provided for both remaining options as they do not meet the required minimum percentage and due to the urban environment through which they pass.

5.12 Geotechnical

5.12.1 Earthworks

Construction and landscaping can have an enormous impact on soil quality within the urban environment. Using techniques that maintain soil quality and function help ensure that soils can continue to maintain drainage characteristics, support vegetation and provide the basis for green spaces, while minimising the risk of causing flooding or erosion.

Table 5.11 below outlines the approximate earthwork quantities for each option considering unsuitable material, surplus and shortfall of materials.

Table 5.11 – Earthworks

Route Option	Total Cut (m ³)	Total Fill (m ³)	Unsuitable Material	Surplus (m ³)	Shortfall (m ³)	Import Required
2007 Preferred Option	51,000	14,000	30%*	22,000	n/a	No
Option 12	163,000	115,000	30%*	n/a	1,000	Yes
Option 16	114,000	98,000	30%*	n/a	18,000	Yes
Option 50	262,000	186,000	30%*	n/a	3,000	Yes

*Assuming that 30% material is unsuitable due to drumlin landscape; this material would also need to be disposed of.

The analysis of earthwork quantities assumes that 30% of all drumlin material is unsuitable for reusing across the scheme. The analysis shows that:-

- Option 50 has the highest cut and fill quantities which equates to a 3,000m³ shortfall in materials which would require materials to be imported;
- Option 12 has the second highest cut and fill quantities which equates to a 1,000m³ shortfall in materials which would require materials to be imported;
- Option 16 has the second lowest cut and fill earthwork quantities which equates to a 18,000m³ shortfall of materials which would require materials to be imported; and,
- The 2007 preferred option has the lowest cut and fill earthwork quantities which equates to a 22,000m³ surplus of materials which would require material to be disposed of.

The above analysis of earthworks are at high level and at preliminary design stage. The figures above are for the purpose of this report and do not include for quantities relating to the following:-

- Capping Layers;
- Earthworks improvements;
- Topsoil strips; and
- Box cuts.

The earthwork quantities are analysed from existing surface to proposed surface in the preliminary design models.

5.12.2 Drift Geology

The superficial soils along the 2007 Preferred Option are predominately Till-Diamicton (glacial stony clay) with areas of Alluvium (clays, silts, sands and gravels) at the proposed junction at Ardmore Road.

The majority of the superficial soils along Option 12, 16 and 50 is predominately Till-Diamicton (glacial stony clay) with areas of Alluvium (clays, silts, sands and gravels) at Edenaveys Industrial Estate along the section of newly constructed road (Ch50 to Ch140 and Ch220 to Ch480). Option 12 also has Alluvium Deposits at the A51 Hamiltonsbawn Road Crossing from Ch1650 to Ch1860. Option 12 and Option 50 have Alluvium deposits along the realigned A51 Hamiltonsbawn Road.

The *Drift Geology Map* for the scheme study area is presented in *Appendix C*.

5.12.3 Solid Geology

The underlying rock along the all of the 4 options consist largely of the Leadhill Supergroup, Wacke and Sandstone (poorly sorted, mixed sandstone, gritstone and mudstone). The northern end of the proposed options towards A3 Portadown Road is underlain by rocks of Killuney Conglomerate formation (Sandstone and Siltstone) and Ballynahone Micrite Formation (Limestone). The proposed junction with the A3 Portadown Road on Option 50 has underlain Limestone from the Armagh Group (Argillaceous rocks and subordinate sandstone and siltstone).

The *Solid Geology Map* for the scheme study area is presented in *Appendix C*.

5.13 Vehicle Restraint System

At this stage no detailed design has been carried out on Vehicle Restraint System (VRS) for the four proposed options, although it is envisaged that any proposed option that requires an overbridge to cross existing road networks would require a VRS to be in place on, before and after the structure as this is classed as a hazard and must be mitigated.

5.14 Climate

The climate is typical of that to be expected in Northern Ireland with no significant aberrations or conditions of special interest.

5.15 Topography

The EHS NI Landscape Character Assessment states the principles for accommodating new development as follows:-

- New development should be located on the mid slopes of drumlins and blend with existing landform; and,
- As far as possible, existing hedgerows should be retained and reinforced.

2007 Preferred Option

The 2007 Preferred Route option starts along the existing Ardmore Road in a residential setting, the existing road extends for 680m before stopping just after Greenfield Close.



*Figure 5.1 – Looking towards A28 Markethill Road from Ardmore Road / Greenfield Close
(approx. Ch680m)*



Figure 5.2 – Looking towards A51 Hamiltonsbawn Road from Ardmore Road on the 2007 Preferred Route Option (approx. Ch680m)

After Greenfield Close (Ardmore Road) the land to the right of the route is relatively flat and is dominated by agricultural grassland of varying quality incorporating hedges and trees, the land to the left of the proposed route can be classed as residential with some commercial properties and land to the right is agricultural up to the existing A51 Hamiltonsbawn Road. After the A51 Hamiltonsbawn Road, to the left is the decommissioned army barracks and to the right of the route is the A51 Hamiltonsbawn Road Industrial Estate where the route runs from the industrial estate to the west of Linsey's Heights residential properties. The land is reasonably flat and poorer ground can be found in this area, along with an existing watercourse and trees close to the tie-in with A3 Portadown Road, with, residential properties adjacent to the tie-in.



*Figure 5.3 – Looking north towards Linsey’s Heights from Hamiltonsbawn Industrial Estate
(approx. Ch1600m)*



*Figure 5.4 – Looking south towards Hamiltonsbawn Industrial Estate from Linsey's Heights
(Large groups of trees present, approx. Ch2150m)*



*Figure 5.5 – Looking north towards proposed junction and tie in with A3 Portadown Road
(watercourse and trees present, approx. Ch2150m)*

Option 12

Option 12 follows the route of Edenaveys Road for approximately 450m before diverging northwest towards the Ballynahonemore Road across agricultural lands.



Figure 5.6 – Looking northeast along Edenaveys Road (approx. Ch50m)



Figure 5.7 – Looking northwest towards Ballynahonemore Road across agricultural lands along line of the proposed alignment (approx. Ch450m)



Figure 5.8 – Looking south towards Edenaveys Road and Industrial Estate along the line of the proposed alignment (approx. Ch600m)

The alignment runs through agricultural land for the majority of the route up to the A51 Hamiltonsbawn Road realignment and on towards the tie in at the A3 - Drumman Heights Roundabout. The land from Ch450 rises until Ch700 where it becomes flat until the existing Ballynahonemore Road. North of Ballynahonemore Road the land is made up of rolling north to south drumlins. The field boundaries are made up of hedgerows and mature trees.



Figure 5.9 – Looking north towards A51 Hamiltonsbawn Road (approx. Ch850m)



Figure 5.10 – Looking southeast towards Edenaveys Road (approx. Ch850m)



Figure 5.11 – Looking towards the existing roundabout at Drumman Heights / Drummanmore Road (northern tie in)

Option 16

Option 16 follows the same route to that of Option 12 until it reaches the Ballynahonemore Road. It follows Edenaveys Road then deviates northwest (Ch450m) up and over the hills and connects to the 2007 Preferred Option at approx. Ch1650m, running through commercial areas and brownfield sites to tie in to the A3 Portadown Road at Linsey's Heights. The land between Ballynahonemore Road and

A51 Hamiltonsbawn Road can be classed as east to west rolling drumlins separated by hedgerows and mature trees.



Figure 5.12 – Looking north towards proposed junction and tie in with A3 Portadown Road (watercourse and trees present, approx. Ch2100m)

Option 50

Option 50 follows the same route to that of Option 12 and Option 16 until it reaches the Ballynahonemore Road. It follows Edenaveys Road then deviates northwest (approx. Ch450m) and runs up over the drumlins towards the Ballynahonemore Road (approx. Ch900m). This option then runs through agricultural grazing land from approximately Ch900m to Ch1950m where it meets the realigned A51 Hamiltonsbawn Road Junction. The land can be classed as east to west rolling drumlins, and field boundaries are made up of hedgerows and mature trees.



Figure 5.13 – Looking northeast along the line of Option 50 towards the A51 Hamiltonsbawn Road and proposed junction (approx. Ch1650m)



Figure 5.14 – Looking towards the A3 along the line of Option 50 from drumlins north of A51 Hamiltonsbawn Road (approx. Ch1950m)



Figure 5.15 – Looking towards the A51 Hamiltonsbawn Road along the line of Option 50, south of Killuney Road (approx. Ch2900m)



Figure 5.16 – Looking towards the A51 Hamiltonsbawn Road along the line of Option 50, north of Killuney Road (approx. Ch2900m)

The northern junction cuts through the end of a disused railway line and ties in at grade with the A3 Portadown Road. This area is predominantly made up of grassland and gorse scrub.



Figure 5.17 – Looking towards the disused railway line and line of grassland south of the northern tie in with A3 (approx. Ch3100m)



Figure 5.18 – Looking east along the line of the disused railway (approx. Ch3340m)



Figure 5.19 – Looking towards the A3 Portadown Road in the direction of the at grade junction from disused railway (approx. Ch3350m)

5.16 Hydrology

The following water courses have been identified:-

- The Ballynahone River; and,
- Killuney Stream.

The Ballynahone River runs from south to north. The river is close to the Ardmore Road / Markethill Road intersection.

Killuney Stream skirts the southern and western edge of Linsey's Hill before crossing beneath the A3 Portadown Road in an existing culvert. This watercourse would potentially require two culvert crossings of the route, and possibly a substantial re-alignment of the northern section of the stream where it runs parallel to the 2007 Preferred Route.

A mill stream diverging from the Ballynahone River also crosses beneath the southern end of Ardmore Road in an existing culvert crossing.

5.17 Hydrogeology

There are no significant aquifers in the study area. Drainage of the earthworks would be important to maintain their stability. Sands and gravels exposed in cutting may be significantly water bearing in the temporary works.

The low lying ground between Drumadd and Linsey's Hill is likely to have a high ground water level, which may have an impact on construction works. Such impacts may include the requirement for a geotextile layer with granular material beneath the embankments to minimise and control settlement.

5.18 Drainage

At this stage no detailed drainage design work has been carried out for the four proposed options. From an initial desktop study and site walkover there are limited watercourses to outfall to throughout the study area. The two potential types of drainage that could be incorporated into the detailed design are as follows:-

- Outfall to watercourses (piped); and,
- Sustainable Urban Drainage System (SUDS), incorporating ponds.

Rivers Agency approval would be required if in the event of discharging to watercourses. Rivers Agency would require a *Schedule 6 Application Form for Consent to Undertake Works to a Watercourse* would need to be submitted under the *Drainage (Northern Ireland) Order 1973*.

For the 2007 Preferred Option and Option 16 the drainage generally falls towards the A28 Markethill Road, A51 Hamiltonsbawn Road and the A3 Portadown Road. There are the potential for impacts on the large watercourse adjacent to the A3 at Linsey's Hill / Linsey's Heights which can be seen below in *Figures 5.21 and 5.22*.



Figures 5.20 & 5.21 – Existing watercourse and culvert adjacent to A3 Portadown Road at Linsey’s Heights / Linsey’s Hill

Option 12 would require outfalls at Ch 300m and Ch 2950m (Killuney Bridge) as an absolute minimum.

Option 50 would require outfalls at Ch 320m and Ch 3390m as an minimum.

5.19 Cost Estimates

Preliminary cost estimates were produced for each of the four proposed options. The same junction choice was used for each assessment (roundabouts at the A28, A51 and at the A3). The costs for each option are set out in *Table 5.12* below.

Element of Works	2007 Preferred Option	Option 12	Option 16	Option 50
Preliminary's/Traffic Management	£1,244,146.32	£1,557,180.06	£1,317,765.69	£1,788,701.44
Land / Compensation	£2,053,607.40	£1,557,180.06	£2,328,009.39	£1,296,645.45
Construction Costs	£5,494,022.81	£9,772,127.12	£9,519,651.39	£12,757,968.66
Sub Total	£8,791,776.53	£12,886,487.24	£13,165,426.47	£15,843,315.55
Preparation, Supervision and Design (14%)	£1,055,013.18	£1,546,378.47	£1,428,827.85	£1,918,127.15
Statutory Authorities	£115,531.45	£144,374.48	£122,177.09	£165,840.06
Sub Total	£9,962,321.16	£14,577,240.19	£14,716,431.41	£17,927,282.76
Risk and OB (OB at 44%)	£3,495,746.64	£5,748,841.85	£5,467,843.74	£7,340,471.70
Total	£13,458,067.80	£20,326,082.04	£20,184,275.15	£25,267,754.46

Table 5.12 – Preliminary Cost Estimates

Optimism Bias (OB) has not been applied to land costs in line with industry best practice.

1. Rates, prices and costs above are exclusive of VAT.
2. Based on Q1 2015 and no allowance has been made for inflation.

The assessment of costs and differences alone does not provide a basis on which to choose between the options.

6 Economic Assessment

6.1 Introduction

This section presents a high level assessment of the options presented in Section 4 against Traffic and Economic constraints within the proposed study area. Headings under which assessments are made are listed below:-

- Business Users & Transport Providers;
- Reliability Impact on Business Users;
- Regeneration; and,
- Wider Impacts.

6.1.1 Modelling

Following consultation with Transport NI it was agreed that Mouchel should build a traffic model for Armagh, using the SATURN software (Version 11.1.09), to allow a comprehensive review of the proposed options. The following paragraphs highlight the main points in the development of the Armagh traffic model.

A programme of surveys was undertaken in autumn 2014, comprising Automatic Traffic Counts, Turning Movement Counts and Journey Time surveys. This data was used to update the previous 2006 base year model to a 2014 base model.

The data collection programme comprised:-

- 31 Manual Turning Counts;
- 21 Automatic Traffic Counts;
- 10 Classified Link Counts; and,
- 4 Journey Time Routes.

On the basis of the survey data (Automatic Traffic Counts and Manual Classified Counts) analysis, and in order to be consistent with national methodologies for forecasting, which usually operate on whole hour periods, two time periods were modelled separately as follows:-

- AM Peak hour (08:00 – 09:00); and,
- PM Peak hour (17:00 – 18:00).

The network has been specified by a simulation network in the study area where the junctions are coded and junction delays are modelled explicitly. The highway network was modelled in detail to ensure that all major local and through traffic routes were included. *Figure 6.1* presents the coverage of the traffic model.

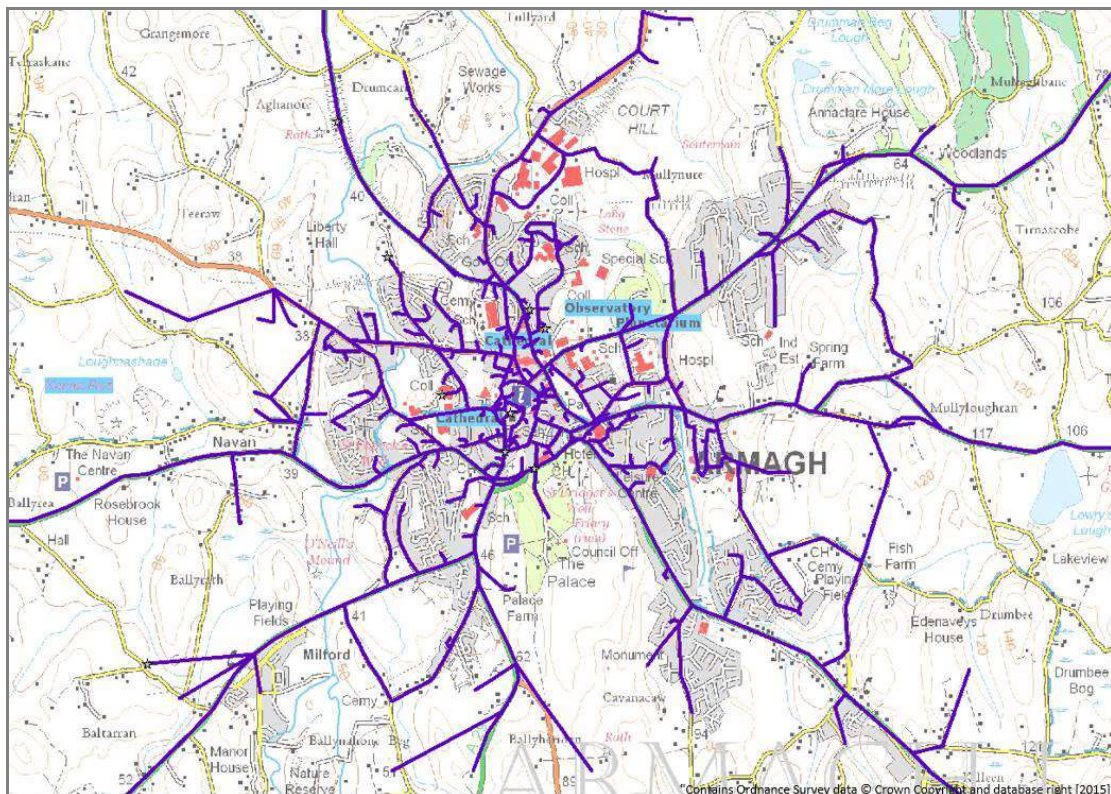


Figure 6.1 – Traffic Model Study Area Network

Information on roads was gathered from maps and plans, aerial photography, inventory surveys and site visits. Speed-flow relationships were then allocated to links based on the following criteria:-

- Their locations and functions (rural, urban, suburban);
- Dual or single carriageway standard;
- Number of lanes;
- Class of road (motorway, A, B, C);
- Quality of road (good, average, poor);
- Speed limit; and,
- Level of frontage development.

Highway junctions were modelled in detail in order to take account of the traffic flows and conflicting movements as well as to represent the effect of traffic delays and

queues. Each junction was coded by using detailed information of the highway network, which included:-

- Junction type (signalised, priority, roundabout);
- Number of arms;
- Allowed turns;
- Turning capacities based on geometric parameters;
- Traffic signal details (stage/phase arrangements and timings); and,
- Vehicle circulating capacity and travel time (for roundabouts).

A zoning system was defined to provide geographical sub-division of the modelled area. A total of 146 zones were defined. Each zone was then represented by column and a row in what is called the demand (or trip) matrix, where the rows represent the trip origin and the columns represent the trip destination. A graphical representation of the zoning system is shown in *Figure 6.2* below.

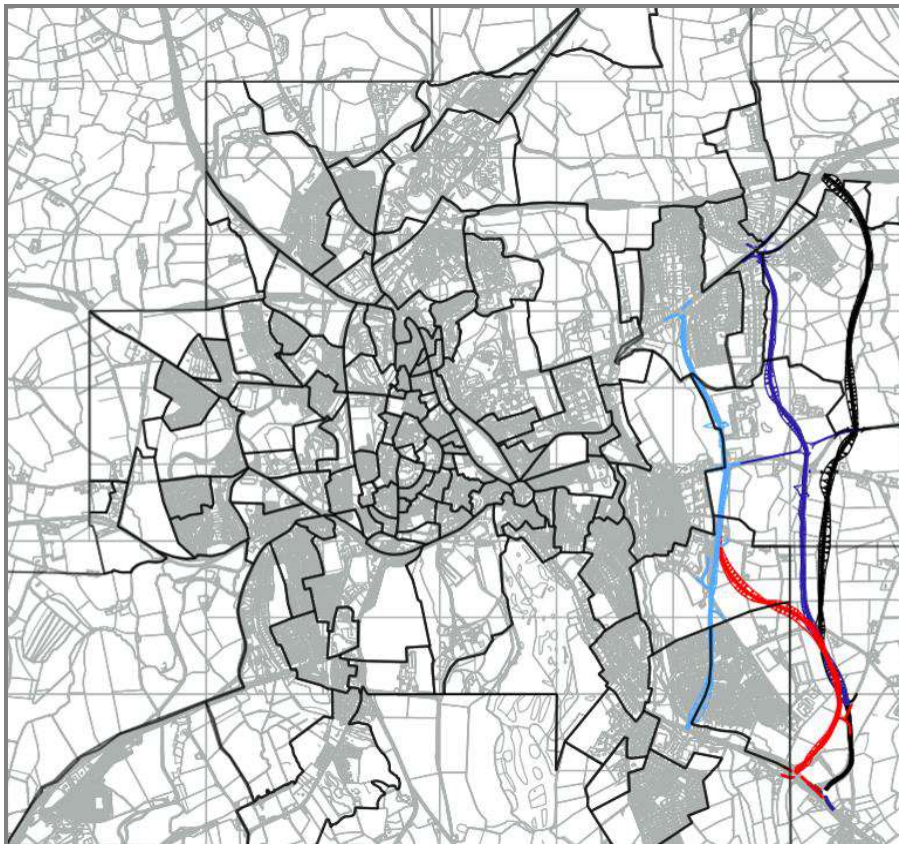


Figure 6.2 – Zoning System

The Base year matrices for this study have been developed to represent an average weekday in 2014. They have been based on the Roadside Interview Survey data

which was collected for an earlier study in 2004. The relevance of the data after almost 10 years was validated using the recent traffic surveys and in the absence of any other source of information relating to trip origins and destinations within the area, the 2004 RSI data was utilised after careful consideration.

Data from Transport NI census points at strategic network locations are collected annually and provide a reliable source of traffic flow information. Analysis of the traffic census data at a number of locations in the vicinity of the study area revealed that during the intervening years between 2004 and 2014 the traffic flow levels have remained relatively unchanged. It was therefore decided that the 2004 trip origin and destination data could be used. The traffic levels at the specific locations for the period 2004-2012 are presented in *Figure 6.3* below.

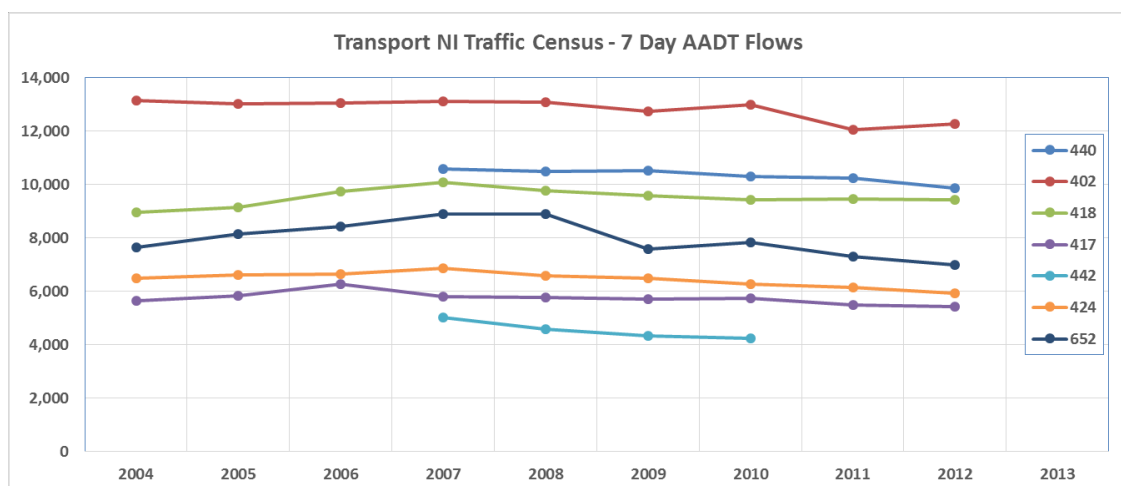


Figure 6.3 – Traffic flow levels at TNI Census Locations

The origin-destination information has been used in conjunction with the 2014 traffic survey data as input to a process known as Matrix Estimation which formed part of the model calibration process.

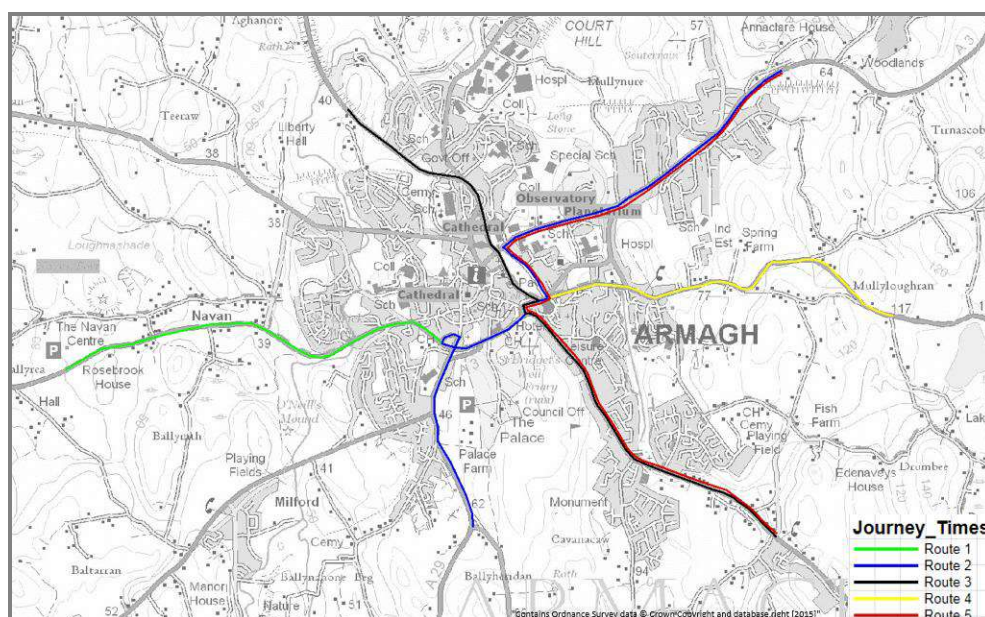
The calibration of the traffic model was undertaken using a standard approach where the network is adjusted to ensure that the model realistically replicates routing and vehicle speeds through the study area. Matrix estimation was incorporated in the model calibration process in order to obtain matrices based on the routing patterns to which the network was calibrated. The matrix estimation procedure is an iterative process and as such allows comparison between iterations to determine which iteration provides the best calibrated model assignment. The matrix estimation

process was therefore monitored to ensure that the estimated matrix converged to a stable solution.

The calibration procedure can be broken into the following activities:-

- Checks to ensure that link speeds on the network are realistic;
- Checks that the delay calculations at junctions are operating realistically;
- Adjustment and checking of the network properties to ensure realistic routing of traffic; and,
- Use of matrix estimation to adjust the secondary trip matrices to match observed link and turning counts.

Following the model calibration process was the model validation process, where the model outputs are compared against independent observed data that have not been used in the model development process. Network validation was undertaken to establish that the network structure was accurate and that characteristics of the network are suitably represented in the model. A number of range and logic checks were undertaken, including routing checks. Assignment validation was then undertaken for the traffic flows (links and turns) and journey times. The journey time routes that have been evaluated are presented in *Figure 6.4* below.



1. Route 5 is a combination of Route 2 and Route 3

Figure 6.4 – Surveyed Journey Time Routes

Tables 6.1 and 6.2 present the validation statistics for the journey time validation. The model compared well with the observed data, and met the DMRB validation criteria. The validation criteria test must fail more than twice for the overall results not be validated.

Table 6.1 – AM Peak Journey Time Validation

Route	Direction	Distance (km)		Journey Times (mm:ss)						
		Obs	Model	Observed			Modelled			
				Observed	Lower	Upper	Modelled	Diff	%Diff	Pass?
Route 1	NB	3.34	3.36	09:19	07:44	10:55	10:32	01:13	13%	✓
	SB	3.36	3.16	11:22	09:54	14:08	10:05	-01:17	-11%	✓
Route 2	EB	0.97	0.96	02:00	01:43	02:13	01:52	-00:08	-7%	✓
	WB	0.97	0.96	01:48	01:42	01:55	01:49	00:01	1%	✓
Route 3	NB	3.19	2.85	08:48	08:48	08:48	08:31	-00:18	-3%	✓
	SB	2.42	2.45	07:15	06:29	08:01	07:00	-00:15	-3%	✓
Route 4	EB	1.76	1.75	02:49	02:46	02:52	02:51	00:02	1%	✓
	WB	1.76	1.75	02:51	02:51	02:51	03:08	00:17	10%	✓
Route 5	NB	3.51	3.59	10:55	10:55	10:55	10:10	-00:45	-7%	✓
	SB	3.47	3.61	10:26	10:26	10:26	09:44	-00:42	-7%	✓

Table 6.2 – PM Peak Journey Time Validation

Route	Direction	Distance (km)		Journey Times (mm:ss)						
		Obs	Model	Observed			Modelled			
				Observed	Lower	Upper	Modelled	Diff	%Diff	GEH
Route 1	NB	3.34	3.36	09:33	08:31	10:25	10:46	01:13	13%	✓
	SB	3.36	3.16	11:00	09:33	13:42	10:23	-00:37	-6%	✓
Route 2	EB	0.97	0.96	01:55	01:46	02:03	01:52	-00:03	-2%	✓
	WB	0.97	0.96	01:57	01:51	02:07	01:53	-00:03	-3%	✓
Route 3	NB	3.19	2.85	10:03	09:44	10:21	08:14	-01:48	-18%	✗
	SB	2.42	2.45	08:07	07:03	09:41	07:45	-00:22	-5%	✓
Route 4	EB	1.76	1.75	02:55	02:42	03:07	03:07	00:12	7%	✓
	WB	1.76	1.75	03:00	02:41	03:35	02:50	-00:10	-5%	✓
Route 5	NB	3.51	3.59	09:39	09:39	09:39	10:30	00:51	9%	✓
	SB	3.47	3.61	09:56	09:56	09:56	09:39	-00:17	-3%	✓

Overall it can be said that the Armagh base model for 2014 represents to a good degree the current traffic conditions and therefore it can be used to form the basis for the forecasting and economic evaluation of the proposed options for the Armagh East Link.

6.1.2 Forecasting

The 2014 Base year traffic model formed the basis for the development of the future year traffic models to support the design and appraisal of the Armagh East Link. The future year models were developed for a scheme opening year of 2020 and a design year of 2035. Global growth factors, extracted from the information contained in the Department's "Road Transport Forecasts 2013" document, have been used to produce the future year trip matrices for 2020 and 2035. The Central growth assumption was used as the basis.

Future year networks for 2020 and 2035 were developed from the base year networks by coding in the proposed highway improvement schemes. Committed schemes were included to create the Do-Minimum networks and the scheme options

for the proposed Armagh East Link were then included to represent the four Do-Something options.

The forecast matrices were assigned to the future year networks (Do-Minimum and Do-Something). The assignment process for each scenario has been observed to converge meeting the convergence criteria set out in the Department's guidance notes.

6.2 Business Users & Transport Providers

For each of the four proposed options, the East Link scheme would have the potential to provide benefits in terms of money and time costs in relation to the trips that business users and transport providers make. Any benefits accrued would be generated from such items as:-

- Reduction in travel time;
- Increased average speeds;
- Reduction in vehicle operating costs;
- Collision reduction;
- Casualty reduction; and,
- Collision reduction;

6.3 Reliability Impact on Business Users

Each of the proposed options would also have the potential to provide benefits to business users and transport providers in terms of reliability of journeys. In comparison to existing conditions the proposed options may relieve an element of the congestion from the city centre in providing increased average speeds and reduction in travel time and improve the reliability for business users.

6.4 Regeneration

Providing an outer link to the city may provide congestion relief in the city centre as well as reduced journey times and increased journey time reliability for some road users. This may provide an opportunity to promote regional economic growth. Encouraging people and business into the city centre can become easier with a reduction in strategic traffic through the city centre.

6.5 Effects of Scheme Options

To assess the effect of the proposed options the journey time between two points on the network has been compared against the modelled time for the Do-Minimum. *Figure 6.5* below presents these two points which are located on the outer limits of the study area on the A28 at the entrance to the Edenaveys Industrial Estate and on the A3 at the Welcome to Armagh City sign.

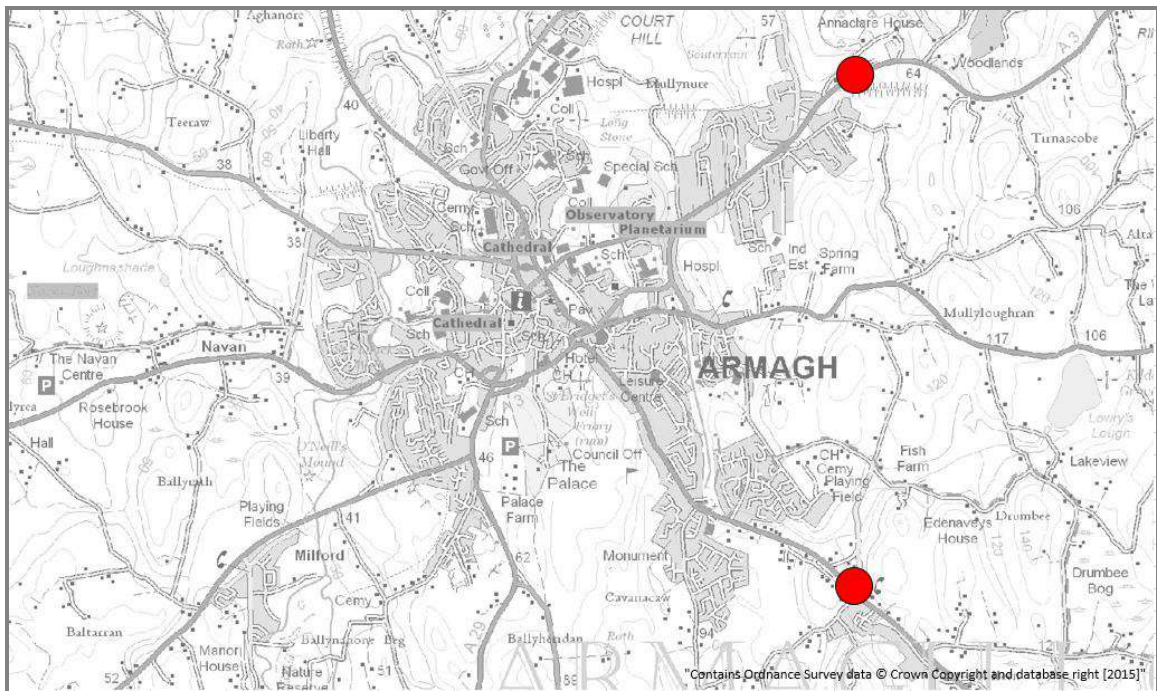


Figure 6.5 – Do-Minimum Survey Points

Route 50 appears to have the greatest effect in reducing the journey times between the two given points due to the higher speed limit arrangements. The journey time used for the Do-Minimum scenario is the one via the City centre.

Figures 6.6, 6.7, 6.8 and 6.9 below present the trips for each of the options against existing conditions. The existing route is the one via the city centre.

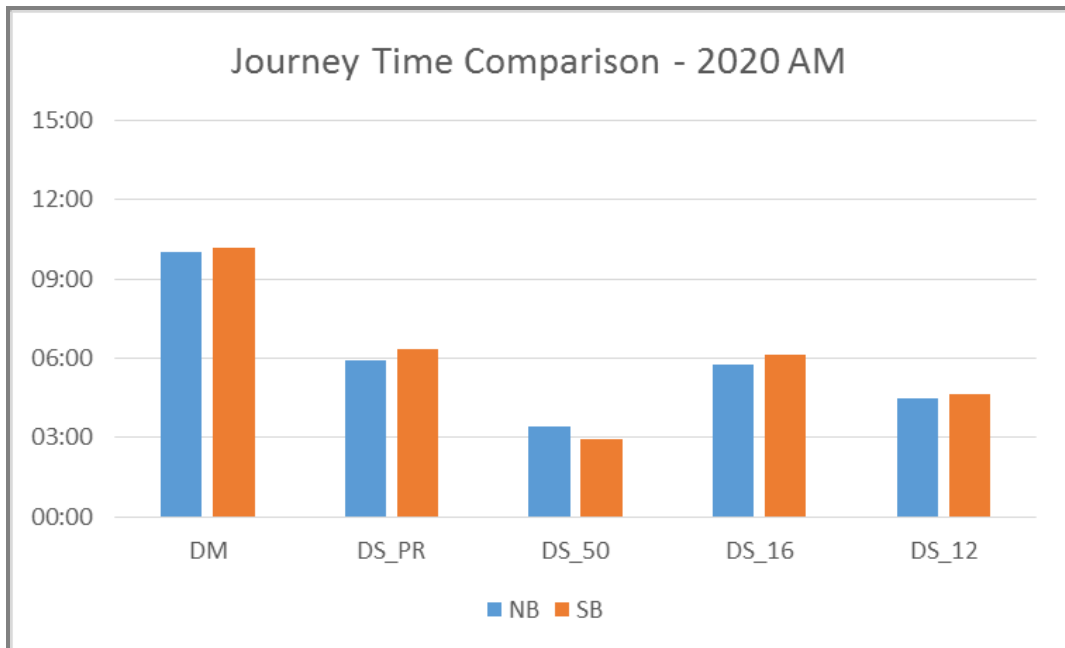


Figure 6.6 – Journey Time Comparison – AM 2020

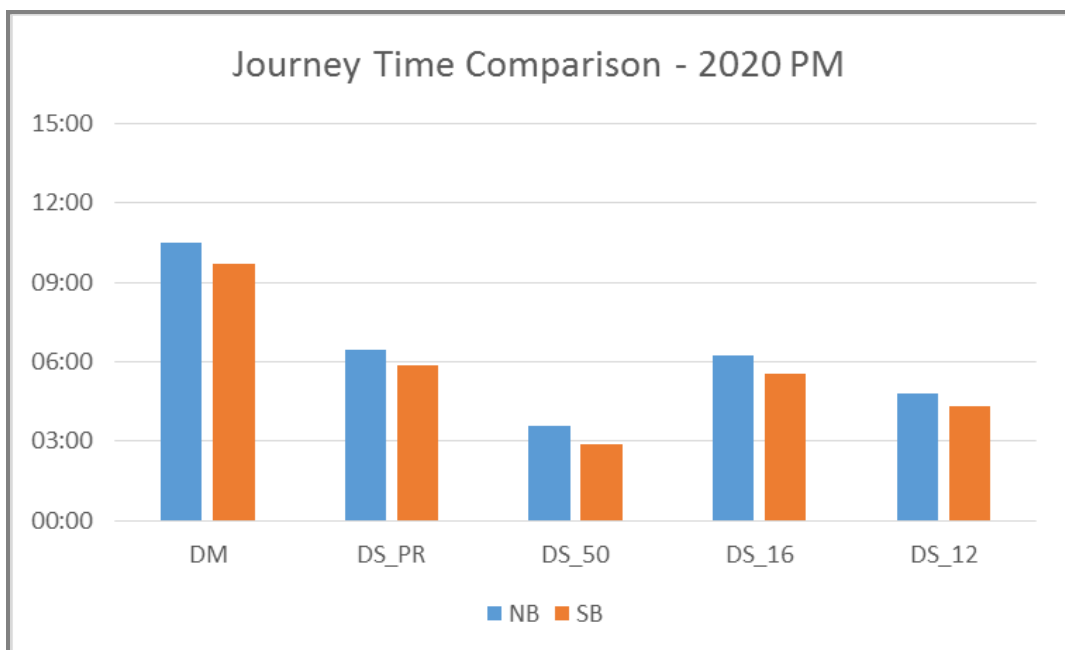


Figure 6.7 – Journey Time Comparison –PM 2020

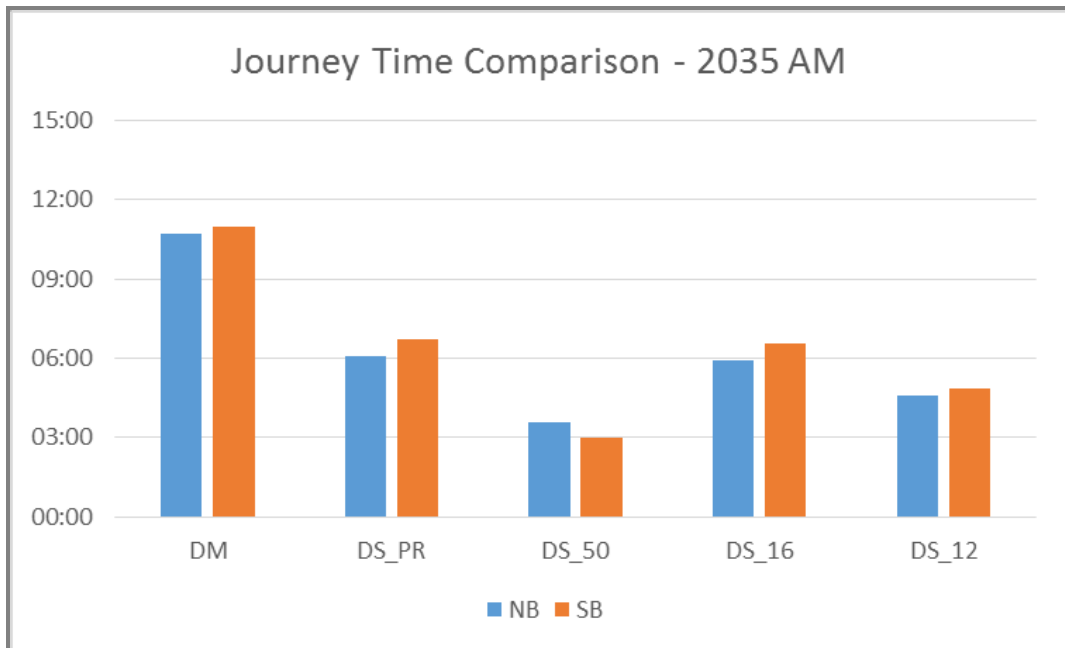


Figure 6.8 – Journey Time Comparison – AM 2035

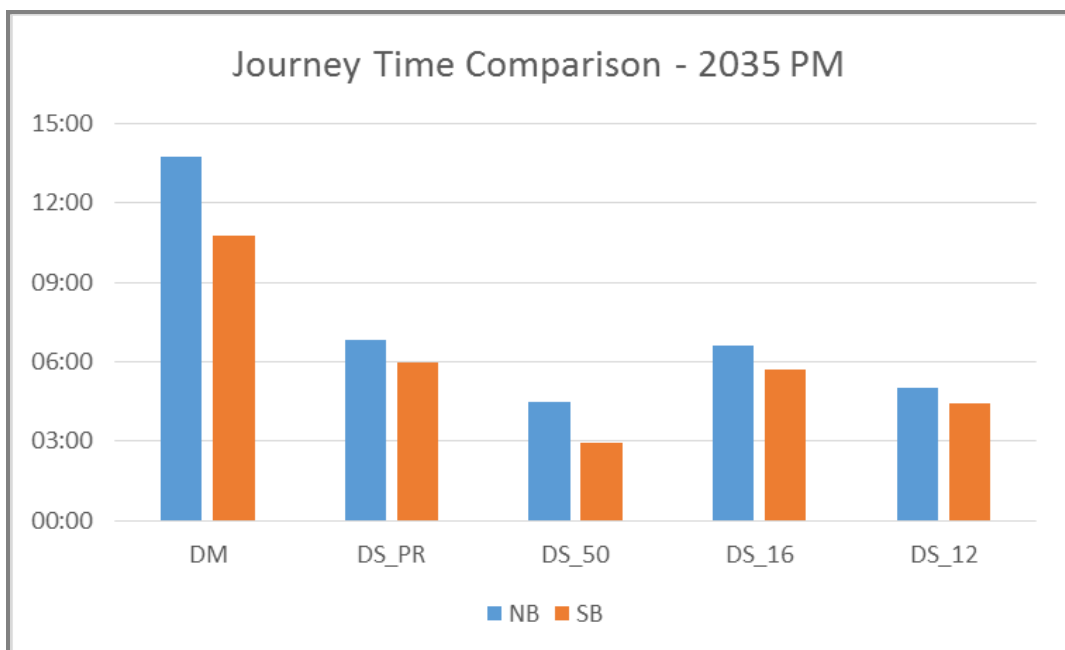


Figure 6.9 – Journey Time Comparison – PM 2035

As can be observed from *Figures 6.6, 6.7, 6.8 and 6.9*, the trips using the Armagh East Link have significantly reduced journey times. The highest reduction being observed consistently across all time periods, and both for the opening and design year, is for Option 50. It can also be observed that Option 16 and the 2007 Preferred Option appear to achieve similar reductions in journey time.

Figures 6.10, 6.11, 6.12 and 6.13 presents the time savings for the same section but assuming that the North-west link has been built. As can be observed overall the effect the East Link is to reduce travel time significantly when compared to the time taken to travel through the city centre.

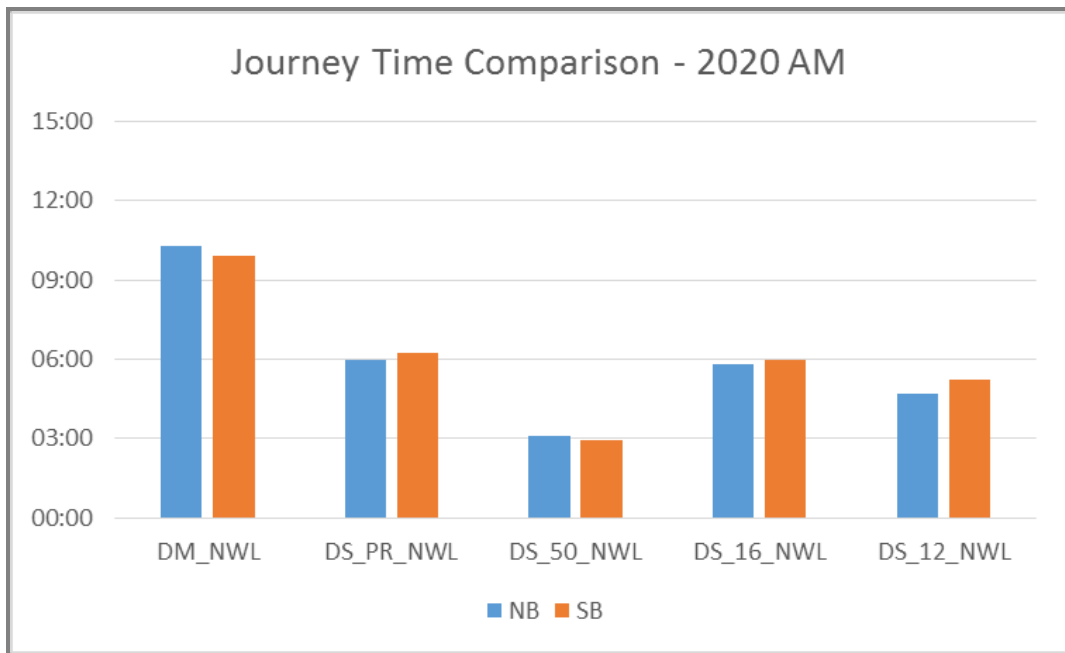


Figure 6.10 – Journey Time Comparison – AM 2020

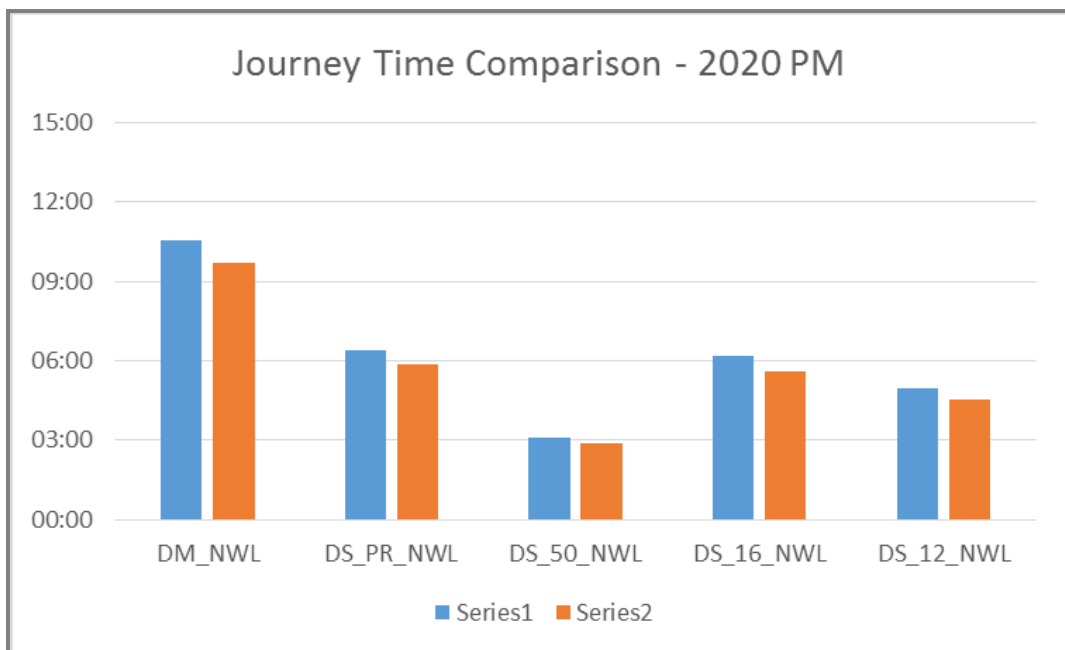


Figure 6.11 – Journey Time Comparison – PM 2020

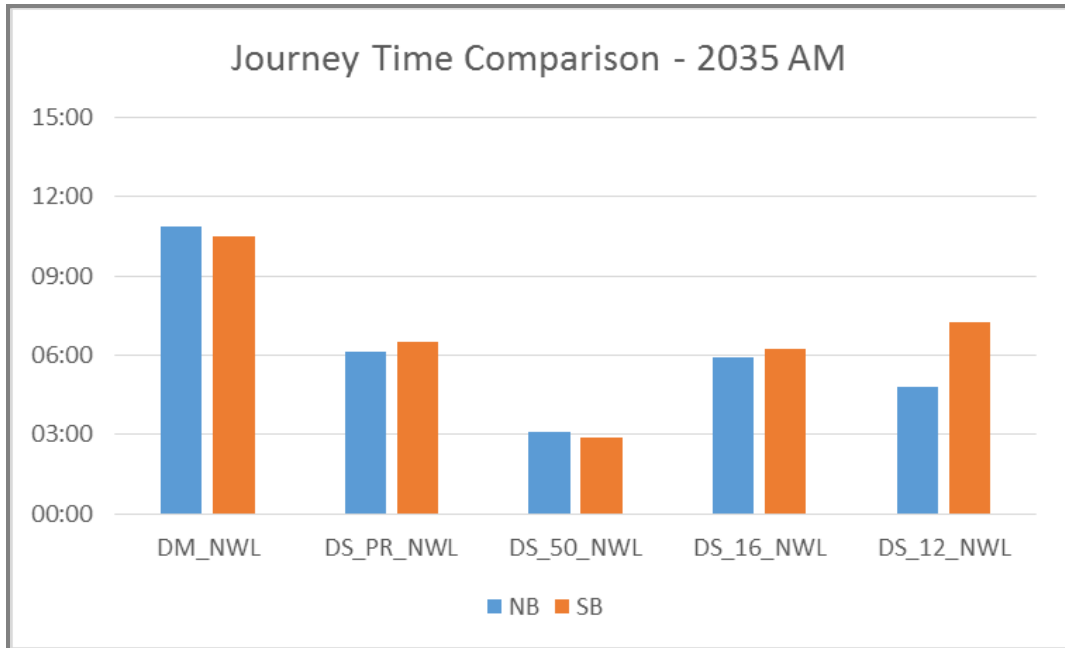


Figure 6.12 – Journey Time Comparison – AM 2035

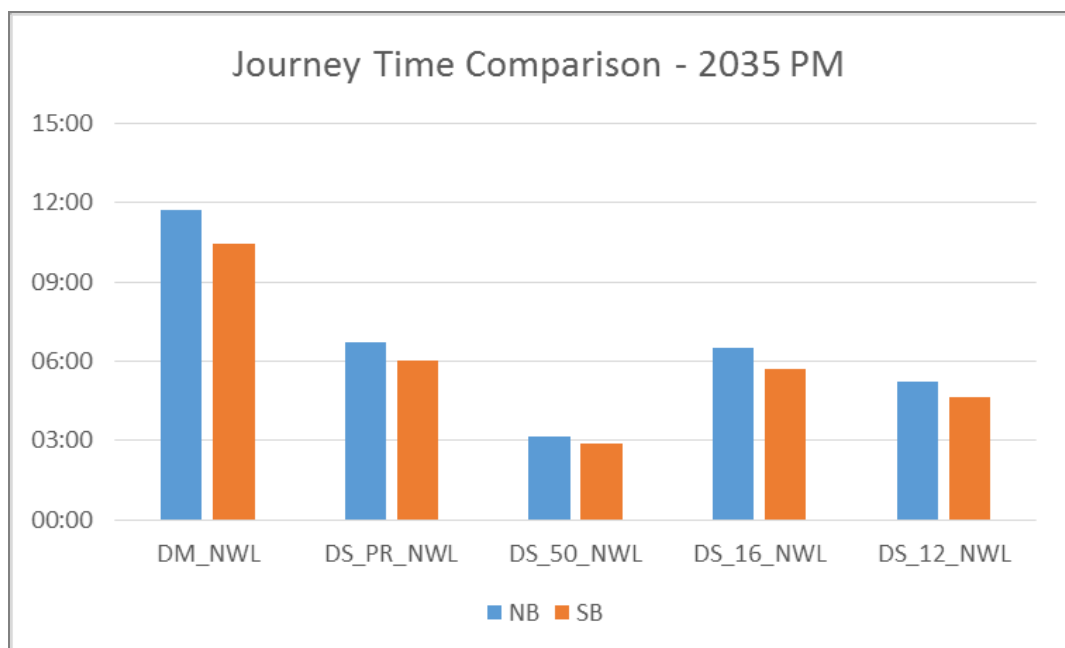


Figure 6.13 – Journey Time Comparison – PM 2035

6.6 Wider Impacts

Assessing the wider impacts of the proposed options involves assessing the integration between different modes of transport; with the environment; with national, regional and local land-use planning; and with other policies such as education, health and wealth creation, these are:-

- To improve transport interchange;
- To integrate transport policy with land-use policy; and,
- To integrate transport policy with other government policies;

6.6.1 Transport Interchange

Transport Interchange relates to the interaction between different modes of transport and the effect on freight or passengers. The sub-objective is split into two elements, which are:-

- Freight interchange; and,
- Passenger interchange.

This scheme makes no impact on the interchange of freight from one mode of transport to another and there are no passenger interchanges within the vicinity.

6.6.2 Land Use and Government Policy

The Land-use policy reviews the scheme proposals against land use and transport policies and proposals. On a national level the policy is set out in the *DRDNI Planning Policy Statement (PPS) 13 – Transportation and Land Use*. This document was produced from recommendations in the *Moving Forward: The Northern Ireland Transport Policy Statement* which outlines the strategy for implementing the objectives of the Government's 1998 strategic policy framework for transport - *The White Paper "A New Deal for Transport"* – in a way which would reflect the particular circumstances in Northern Ireland. The policy focuses on integration within and between different types of transport; integration with the environment; integration with land use planning; and, integration with policies for education, health and wealth creation.

The main objective of *PPS13* is to reduce the dependence on car use and to promote a more balanced and integrated transport system in which public transport

and non-motorised transport would be more viable. The Armagh East Link provides the opportunity to improve the area's public transport system and the level of NMU provision means the scheme is in line with the objectives of *PPS13*. By relieving city centre congestion and providing the proposed standard of link road between the A28 Markethill Road and A3 Portadown Road the scheme also integrates the transport system with important public facilities regarding education, health, etc. However, the policy issues above do not have any impact on the choice between options described in Section 4 of this report. Any environmental issues relating to the different options reviewed in this report have been discussed in Section 7.

The *Regional Development Strategy: Shaping Our Future (RDS)* is a strategy to guide the future development of Northern Ireland to 2025. A key theme of this document is sustainability with a strong emphasis on social cohesion and economic progress, which complies with the *PPS13* objectives stated above. The pivotal section of the *RDS* is the Spatial Development Strategy. This proposes a framework of hubs, corridors and gateways across Northern Ireland to focus and integrate regional development. Armagh is classed as a Main Hub within the framework on a Link Corridor, and also a Major Tourism Development Opportunity. The Armagh East Link location satisfies the objectives of creating urban hubs – the improvement of the transport system locally and in terms of the national road network; providing the opportunity for economic investment through the potential for development opportunities along the link; and, maintaining the 'compact' nature of the city by keeping development opportunities close to existing built up areas.

The guidance in the *RDS*, and its "daughter document" the *Regional Transportation Strategy (RTS)*, was used to produce the regional objectives set out in the *Sub-Regional Transport Plan (SRTP) 2015*. The relevant objectives of this report are to:

- Reduce the number of people killed or seriously injured in collisions each year by one third:-
 - The aim of this Safety objective is to reduce the loss of life, injuries and damage to property resulting from transport collisions and crime.
- Quadruple the number of cycle trips by the end of 2015:-
 - The 3-3.5m wide combined footway/cycleway of the proposed East Link and connection to the National Cycle Network would encourage

cycle use in Armagh and contribute towards compliance with this objective.

- Increase short walking trips by 20% and average distance walked per person by 10%:-
 - The 3-3.5m wide combined footway/cycleway along the proposed East Link would help to integrate Armagh and comply with this objective.
- Enhance safety levels in urban areas for vulnerable road users such as pedestrians:-
 - 0.5m hardstrips are provided at the carriageway edge and crossing facilities are proposed as enhanced provision for vulnerable road users. The removal of some traffic from the city centre, which has higher pedestrian volumes, would further assist in attaining this target.

The proposals, as set out in this report, for the Armagh East Link, would comply with the ethos of these policies.

The Draft Armagh Area Plan 2018 sets the local policy regarding transportation and land use. It covers the whole of the Armagh City & District Council Area (670km²) and applies the strategies set out in the *RDS/RTS* to the Armagh region. In terms of residential Land Use the plan states that of the 180 hectares of land identified for housing in the Draft Area Plan, 85 hectares remain undeveloped. Also, of the 34 hectares of land identified for Industrial & Commercial use only 2 hectares have been developed. The improved transport links around the city, relief of city centre traffic, and the potential location of the Armagh East Link would both encourage and facilitate further development to the east of Armagh City, therefore the proposal would be in line with the Draft Area Plan.

7 Environmental Assessment

7.1 Focus of the Review

The aim of this route option environmental review has been to gain an understanding of the environmental sensitivities within the area of the route options being considered as well as to gain an appreciation of the environmental sensitivities of each route.

The environmental review of the potential impacts of the options has been based on mainly publicly and readily available information. Where not readily available information from the 2006 Armagh East Link Options Study (also referred to as the 2006 report) has been used, this limitation has been highlighted in this report. A general environmental walkover was undertaken in March 2015 to gain a better understanding of the natural and social environment along the proposed route options.

Headings under which assessments are made are listed below:-

- Air Quality;
- Noise;
- Ecology & Nature Conservation;
- Landscape and Visual ;
- Cultural Heritage/Archaeology; and,
- Effects of All Travellers.

7.2 Air Quality

7.2.1 Baseline Conditions

Air Quality Management Areas (AQMAs) are declared where the European Union limit and Government standards, as defined in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland as adopted for nitrogen dioxide (NO₂) and dust particles: particulate matter (PM₁₀), are not being achieved or are in danger of being exceeded. Two AQMAs have been designated in Armagh according to the Department of the Environment Northern Ireland website. These are:-

- Armagh AQMA: An area encompassing the A29 and A3 in Armagh, running from railway Street in the north, along Lonsdale Road, Mall West and along

Barrack Street in the south. Declared for exceedances of the annual mean objective of $40\mu\text{g}/\text{m}^3$ NO_2 ; and,

- Greenpark Terrace Armagh AQMA: Incorporating numbers 1 to 4 Greenpark Terrace and numbers 74 to 94 Irish Street. Declared for exceedances of the annual mean objective of $40\mu\text{g}/\text{m}^3$ NO_2 .

Table 7.1 below outlines the distances between each of the proposed routes and AQMAs.

Table 7.1 – AQMAs

AQMA	2007 Preferred Options	Option 12	Option 16	Option 50
Armagh	1.2km	1.3km	1.2km	1.7km
Greenpark Terrace Armagh	1.7km	2.1km	1.7km	2.2km

There are no ecological designated sites, sensitive to air quality within 200m of the proposed routes.

Air quality sensitive receptors within 200m of the proposed routes have been identified. Table 7.2 below outlines the number of dwellings within banded distances up to 200m of the proposed scheme. Properties nearer the routes are likely to be subject to greater impacts dependent on local conditions.

Table 7.2 – Residential Properties within 200m

Distance Buffer	2007 Preferred Options	Option 12	Option 16	Option 50
0m – 50m	228	21	177	18
50m – 100m	439	38	353	20
100m – 150m	137	44	58	38

Distance Buffer	2007 Preferred Options	Option 12	Option 16	Option 50
150m – 200m	166	295	104	293
Total	970	398	692	369

Table 7.3 below identifies other air quality sensitive receptors within 200m of the proposed routes based on Pointer dataset.

Table 7.3 – AQ Sensitive receptors within 200m

Receptor type	2007 Preferred Options	Option 12	Option 16	Option 50
Education	0	1	0	0
Leisure and Tourism	0	0	0	0
Health	2	1	2	1
Hospitality	0	0	0	0
Total	2	2	2	1

The figures in Tables 7.2 and 7.3 above are calculated using the pointer dataset which was received in July 2013. Pointer is a dataset for addressable buildings in Northern Ireland. Each building has a unique building ID, which identifies a Primary Addressable Object (PAO). A PAO is defined as the 'physical footprint', for example, the building shell.

Each property has a Unique Property Reference Number (UPRN). The UPRN represents the Secondary Addressable Object (SAO) such as a residence or business within a building.

Pointer is supplied either as Local Government District areas or as a bespoke clip out centred on a site-specific area. Pointers Key features are as follows:-

- The definitive Spatial address database for Northern Ireland;
- Full Northern Ireland coverage;
- Locations assigned Irish Grid coordinates;
- Contains information on multiple occupancy and building use;
- Full incorporation of townland names; and,
- Extension file containing ward names and parliamentary constituency information.

Pointer has been allocated a set of UPRNs from the national hub which are allocated to all addresses within the dataset. This would make sure consistency of UPRNs across Northern Ireland and Great Britain. Each building would be assigned a geographic position (x and y coordinates) and a postal address.

7.2.2 Potential Environmental Impacts

None of the proposed route options are located within or in close proximity (<1km) of the AQMAs. Further air quality assessment would be required for all the routes to determine the impact on the AQMAs in central Armagh, as the introduction of any route option is likely to change the traffic dynamic in the wider area and in so doing, fail to satisfy the air quality scoping criteria outlined in the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 1, HA 207/071.

The 2007 Preferred Route would introduce a road close to the highest number of dwellings of all 4 routes within 200m; notably, 970 dwellings. This includes a large proportion of dwellings which are in close proximity to the proposed alignment. Option 16 has fewer dwellings (i.e., 692 dwellings) located within 200m. For both these alignments, the high number of dwellings is a result of these routes running through or in close proximity to the residential areas along Linsey's Heights and Ardmore Road.

Options 12 and 50 run through what is predominantly agricultural land located further east of the urban area, and both have similar and lower numbers of dwellings in close proximity; i.e., 398 and 369 dwellings respectively.

The introduction of a new link road would change the traffic dynamic in Armagh. The effects of this on the air quality cannot be determined at the time of this writing without conducting a more detailed air quality assessment. Without the availability of the relevant traffic data, it is not possible to conclude what the effects of the various

options would be on the potential to breach the air quality standards. However, as an initial indication, it can be assumed that based purely on the positioning of the route options in relation to sensitive receptors, that the option with the greatest potential to cause a detrimental effect on air quality is the 2007 Preferred Option. This is because the 2007 Preferred Option route takes traffic closer to the greatest number of sensitive receptors. In addition, Option 16 also takes traffic closer to a large number of sensitive receptors located in the north of the study area.

Whichever route is chosen, it is recommended that these follow the DMRB guidance and that a detailed assessment using adequate traffic data is conducted to establish those road links which would have a negative impact on the local air quality.

In addition to determining the effect on regional air quality, a screening exercise should be conducted using DMRB-compliant traffic data including, but not limited to, data on flows of traffic and traffic speed so as to identify those road links which would be affected and which are likely to have impact on regional emissions. The screening criteria are provided in DMRB 11.3.1 HA207/07 guidance and are cited below:-

- A change of more than 10% in AADT; or,
- A change of more than 10% to the number of HDV; or,
- A change in daily average speed of more than 20 km/hour.

7.3 Noise and Vibration

It has not been possible to undertake a full appraisal of the noise impact of the proposed option as appropriate traffic data is not available at the time of this report.

It must be noted that due to the lack of access to robust noise and vibration data, the level of uncertainty of this appraisal is high because the methodology is purely qualitative and based on only one parameter; notably, the number of dwelling receptors located within 300m of the proposed option(s).

The appraisal does not take into account modelled changes in noise levels as a result of changes in traffic flow, speed, road surface and compositions brought on by the scheme and other natural terrain influences, such as screening from landforms, buildings and barriers.

7.3.1 Baseline Conditions

The generation of noise is a significant issue when assessing the likely impacts of any new road scheme. Noise generated from traffic has the following two common components:-

- Noise generated from the engine of the car; and,
- Noise generated from the interaction of the car's wheels/tyres with the road surface.

The proposed options would introduce a new source of noise and vibration into the environment.

Receptors sensitive to noise and vibration located within 300m of the proposed routes have been identified. *Table 7.4* below outlines the number of dwellings within banded distances up to 300m of the proposed scheme. Properties nearer the routes are likely to be subject to greater impacts (local conditions dependent).

Table 7.4 – Properties within 300m

Distance Buffer	2007 Preferred Options	Option 12	Option 16	Option 50
0m – 50m	228	21	177	18
50m – 100m	439	38	353	20
100m – 150m	137	44	58	38
150m – 200m	166	295	104	293
200m – 250m	179	376	129	255
250m – 300m	208	84	166	45
Total	1357	758	987	669

Table 7.5 below identifies other noise sensitive receptors within 600m.

Table 7.5 – Noise sensitive receptors within 600m

Receptor type	2007 Preferred Options	Option 12	Option 16	Option 50
Education	4	2	4	2
Leisure + Tourism	2	1	1	1
Health	10	8	10	8
Hospitality	1	0	0	0
Total	17	11	15	11

7.3.2 2007 Preferred Option

The 2007 Preferred Route starts along the existing Ardmore Road where the road is abutted by a residential area and there is a high concentration of sensitive residential receptors. Moving north, the road runs through a more open area along the urban boundary with commercial areas and the edge of agricultural land at the A51 Hamiltonsbawn Road. The roads runs along the lowland to the west of the Linsey's Heights residential area. A new junction would be built along the A3 Portadown Road, adjacent to residential areas.

7.3.3 Option 12

This route follows Edenaveys Road approximately 300m east of a built residential area of Armagh. The route runs north through drumlins and agricultural land. The route passes intermittent residential dwellings and would introduce a new junction adjacent to A51 Hamiltonsbawn Road in close proximity to a farm residence. The route continues north and runs along the east of Killuney Park Road. The scheme terminates in an upgraded roundabout at the junction of the A3, Killuney Road, Portadown Road and Drumman Heights in a residential area.

7.3.4 Option 16

This route follows Edenaveys Road approximately 300m east of a built residential area of Armagh. The route deviates northwest of Edenaveys Road though

agricultural land, past isolated dwellings and ties into the 2007 Preferred Route running through commercial areas, the Linsey's Heights residential area and tying into a new junction at A3 Portadown.

7.3.5 Option 50

This route follows Edenaveys Road approximately 300m east of a built residential area of Armagh. The route runs north through undulating agricultural land to the east of Route 12 on higher ground. At the northern extent the route passes in proximity to some residential areas around Killuney Road and a new junction built on the A3.

7.3.6 Potential Environmental Impacts

Potential noise impacts can be split into two phases:-

- Construction phase; and,
- Operation phase.

During construction, the scheme would cause a negative noise impact on nearby sensitive receptors, particularly those residential areas located in close proximity to the final route.

During the operational phase, the new road alignment would cause a traffic noise impact upon sensitive receptors located along the line of the scheme corridor. Those receptors located in close proximity to the proposed scheme are likely to be subject to the highest adverse impact as a consequence of increased exposure to elevated noise levels resulting from the traffic.

The impact from all the proposed options are considered to be adverse in terms of noise. This is because each option would introduce a new road alignment and increased traffic flows into areas of Armagh where no road and therefore no traffic existed previously. However, it must be highlighted that this assessment does not take into account the likely reduction in traffic noise impact that all proposed options would introduce primarily in the centre of Armagh, as a result of diverting traffic flows from existing routes.

The introduction of a new link road would change the traffic dynamic in Armagh. The effects of this on noise and vibration on affected roads cannot be determined at this stage without undertaking a more detailed assessment which incorporates adequate

quantitative data. No conclusion can be made at this time regarding the effects of the various options on receptors in the wider road network.

The 2007 Preferred Route would introduce a road close to the highest number of dwellings of all 4 routes within 300m; notably, 1357 dwellings. This includes a large proportion of dwellings which are in close proximity to the proposed alignment. Option 16 has fewer dwellings (i.e., 987 dwellings) located within 300m. For both these alignments, the high number of dwellings is the result of these routes running through or in close proximity to the residential areas along Linsey's Heights and Ardmore Road.

The 2007 Preferred Route and Option 16 also contains a significantly higher concentration of sensitive dwellings in close proximity to the road alignment; notably, the dwellings are located between 0m and 100m from the aforementioned options. This is likely to result in a larger traffic noise impact on these dwellings. Options 12 and 50 run through predominantly agricultural land further east of the urban area and both have similar and lower numbers of dwellings in close proximity; i.e., 758 and 669 dwellings, respectively. These routes, however, would subject fewer dwellings to noise and vibration impacts resulting from the introduction of a new road.

For both Options 12 and 50, the majority of the sensitive dwellings are located further away from the road alignments, with the majority of dwellings located being between 150m and 250m from the proposed alignment. This is likely to result in a reduced traffic noise impact when compared against the 2007 Preferred Route and Option 16.

7.4 Ecology and Nature Conservation

7.4.1 Baseline Conditions

There are no statutory designated wildlife sites within 1km of the proposed routes. A single non-statutory local designated site has been identified within 1km of the route options (2006 Report data). Castle Dillon Lake Site of Local Nature Conservation Interest (SLNCI) is located approximately 680m to the north-east of Option 50 and is over 1km from the other 3 proposed routes.

No detailed ecological walkover or Phase 1 Habitat Survey has been undertaken. However, the general route walkover survey in March 2015 identified some key

habitats types and areas of ecological potential along each route option which are detailed below.

7.4.2 2007 Preferred Option

The southern section of the 2007 Preferred Option is already constructed at Ardmore Road. The road continues north out of the urban area and runs through agricultural grazing land. The route would affect the field boundaries which are made up of hedgerows with intermittent mature trees and a small area of coniferous trees. The route re-enters the urban area through a commercial area adjacent to the A51. The northern section goes through a brown field site of scrub and grassland and finally through a small section of wooded valley. Through this valley, a Callin River tributary stream flows and the banks are wooded with mixed deciduous/coniferous trees. The stream would be affected and would require culverting under the proposed A3 junction. A number of protected species are associated with these habitats.

7.4.3 Option 12

The southern section follows the route of Edenaveys Road for a short length then deviates north-west. The alignment runs through agricultural grazing land for the majority of the route. The field boundaries are made up of hedgerows and mature tree standards acting as wildlife corridors and habitat. The northern junction cuts through the end of a disused railway line of grassland and gorse scrub and affect the verge vegetation of the A3, predominantly woodland and grassland. A number of protected species are associated with these habitats.

7.4.4 Option 16

Option 16 follows the route of Edenaveys Road then deviates northwest through agricultural land running through a small field of pasture with field boundaries that are made up of hedgerows and mature trees which act as wildlife corridors. The route connects to the 2007 Preferred Route corridor running through the commercial area, brownfield site and wooded stream valley detailed above. A number of protected species are associated with these habitats.

7.4.5 Option 50

The southern section follows the route of Edenaveys Road for a short length and then deviates north-west. The route then runs through agricultural grazing land for

the majority of the route. The field boundaries are made up of hedgerows and mature tree standards acting as wildlife corridors. The northern junction cuts through the end of a disused railway line of grassland and gorse scrub and affect the verge vegetation of the A3, predominantly woodland and grassland. A number of protected species are associated with these habitats.

No information is held on recent records of protected species along the route corridors.

7.4.6 Potential Environmental Impacts

All the routes are likely to have a negative impact on habitats and protected species along their alignment through the loss, disturbance, severance and degradation of habitats. The routes would impact upon a number of habits, including areas of woodland, mature hedgerows, mature trees, watercourses, grassland and scrubland, and all these habitats have the potential to be utilised by protected species. This high level assessment cannot recommend a route based on ecological feature as with the limited information available, all routes have the potential to negatively impact the ecology of the area. It is therefore recommended that a detailed Phase 1 Habitat Survey is undertaken within the study area including the purchase of local species records. This can be used to scope out impacts of routes on specific protected species and further facilitate the option selection process.

None of the proposed options are likely to impact on any statutory designated sites for nature conservation as there are no sites within proximity to the study area.

7.4.7 Landscape and Visual Effects

7.4.7.1 Landscape

Armagh is a cathedral city with a distinctive landscape setting and prominent landmarks. The city centre has a strong historic core added to by impressive Georgian buildings that surround the Mall and are scattered throughout the city, with the two distinctive hill top cathedrals of the main religions dominating the skyline. Due to the long history of human development, the area is rich in archaeological remains exhibited best by the Neolithic tomb at Navan Fort to the west of the city centre. The city has a drumlin setting with key landmark buildings perched on hilltops

visible from the many radial approach routes to the city. To the south of the city, drumlins rise to form relatively pronounced hills. Wooded estates are found to the south and east while the tree lined Mall with its open lawns is one of the most significant city centre open spaces in Ireland.

The proposed route options are located to the east of Armagh set within the predominantly settled rural landscape surrounding the city. The landscape character area is the Drumlin Agricultural Landscape.

7.4.7.2 Drumlin Agricultural Landscape

The landscape around the developed Armagh City consists of a drumlin agricultural landscape that is predominantly pastoral in use. The drumlins are orientated north to south and cover an extensive area. The drumlins located to the south rise to form high hills that offer views across the Armagh drumlin landscape and views to the city's landmark buildings. Numerous small rivers and streams cross the area and most drain into the River Callan. In wetter locations, small lakes and bogs occupy the hollows between drumlins. Improved pastures that are subdivided by well-maintained hedgerows and tree belts dominate the agricultural landscape in the area. The hollows between the drumlins provide a sense of enclosure for the landscape and prevent long distance views from within this landscape. Scattered housing and farms are found throughout this landscape on the urban/rural fringe. The Drumlin Agricultural Landscape is well-maintained and important to the appreciation of Armagh from the strategic approaches to the city.

7.4.7.3 Townscape

The distinctiveness of the townscapes in the study area can be sub-divided into four townscape character areas with broadly homogenous features as follows:-

- Portadown Road Residential townscape;
- Newry Road Residential townscape;
- Industrial townscape; and,
- Historic City Centre townscape.

7.4.7.4 Portadown Road Residential Townscape

In modern times residential housing has spread beyond the historic city centre along the A3 Portadown Road. The old railway line has been used as new outer limit to

this latest wave of development. The A3 is the key strategic approach to Armagh from the north. House types vary in style with brick and rendered properties present in broadly equal numbers. Houses are consistent in plot size with two storey detached properties in large gardens. The character of the houses is not related at all to the distinctive buildings of the city centre. North of the A3 the housing is located on lower lying but gently undulating lands. To the south of the A3, housing is located across higher drumlins permitting long distance views from the houses across Armagh City Centre to the west. Vegetation has largely been removed during construction of the houses and replaced by garden vegetation that is inconsistent in quality and quantity. More mature trees are found in gardens of older houses immediately east of the A3 roundabout. This townscape contains many common landscape features and can be classified as an “Ordinary” townscape.

7.4.7.5 Newry Road Residential Townscape

The location of the Palace Demesne and the Folly Glen on the southern side of Armagh has created a restriction for development along the A28 Markethill Road. Land is not so readily available and therefore plot sizes for housing are correspondingly smaller than plot sizes to the north. House types are predominantly rendered single storey but larger individually designed houses are located west of the A28 and overlook the Palace Demesne. Direct linkages are available from this landscape to the Folly Glen footpath system. Open space is extremely restricted. The A28 is the main strategic approach to the city from the south. Occasional commercial premises such as garages are located on the A28 frontage. This townscape contains many common townscape features and can be classified as an “Ordinary” townscape.

7.4.7.6 Industrial Townscape

Mixed industrial and commercial premises lie to the north and south of the A51 Hamiltonsbawn Road. The appearance of the premises is generally poor and detracting from the adjacent agricultural landscape and residential townscape. Buildings are predominantly steel-framed structures with external cladding of various colours. The main Armagh military barracks has been included within this landscape as it consists of buildings of a similar scale and appearance to the mixed industrial areas. Trees are generally absent from this townscape.

7.4.7.7 Historic City Centre Townscape

Armagh City has a rich heritage. The city was historically developed as a hilltop settlement and enjoys one of the most distinctive urban settings in Ireland. The city townscape is characterised by a concentric street pattern around St Patrick's Cathedral and radial streets that emanate from it. Market Square lies at the core and was traditionally used for fairs and markets. The buildings predominantly date from the 18th Century and streets in the centre are narrow. The buildings found in the city are stone built from Armagh limestone. To the east of the city centre more extensive Georgian buildings are found best exhibited around the Mall where many listed buildings are found within the Armagh Conservation Area. The appearance of the centre is detracted by clutter due to high levels of through traffic and parked cars particularly around the Mall. There are many key landmark buildings throughout this area including the observatory, cathedrals, churches and monuments, Armagh Gaol, Armagh Court House and the Mall. The setting of all such landmarks is important.

7.4.7.8 2007 Preferred Route

Landscape/Townscape

The route is proposed within the existing urban fringe to the east of Armagh. The route runs through the Newry Road Residential townscape along an existing section of road, skirting the urban edge within the Drumlin Agricultural Landscape through the Industrial Townscape and briefly along the edge of the Folly River Valley Landscape before it terminates at Portadown Road. The entire route would be lit. The proposed route would be set in the urban fringe in an area that is built up and lit including local roads, residential housing and industrial/commercial properties.

This route option utilises existing sections of road and requires comparatively less earthworks than the other options and would result in the least amount of modification to the existing landform. Furthermore loss of established vegetation would be limited to the tie in with Portadown Road and some field boundary vegetation.

Given the proximity of this route to the urban edge of Armagh there is a higher tolerance within this urban fringe landscape to accommodate this type of proposed scheme into the existing landscape/townscape character.

Visual

This route alignment would be visible in nearby views to residential receptors and commercial properties along the east of Armagh including Portadown and Newry Road residential areas. The road infrastructure is broadly fitting within the existing urban and urban fringe views and the change in view would be less pronounced than that of the other options, and impacts are likely to be minor.

7.4.7.9 Option 12

Landscape/Townscape

The route runs through the drumlin fields of the Drumlin Agricultural Landscape along its length and runs adjacent to the Portadown Road residential area as it connects to the A3. The route has been designed to follow the natural contours of the landscape, however there would be some modifications to the natural drumlin forms, particularly where the road is on embankment. The proposed junction at A51 Hamiltonsbawn Road would be a notable large feature in the landscape and would be lit to meet road standards which would introduce an urbanising element within the rural setting. The route also runs through an established landscape of mature hedgerows and would result in the loss of a mature stand of trees around the tie into Portadown Road.

The route is likely to have an adverse impact on the rural drumlin landscape character due to the proposed lit junction and the modifications to the drumlin landform.

Visual

The drumlin landscape serves to minimise views of the road for the more distant receptors to the west, however throughout the route there are intermittent residential areas and isolated properties that would have views of the new road. In addition the northern extent of the scheme lies in close proximity to the Portadown Road residential area that would have a view of the road. The junction at A51 Hamiltonsbawn Road is a large intrusive feature that would be lit which would have a negative impact on views. Properties on high ground, for example A51 Hamiltonsbawn Road would have extensive views of the route.

Given the rural quality of the landscape in existing views the road is likely to result in a higher degree of visual intrusion due to the views of traffic and the resulting urbanising of the landscape.

7.4.7.10 Option 16

Landscape/Townscape

The route starts in low lying land of the drumlin fields of the Drumlin Agricultural Landscape and the runs north east along the edge of the Newry Road area. The route merges with the alignment for the 2007 Preferred Route and runs through the industrial areas and Portadown Road residential landscapes on the urban fringe of Armagh.

The proposed route is already predominantly in an area that is built up, lit and includes local roads, residential areas and industrial/commercial properties. Given the urban fringe nature of the landscape along the northern half of this option there would be a higher tolerance to accommodate this type of proposed scheme. However this alignment would introduce some significant modifications to the drumlin landform to the east of the Newry Road area where the road would be set on large embankment and deep cutting as it cuts across the grain of the drumlin field. This route option would result in the loss of some mature hedgerow trees before it follows the urban edge.

Visual

The southern extent of the route runs through predominantly agricultural land with views from the surrounding intermittent properties and the urban edge of the Newry Road area. The section over Ballynahonemore Road is raised on large embankment which could lead to a higher degree of visual intrusion to nearby receptors. The northern section of the route would be more in keeping with urban edge landscape as for the preferred 2007 route.

7.4.7.11 Option 50

Landscape/Townscape

The route runs through the drumlin fields of the Drumlin Agricultural Landscape along its length and connects to the A3 to the east of the Portadown Road residential

area. The route has been designed to follow the natural contours of the landscape but would still result in some modifications to the drumlin landforms. Furthermore the junction proposed at A51 Hamiltonsbawn Road would be a notable larger feature in the landscape and would be lit to meet road standards, which would introduce an urbanising element within the rural setting. To the south of A51 Hamiltonsbawn Road the route is situated at a higher elevation than Option 12 and would be visible at a greater distance and potentially have a greater influence on the perception of the rolling landscape. The route runs through an established landscape of mature hedgerows and mature standard trees.

The route is likely to have an adverse impact on the rural drumlin landscape character due to the proposed lit junction and the linear nature of the road within the rolling landscape and the frequent modifications to the landform.

Visual

The drumlin landscape serves to minimise views of the road for the more distant receptors to the west for much of the length, though throughout the route there are intermittent residential areas and isolated properties that would have views of the new road. In addition the northern extent of the scheme lies in close proximity to the Portadown residential area that would potentially have a view of the road as it runs to the east of these properties. Properties on high ground, such as those along the A51 Hamiltonsbawn Road would have extensive views of the route through the rural landscape, while the junction at A51 Hamiltonsbawn Road would be a large lit feature that would be a prominent and intrusive new element in the rural views.

Given the rural quality of the landscape in existing views the road is likely to result in a higher degree of visual intrusion due to the views of traffic and the resulting urbanising of the landscape. Furthermore the section of the alignment at higher elevations would be visible from further afield, potentially from the city core to the west.

7.5 Cultural Heritage

7.5.1 Baseline Conditions

2007 Preferred Route

There are three listed buildings, an industrial heritage feature and an archaeology area identified within 300m of the proposed route from interrogation of the Northern Ireland Environment Agency online map. The listed buildings are:-

- HB 15/17/059: Sunnymeade, Portadown (House: B Listing);
- HB 15/17/047: Avon Lodge, Dean's Bridge, Portadown Road (House: B Listing); and,
- HB 15/15/001: Woodford House, Newry Road (House, Gate Piers, Bridge and Garden Features: B1 Listing).

Option 12

There is a single listed building and three archaeology sites within 300m of the proposed route from interrogation of the Northern Ireland Environment Agency online map. The listed building (HB15/17/063: Little Castle Dillon, Portadown Road. (House: B Listing) is located within 60m of the proposed works.

Option 16

There are two listed buildings, an industrial heritage feature and two archaeology areas identified within 300m of the proposed route from interrogation of the Northern Ireland Environment Agency online map. The listed buildings are:-

- HB 15/17/059: Sunnymeade, Portadown (House: B Listing); and,
- HB 15/17/047: Avon Lodge, Dean's Bridge and Portadown Road (House: B Listing).

Option 50

There are no listed buildings, three industrial heritage features and two archaeology areas identified within 300m of the proposed route from interrogation of the Northern Ireland Environment Agency online map. The historic feature 'Bridge Road under the Railway' is located within 10m of the proposed route.

It should also be noted that there are no Conservation Areas or Areas of Historic Townscape Character located on or adjacent to the proposed options (Armagh Area Plan 2004).

7.5.2 Potential Environmental Impacts

The introduction of a new road could impact on the setting of built heritage assets within 300m of the proposed routes. These include listed buildings and industrial heritage features. There are heritage features within 300m of all four routes.

The four routes avoid the known archaeological sites identified above, though run within 300m. All four routes have the potential risk of disturbing unidentified archaeological remains, particularly in areas that have not previously been developed.

7.6 Effects on All Travellers

The Ulster Way long distance footpath and National Cycle Route 91 are within the study area and run along Ardmore Road and east along Ballynahonemore Road. The Ulster Way is a link section at this location where the use of public transport is promoted.

The 2007 Preferred Route overlays the line of these routes along Ardmore Road. Options 12, 16 & 50 crosses these walking/cycling routes along Ballynahonemore Road via an overbridge. All routes include pedestrian footways/cycle facilities to allow for the continuation of the route.

No local roads would be severed as a result of the proposed route alignments (A51 Hamiltonsbawn Road would be slightly realigned).

The 2007 Proposed Route would increase traffic flowing through the Newry Road residential area along Ardmore Road. There are community facilities to the east of the alignment that are utilised by residents to the west. Local residents raised concerns about safety and access at the public exhibition held in June 2014. The route speed has been reduced to 30mph from 40mph. This option would need to ensure that the scheme does not result in severance to the local community.

8 Social Assessment

8.1 Introduction

Social impacts cover the human experience of the transport system and its impact on social factors, not considered as part of economic or environmental impacts. Each social impact is required to be assessed as part of the appraisal. The social impacts are:

- Commuting and Other Users;
- Reliability Impact on Commuting and Other Users;
- Physical Activity;
- Journey Quality;
- Collisions;
- Security;
- Access to Services;
- Affordability;
- Severance; and,
- Option and Non-Use Values.

8.2 Commuting and Other Users

For each of the four proposed options, the East Link scheme would have the potential to provide benefits in terms of money and time costs in relation to the trips in which personal users in both rural and urban areas make. These benefits would include:-

- Reduction in travel time;
- Increased average speeds;
- Reduction in vehicle operating costs;
- Collision reduction;
- Casualty reduction; and,
- Collision benefits;

8.3 Reliability Impact on Commuting and Other Users

Each of the proposed options would also have the potential to provide benefits to business users and transport providers in terms of reliability of journeys. In

comparison to existing conditions the proposed options would relieve congestion for the City Centre in providing increased average speeds and reduction in travel time to improve the reliability for personal users.

8.4 Physical Activity

As stated in Section 5 (engineering assessment) there would be dedicated cycleway and footways throughout the entire length of each of the four proposed options. The urban options (2007 Preferred Option and Option 16) would have separate footway and cycleway of 1.75m and 1.3m wide respectively. The more rural options (Option 12 and Option 50) would have a combined footway/cycleway of 4m in width over the entire length. Provision of NMU facilities provides enhanced opportunities for residences of the area to avail of walking and/or cycling routes.

8.5 Journey Quality

Journey quality will increase along each of the options in comparison to existing conditions. Driver stress should be lower in comparison to existing conditions as new road furniture and layouts will be designed to meet the latest standards. Congestion will be lower and journey times reduced further reducing the stress of the driver.

8.6 Collisions

8.6.1 Collision Savings

Table 8.1 below presents the collision savings resulting from the introduction of the proposed options (measured in persons involved in collisions)

Option	Year	Collisions											
		Do-Minimum (Existing)				Do-Something (Proposed)				Collision Savings			
		Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total
2007 PO	2020	0	4	35	39	0	4	35	39	0	0	1	1
	2035	0	4	40	45	0	4	40	44	0	0	1	1
	60 years	16	249	2367	2632	15	245	2335	2595	1	4	32	37
50	2020	0	4	35	39	0	4	35	39	0	0	1	1
	2035	0	4	40	45	0	4	40	44	0	0	1	1
	60 years	16	249	2367	2632	16	247	2331	2594	0	3	35	38
16	2020	0	4	35	39	0	4	35	39	0	0	0	0
	2035	0	4	40	45	0	4	40	44	0	0	0	0
	60 years	16	249	2367	2632	16	247	2350	2613	0	2	16	19
12	2020	0	4	35	39	0	4	35	39	0	0	0	0
	2035	0	4	40	45	0	4	40	45	0	0	0	0
	60 years	16	249	2367	2632	16	248	2359	2623	0	1	8	9

Table 8-1 – Scheme Options – Collision Savings

8.6.2 Casualty Savings

Table 8.2 presents the casualty savings (measured by the number of persons).

Option	Year	Casualties											
		Do-Minimum (Existing)				Do-Something (Proposed)				Casualty Savings			
		Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total
2007 PO	2020	0	4	50	54	0	4	49	53	0	0	1	1
	2035	0	4	57	61	0	4	56	60	0	0	1	1
	60 years	15	249	3335	3600	15	244	3279	3538	0	5	57	62
50	2020	0	4	50	54	0	4	49	53	0	0	1	1
	2035	0	4	57	61	0	4	56	60	0	0	1	1
	60 years	15	249	3335	3600	16	250	3287	3553	-1	-1	48	46
16	2020	0	4	50	54	0	4	49	53	0	0	0	0
	2035	0	4	57	61	0	4	56	61	0	0	0	0
	60 years	15	249	3335	3600	15	247	3309	3571	0	2	26	29
12	2020	0	4	50	54	0	4	49	53	0	0	0	0
	2035	0	4	57	61	0	4	56	61	0	0	0	0
	60 years	15	249	3335	3600	15	249	3325	3589	0	1	10	11

Table 8-2 – Scheme Options – Casualty Savings

Table 8.3 below presents the collision savings resulting from the introduction of the proposed options (measured in persons involved in collisions) assuming the North-West Link was already in place.

Option	Year	Collisions											
		Do-Minimum (Existing)				Do-Something (Proposed)				Collision Savings			
		Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total
2007 PO + NWL	2020	0	4	35	40	0	4	35	39	0	0	0	0
	2035	0	4	41	45	0	4	40	45	0	0	0	0
	60 years	16	253	2401	2670	16	250	2377	2643	1	3	23	27
50 + NWL	2020	0	4	35	40	0	4	35	39	0	0	1	1
	2035	0	4	41	45	0	4	40	44	0	0	1	1
	60 years	16	253	2401	2670	17	247	2330	2594	0	6	71	76
16 +NWL	2020	0	4	35	40	0	4	35	40	0	0	0	0
	2035	0	4	41	45	0	4	41	45	0	0	0	0
	60 years	16	253	2401	2670	16	252	2393	2661	0	1	8	9
12 +NWL	2020	0	4	35	40	0	4	35	39	0	0	0	0
	2035	0	4	41	45	0	4	41	45	0	0	0	0
	60 years	16	253	2401	2670	16	251	2395	2661	1	2	6	9

Table 8-3 Scheme Options – Collision Savings – East Link + North-West Link

Table 8.4 below presents the corresponding casualty savings (measured by the number of persons).

Option	Year	Casualties											
		Do-Minimum (Existing)				Do-Something (Proposed)				Casualty Savings			
		Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total	Fatal	Serious	Slight	Total
2007 PO + NWL	2020	0	4	50	54	0	4	50	54	0	0	1	1
	2035	0	4	57	62	0	4	57	61	0	0	1	1
	60 years	15	253	3386	3655	15	249	3343	3607	0	4	43	48
50 + NWL	2020	0	4	50	54	0	4	49	53	0	0	1	1
	2035	0	4	57	62	0	4	56	60	0	0	2	2
	60 years	15	253	3386	3655	16	251	3290	3557	-1	2	96	97
16 +NWL	2020	0	4	50	54	0	4	50	54	0	0	0	0
	2035	0	4	57	62	0	4	57	62	0	0	0	0
	60 years	15	253	3386	3655	15	253	3376	3644	0	1	10	11
12 +NWL	2020	0	4	50	54	0	4	50	54	0	0	0	0
	2035	0	4	57	62	0	4	57	62	0	0	0	0
	60 years	15	253	3386	3655	15	251	3363	3628	0	3	23	26

Table 8-4 Scheme Options – Casualty Savings – East Link + North-West Link

8.6.3 Collision Reduction

The *Sub-Regional Transport Plan (SRTP) 2015* sets out information on mitigation on collision remedial schemes. Most road traffic collisions resulting in deaths or serious injuries are avoidable. The main causes for this are, excessive speeds (inappropriate for the conditions or in excess of speed limit), alcohol and drug consumption (both driver/rider and pedestrian) and failure to wear a seat belt. Continued success in reducing the numbers killed or seriously injured would depend on the combined effects of education, enforcement and engineering.

DRD is committed to ensuring that the public road network is developed and maintained to improve road safety. Transport NI has prepared a Road Safety Plan, which sets out the Agency's intent to make a contribution to the Northern Ireland Road Safety Strategy. The Plan proposes a number of 'Actions' aimed at refining and improving Transport NI contribution to improving safety on our roads.

The inclusion of speed restrictions, road markings, traffic signage and street lighting along the proposed Armagh East Link would support collision reduction for both vehicles and NMU's.

8.7 Security

Security is concerned with the personal security of travellers and their property. The main area of concern regarding security and crime issues is at public transport interchanges and at services areas or car parks.

For the 2007 Preferred Option and Option 16 the inclusion of lighting along the proposed East Link would improve security for those vehicles forced to stop (including at junctions) and for NMU's using the facilities for each. For Option 12 and Option 50 Street lighting would be at Junctions only because of its rural location, in turn still providing security for those vehicles negotiating junctions.

8.8 Access to Services

Access to services assesses the availability of viable transport for the local population. According to the 2001 census 18% of households in Armagh (compared to a 26.32% in Northern Ireland) do not have access to a car or van, therefore are likely to be reliant on the public transport network. However, only 2% of the total persons employed (106 people out of 5321) use public transport (buses in this case due to the lack of rail facilities in Armagh) to travel to work. Updated figures in the 2011 Census was given for Northern Ireland but not for the local Armagh Area. *Table 8.1* below presents the Census information gathered.

Data	Armagh	Northern Ireland
2001 Census	18% (3,328)	26.32% (164,949)
2011 Census	None Given	22.7% (159,643)

Table 8-5 – Census Information - No Access to Car or Van in the Household

Comparing the 2001 Census information to the 2011 Census information in *Table 8.1* above, it can be seen that there has been a decrease in the amount of people who do not have access to a car or van in Northern Ireland, unfortunately, due to the

lack of information locally in the 2011 Census, it is unclear whether there has been an increase or decrease in relation to the Armagh Area.

The choice of junction type in further detail design would not significantly alter the population's access to the transport system. NMU facilities along the proposed link would have a positive benefit for access to services from north to south of the outer Armagh areas for local residents without access to a private vehicle. Motorists travelling from along the eastern fringes of the city to avail of services in the north or south of the city would benefit from improved connectivity via the link.

8.9 Affordability

Funding for the scheme would be provided by the Department for Regional Development.

8.10 Severance

Severance is concerned with non-motorised modes of transport and whether the scheme benefits or hinders their movement. Whilst the consideration of impacts does include cyclists and equestrians, the actual classification assesses only pedestrian severance, as pedestrians are considered to be most affected by severance issues.

Comparing existing severance to that following the construction of the Armagh East Link shows that the scheme would have beneficial impact on severance.

Currently limited pedestrian links are in place between the Ardmore Estate and A51 Hamiltonsbawn Road and no links exist up to the Linsey's Hill area along the route. For options 12, 16 and 50 the proposed alignments do sever sections of agricultural land. The 2007 Preferred Option does sever the west side of Ardmore Road from the east side and its facilities (Cemetery, play parks and football pitches), consequently impacting the community in a negative manner at the southern end of the scheme.

For the 2007 Preferred Option and Option 16, non-motorised Users (NMU's) would benefit with links from the North (A3) to the South (A28), this would improve access to the Saints and Scholars Primary School, Tower Hill Hospital, Drelincourt School, Ardmore Recreation Centre, Appleby Social Education Centre, Ballynahone Cemetery, a Library and a number of churches and nursing/residential homes.

It is important to assess the route in terms of its amenity (defined as the relative pleasantness of a journey) as well as quantity and frequency of use. Provision of a 1.75m footway and 1.3m cycleway on both sides of the carriageway or a 4m combined footway/cycleway with a 0.5m separation from the carriageway would ensure a high level of amenity for road users wishing to avail of this new facility.

8.11 Option and Non-Use Values

Option values relate to changes in public transport service within the study area and the impact on the community. Even if an individual does not regularly use a public transport service there may still be some value in having the option.

As described in Section 3 of this report, there is no rail service to Armagh but there is a network of cross-country bus routes linking Armagh to most major towns and cities in Northern Ireland provided by Translink. The network also provides cross border services to the Republic of Ireland (ROI). Within the city itself, there are a number of local bus services serving the Ardmore Estate via A51 Hamiltonsbawn Road and Ballynahonemore Road. The proposed options for consideration for the Armagh East Link would not have any adverse effects to any existing public transport service presently running in and around Armagh.

9 Public Accounts

9.1 Cost to Broad Transport Budget

9.1.1 Economic Performance

Following the production of the traffic forecasts, an assessment of the economic benefit of each scheme option, was undertaken as part of the overall appraisal leading to the selection of a preferred option.

A full cost benefit assessment was required to allow the comparison of the value for money provided by each of the proposed route options. The chosen tool for this part of the project was TUBA (Transport User Benefit Appraisal), a computer program developed for the Department for Transport (DfT) to undertake the appraisal of highway schemes and multi-modal transport studies.

The collision benefits were assessed using a spreadsheet tool which utilises the same principles as DfT's COBA software. Subsequently the benefits were compared against the scheme's cost to obtain a Benefit to Cost Ratio (BCR) for each of the proposed options.

TUBA undertakes a matrix-based appraisal using as inputs trip, time and distance, and cost matrices. Costs associated with the Do-Minimum and Do-Something schemes are also used as input to the program. Using these inputs TUBA calculates the user benefits in time, fuel vehicle operating costs (VOC), non-fuel VOC and charge; operator and government revenues; and scheme costs. Costs and benefits arising in different years are expressed in terms of their value from the standpoint of a given year known as present value year. Summing the present values of costs and subtracting these from the present value of benefits gives the 'net present value' of the scheme.

TUBA Version 1.9.4 was used to perform the economic analysis, which has 2010 as the base year for economic parameters. This means that value of time, value of fuel, etc. are defined in 2010 prices. The scheme costs that were used as input into the TUBA program are defined for the following four categories:

- Construction costs (including Risk and Optimism Bias);
- Land costs (Optimism Bias is not added to land costs);

- Preparation costs; and,
- Supervision costs.

Table 9.1 below details the BCRs for the options assessed. These values are taken from the Analysis of Monetised Costs and Benefits Worksheet that summarise the TUBA. The higher the ratio the higher the financial benefits of the scheme in relation to the cost.

Analysis of Monetised Costs and Benefits	2007 PO	Option 16	Option 12	Option 50
Greenhouse Gases	276	210	302	22
Economic Efficiency: Consumer Users (Commuting)	22999	21079	28555	12026
Wider Public Finances (Indirect Taxation Revenues)	-681	-504	-742	-40
Present Value of Benefits (PVB)	22594	20785	28115	12008
Broad Transport Budget	11385	17035	17119	21336
Present Value of Costs (PVC)	11385	17035	17119	21336
OVERALL IMPACTS				
Net Present Value (NPV)	11209	3750	10996	-9328
Benefit to Cost Ratio (BCR)	1.985	1.22	1.642	0.563
Collision Benefits	2025	962	391	377
BCR (including collision benefits)	2.162	1.277	1.665	0.580

Table 9-1 – Economic Assessment Summary without North-West Link

Table 9.1 shows the BCRs which are a reflection of the monetised costs and benefits associated with a highway scheme and the PVB typically includes collision benefits. For schemes where it may be relevant for decision makers to understand the relative Economic Efficiency (time savings and operating cost savings, i.e. excluding collision benefits), the BCR is also presented with and without collision benefits included. A BCR greater than 1 indicates a positive return on investment as the value of benefits gained exceeds the original investment and operating costs; a BCR equal to 1 indicates that the total cost of investment is equivalent to the benefits that are estimated to accrue; and, a BCR less than 1 indicates that the benefit savings that accrue are estimated to be less than the total investment, and the scheme may therefore not be value for money.

The results show that the former 2007 Preferred Option has the highest Benefit to Cost Ratio, with a BCR of the order of 2 demonstrating value for money, with or

without the inclusion of collision benefits. Option 50 provides the least value for money, with a poor return on investment as indicated by the BCR values of less than 0.6, with or without the inclusion of collision benefits.

A sensitivity test was undertaken to consider a situation where the East Link and the proposed North-West Link would both be operational, the North-West Link being considered to be opened prior to the East Link. If the North-West Link were to be constructed in advance of the East Link some benefits that the East Link would otherwise have generated would already have been realised prior to the East Link becoming operational. For example, prior to the opening of the East Link, a proportion of traffic in the city centre would already have been redistributed onto the North-West Link, resulting in lower flows through the city centre. In turn this would mean that the subsequent opening of the East Link would deliver a lower reduction in trips in the town centre, and hence delay, compared to a scenario where only the East Link is operational. Likewise, if the North-West Link was constructed first, the collision benefits arising from the subsequent introduction of the East Link would be decreased due to the prior reduction in traffic levels travelling through the city centre.

Notwithstanding, the addition of the East Link after the opening of the North-West Link, would further reduce the traffic levels and delay within the city centre. Table 9.2 below presents the BCR for the proposed options under the assumption that the North-West Link would be in place by 2020. It can be observed the introduction of the North-West Link, as expected, would result in a reduced BCR across all the options. However, the 2007 Preferred Option retains a BCR greater than 1, demonstrating that it would continue to provide value for money in a situation where both the East Link and the North-West Link were both operational.

Analysis of Monetised Costs and Benefits	2007 PO	Option 16	Option 12	Option 50
Greenhouse Gases	166	133	56	22
Economic Efficiency: Consumer Users (Commuting)	12408	13334	9808	9041
Wider Public Finances (Indirect Taxation Revenues)	-420	-326	-148	-67
Present Value of Benefits (PVB)	12154	13141	9716	8996
Broad Transport Budget	11385	17035	17119	21336
Present Value of Costs (PVC)	11385	17035	17119	21336
OVERALL IMPACTS				
Net Present Value (NPV)	769	-3894	-7403	-12340
Benefit to Cost Ratio (BCR)	1.068	0.771	0.568	0.422
Collision Benefits	1521	363	760	1900
BCR (including collision benefits)	1.245	0.828	0.590	0.439

Table 9-2 – Economic Assessment Summary with North-West Link

With the addition of the North-West Link the collision benefits are increased due to in Options 12 and 50. The options closer to the City (Option 16 and the 2007 Preferred Option) have higher collision benefits without the North-West Link. The introduction of the East Link on its own would have a greater impact on reducing traffic levels within the City Centre, where the majority of the collisions occur, compared to a scenario with the North-West Link already in place.

9.2 Indirect Tax Revenues

As it can be seen in *Table 9.1* and *Table 9.2* above, that the initial Forecast results indicatively show that drivers would consume less fuel and thus pay less fuel tax to the government (Wider Public Finances).

10 Summary of Findings

10.1 Introduction

This section presents the summary and conclusions of each of the WebTAG assessment criteria which are detailed in Sections 4 to 9. A summary of findings and conclusions are drawn for each of the headings below:-

- Engineering Assessment;
- Economic Assessment;
- Environmental Assessment;
- Social Assessment; and,
- Public Accounts.

10.2 Assessment Scoring Matrix

In comparing the options, a mathematical ranking approach has been adopted for the 7 point scale of impacts. Zero (0) has been awarded for appraisal conclusions of neutral, an “x” mark (negative) for the adverse scale of impacts and a “✓” symbol (positive) has been used for beneficial impacts. *Table 10.1* provides an outline of the scoring system.

This provides a qualitative appraisal on the potential impacts of the routes given the information available. The reason for any potential impacts are outlined in the relevant chapters above and with further survey/investigation more certainty can be designated on each score.

Table 10.1 – Assessment Scoring Matrix

Appraisal Scale	Appraisal Score
Large Beneficial	✓✓✓
Moderate Beneficial	✓✓
Slight Beneficial	✓
Neutral	0
Slight Adverse	x
Moderate Adverse	xx
Large Adverse	xxx

For each of the assessments areas an overall ranking score has been produced by taking the beneficial impacts and taking away the adverse impacts therefore giving a quantitative means of assessment as a + or – value.

It is worth noting that the above matrix represents a mathematical ranking of the option against the sub-impacts of each of the main assessment criteria. The ranking does not value/weigh performance OF one topic area against another. If possible, the value systems/views of the key stakeholders or objectives of existing environmental conservation plans, if known, should be recognised in a final ranking of the options against the Environment topic areas. This can be done by ranking the topics to reflect the value system of the key stakeholders and inputting this into a matrix / ranking scheme.

10.3 Engineering Assessment

The Engineering Assessment of the options described each preliminary design in detail and noted significant features and concerns. The options were appraised with due consideration given to the design and cost of each option, their safety in use and impact on the local community. Additionally, the topography, geology, drainage and land uses within the surrounding area were taken into account to assess which option was best suited to the area. *Table 10.2* below sets out the scoring matrix for the engineering option performances.

Table 10.2 – Engineering Option Performances

Topic Area	Route Options			
	2007 Preferred Option	Option 12	Option 16	Option 50
Street Lighting	0	0	0	0
Footway / Cycleway	0	0	0	0
Junction Type	0	0	0	0
Speed Restrictions	0	0	0	0
Departures from Standard	✓	✓	✓	x
Relaxations From Standard	x	x	x	x
Major Structures	xx	x	xxx	x
Roads Stopped Up	✓	x	✓	x
Landtake	x	xxx	xx	xxx
Properties Affected	0	0	0	xxx
Overtaking	✓	✓	✓	✓
Earthworks	x	x	x	x
Geotechnical	0	0	0	0
Drainage	✓	x	✓	x
Build-ability	x	✓	x	✓
Overall Engineering Ranking	-2	-5	-4	-10

From *Table 10.2* above and in the assessment of the proposed route options, aspects such as street lighting, footway widths, cycleway widths, combined footway/cycleway widths and junction type are in accordance with industry standards

(DMRB) and would have no real advantage or disadvantage when comparing one option over another, therefore, these can be class as a 'neutral'.

The speed restrictions on the roads are relative to the environment in which they are situated in and also the design speed of the road itself. Options in a rural environment are classed as 60mph. As the options progress towards the city centre/residential areas the speed limits decrease to 30/40mph for rural/urban and 30mph for urban areas. These comparisons were classed as 'Neutral' across all options.

Potential departures required are a combination of relaxations in horizontal and vertical geometry and are minimal in terms of the quantity. Departures and Relaxations for the proposed options are classed as "Slightly Adverse". This is due to elements such as section through existing geometry such as the newly constructed Edenaveys Road at the industrial estate.

Major Structures such as over/under bridges and culverts have an impact on the environment, construction costs and construction time. The greater the number of major structures the greater adverse effect on the scheme and the surrounding environment. Option 12 and Option 50 have been classed as "Slight Adverse" as they require only have 1 major structure. The 2007 Preferred Option could be classed as "Moderate Adverse" as 2 major structures are required. Option 16 has 3 major structures therefore "Large Adverse" is a suitable classification compared to the other options.

Roads required to be stopped up can adversely affect residents in both construction and operational periods. Option 12 and Option 50 have two roads required to be stopped up, therefore, the effects of this on the scheme could be classed as "Slight Adverse". However the 2007 Preferred Option and Option 16 require no roads to be stopped up and therefore can be classed as "Slight Beneficial" as there is less disruption to the local residents of Armagh City.

All of the options with regards to landtake adversely affect the environment and the local community although the severity differs for each option. The highest landtake figures are that of Options 12 and 50 at approximately 23 and 29 hectares respectively. As these routes are in a rural environment and passing through north to south rolling drumlins throughout the length, these have been classed as "Large

Adverse” due to the large amount of land required. Option 16 is a mix between rural and urban areas, which requires approximately 14 hectares of land. Therefore this option has been classed as “Moderate Adverse”. The 2007 Preferred Option, at 11 hectares, is the lowest of all four option in respect to landtake. With that in mind, TransportNI already own 90% of the land required and “Slight Adverse” would be a suitable classification.

Properties affected was scored by looking at the number or potentially properties to be demolished. A property requiring to be demolished would cause an adverse effect to the value of any option. Option 50 has one property potentially required to be demolished: this would be classed as “Large Adverse”. All of the reaming options could come under the classification of “Slight Adverse” as these options do not require any properties to be demolished.

Overtaking opportunities in rural settings are beneficial for road users. They help alleviate traffic congestion and queues along all road networks. Option 12 and Option 50 are classed as “Slight Beneficial” due to their ability to provide overtaking sections northbound and southbound on the proposed mainline alignment. Overtaking should not be encouraged through design within urban areas, to increase road safety. The 2007 Preferred Option and Option 16, which are predominantly located within urban limits are classed as “Slight Beneficial”. Furthermore, these options do not facilitate overtaking sections.

In relation to earthworks and the shortage or surplus of materials, regardless of the quantity, the impacts at construction stage (from the use of heavy machinery) to the ground and the atmosphere is a dis-benefit to a scheme. Consequently all four options would be classed as “Slight Adverse”.

In regards to the geotechnical aspect of the scheme, the majority of the superficial soils along all four of the proposed options are till. Till presents itself as a relatively good material to construct on. However, because there are no comparable differences in relation to superficial soils, all four options could be classed as “Neutral”. Offering no real advantage or disadvantage to one option over another, the same conclusions can be made for the solid geology of the scheme, being predominately Wacke and Sandstone, so this has been classed as “Neutral”.

In regards to drainage aspects of the proposed options and their assessment, it is preferable in any drainage design to outfall to watercourses whether designated or undesignated. The 2007 Preferred Option and Option 16 have a small number of watercourses available to discharge into, which from a high level review is beneficial to the scheme. These options therefore can be classed as "Slight Beneficial". On the other hand, Options 12 and Options 50 have little to no watercourses available to discharge into, consequently would be classed as "Slight Adverse".

Buildability of the scheme takes into consideration factors such as, but not limited to:-

- Construction Time;
- Ease of Construction;
- Disruption;
- Travel time;
- Noise Pollution; and
- Haulage Routes;

In regard to the 2007 Preferred Option and Option 16 (urban environment) and in relation to the items above, construction time would be greater than that of Options in a rural environment (Option 12 and Option 50). The construction of these routes could potentially be constructed in phases, for both the mainline section, tie-ins to existing junctions and access roads so as not to require road closures (for haulage routes) that could increase delay. In regard to noise pollution the construction would potentially have time restrictions on construction periods so as not to start too early in the morning or finish too late in the evening to reduce disruption to local residents. Consequently the two options could be classed as "Slight Adverse" due to these reasons.

Option 12 and Option 50 lend themselves more favourably to ease of construction and less disruption due to their rural settings. Greater working areas can be used and do not need to be completed in phases. Haulage routes would not be affected as greatly as that of the other two options. As a result Options 12 and 50 have been classed as "Slight Beneficial".

10.4 Economic Assessment

The aim of the Economic Assessment was to ensure that the proposed options considered business users and providers and that the proposed options also consider the wider impacts on Transport Interchange, Land Use and Government Policy. *Table 10.3* below sets out the scoring matrix for the economic option performances.

Table 10.3 – Economic Option Performances

Topic Area	Route Options			
	2007 Preferred Option	Option 12	Option 16	Option 50
Business Users & Transport Providers	✓✓	✓✓	✓✓	✓✓
Reliability Impact on Business Users	✓✓	✓✓	✓✓	✓✓
Regeneration	✓✓	✓✓	✓✓	✓✓
Wider Impacts (Transport Interchange)	0	0	0	0
Wider Impacts (Land Use Policy)	✓✓	✓✓	✓✓	✓✓
Wider Impacts (Government Policy)	✓✓	✓✓	✓✓	✓✓
Overall Environment Ranking	+10	+10	+10	+10

The scheme has the potential to provide significant benefits. Over the 60 year appraisal period, travel time benefits accrue for business users, with savings in vehicle operating costs and collision benefits. Overall, benefit to cost ratios indicate that Options 12, 16 and the 2007 Preferred Route would provide value for money. The East Link may also ease congestion which in turn improves reliability of journeys. Therefore a classification of “Moderate Beneficial” was recorded.

Improvements to the road network would provide congestion relief in the City Centre as well as reduced journey times and increased journey time reliability for road users, this would provide an opportunity to promote regional economic growth. This has the potential to encourage people and business into the City Centre making it

easier to access with the reduction in strategic traffic. This can be classed as “Moderate Beneficial” for each of the proposed options.

In respect to wider impacts of the scheme on economic performance it can be said that the scheme makes no impact on transport interchange therefore the conclusion to this assessment is ‘neutral’.

Regarding the impact on polices, on land use, transportation and other governmental policies, the conclusion is that the scheme is ‘Moderate Beneficial’ for all four proposed options. The scheme contributes to achieving the objectives set out to improve the road network and develop Northern Ireland.

10.5 Environmental Assessment

The aim of the Environmental Assessment was to identify significant impacts associated with the introduction of the scheme and hence inform decision-making. To do this the impacts of each option were assessed with due regard to Land Use, Noise, Air Quality, Landscape, Townscape, Cultural Heritage and Archaeology. *Table 10.4* below sets out the scoring matrix for the environmental option performances.

Table 10.4 – Environmental Option Performances

Topic Area	Route Options			
	2007 Preferred Option	Option 12	Option 16	Option 50
Air Quality	xx	x	xx	x
Noise & Vibration	xxx	x	xxx	x
Ecology	x	x	x	x
Landscape /Townscape	x	xx	xx	xx
Visual Effects	x	xx	x	xx
Cultural Heritage	x	x	x	x
Effects on All Travellers	x	0	0	0
Overall Environment Ranking	-10	-8	-10	-8

In relation to air quality, the new road infrastructure will be introducing a new source of air pollution to the local environment which has the potential to result in adverse impacts on nearby receptors such as residential dwellings. The 2007 Preferred Route and Option 16 introduce the proposed road through or adjacent to the Portadown and Markethill Road residential areas. There are high numbers of receptors within 200m of these routes. Option 12 and Option 50 are set further east away from the main residential areas. These routes still run near to intermittent dwellings along their alignment. There are fewer properties within 200m of these routes. A larger impact can therefore be anticipated for the 2007 Proposed Route and Option 16.

In regards to noise and vibration, the introduction of a new road will introduce a new source of noise and vibration into the environment. As outlined above under air quality, the 2007 Preferred Route and Option 16 run in close proximity to residential areas whilst Options 12 and 50 are in a more rural setting with fewer receptors. As such, a higher level of impact can be anticipated for the 2007 Preferred Route and Option 16 as there are more receptors likely to be impacted. However, it is proposed that these routes will be 30mph, rather than 40mph, which would reduce the potential impacts.

The ecology of the scheme shows that there are no designated site for nature conservation in proximity to the route options. All route options have the potential to result in the loss, fragmentation and degradation of habitats, including areas supporting protected species. An adverse impact of some level can be anticipated for all route options. A phase 1 habitat survey of the routes can be undertaken to scope out species/surveys for the route options and may facilitate the option selection process.

In relation to landscape and townscape it shows that the 2007 Preferred Route and Option 16 are located along the urban fringe in areas that are predominantly characterised by being built up, lit and containing local roads, residential and commercial areas. There is a higher tolerance in the landscape to accommodate the proposed routes. Options 12 and 50 are predominantly rural in a drumlin setting. In addition, for these options, the proposed junction along A51 Hamiltonsbawn Road will be a notable feature in the landscape. These routes would have a greater impact on the landscape, particularly Option 50 which runs at a higher elevation.

The visible effects of the proposed options show that the 2007 Preferred Route and Option16 run along the urban fringe and will be visible in nearby views by adjacent residential areas. The proposed road infrastructure is more in setting with the existing area, therefore the change in views will be less pronounced. For Options 12 and 50, their quality rural setting is likely to result in a higher visual impact as a result of the increasing urbanisation. The drumlin landscape however would serve to screen some long views as the routes follow the existing contours. The section of Option 50 at higher elevations would be visible from further afield, potentially from the city core to the west.

With Cultural Heritage each alignment runs within 300m of built heritage assets and areas of known archaeological importance. The routes have been designed to avoid direct impacts on these assets. All the proposed route options, however, have the potential to impact on the setting of heritage assets or impact upon unknown archaeological remains.

In regards to the effects on travellers it shows that the Ulster Way long distance walking route and National Cycle Route 91 are within the footprint of the route options. All options accommodate these routes and are unlikely to result in an adverse impact. The 2007 Proposed Route will increase traffic flowing through the Markethill Road residential area along Ardmore Road. There are community facilities to the east of the alignment that are utilised by residents to the west. This option has the potential to result in some severance without suitable mitigation for the community.

10.6 Social Assessment

The aim of the Social Assessment was to review and consider commuters and others users and how the scheme would impact areas such as journey quality and reliability, collisions, security and also to review the proposals against the effect on NMU movements within the area in relation to Option Values, severance and access to public services. *Table 10.5* below sets out the scoring matrix for the accessibility option performances.

Table 10.5 – Social Option Performances

Topic Area	Route Options			
	2007 Preferred Option	Option 12	Option 16	Option 50
Commuting and Other Users	✓✓	✓✓	✓✓	✓✓
Reliability Impact on Commuting and Others Users	✓✓	✓✓	✓✓	✓✓
Physical Activity	✓✓	✓	✓✓	✓
Journey Quality	✓✓	✓✓	✓✓	✓✓
Collisions (Collision Savings)	✓	✓	✓	✓
Collisions (Casualty Savings)	✓	✓	✓	x
Collisions (Collision Benefits)	✓	✓	✓	✓
Security	✓✓	✓✓	✓✓	✓✓
Access to Services	✓✓	✓✓	✓✓	✓✓
Affordability	0	0	0	0
Severance	x	✓	✓	✓
Option and Non-Use Values	✓	✓	✓	✓
Overall Social Ranking	+15	+16	+17	+14

With the inclusion of provision for vulnerable road users the scheme would provide increased opportunities for physical activity along the length of each of the four proposed options. The urban options would have separate footways and cycleways and the more rural options would have a combined footway/cycleway. This may encourage the use of non-motorised forms of transport. Therefore a classification of “Moderate Beneficial” has been assigned to the 2007 Preferred Option and Option 16 as these are closer to more residential areas and a classification of “Slightly Beneficial” would be suitable for Option 12 and Option 50 as these are more rural options.

Journey quality would increase along each of the options in comparison to existing conditions. Driver stress should be lower in comparison to existing conditions as new road furniture and layouts would be designed to meet latest standards. Congestion

would be lower and journey times reduced, further reducing the stress of the driver. Therefore a classification of “Moderate Beneficial” has been assigned to all options.

Similarly the results of the economic assessment also suggest that the all options result in a reduction of journey times within the study area and significantly reduce the journey time for vehicles travelling from the A28 Markethill Road to the A3 Portadown Road and vice versa.

The effect of scheme options on traffic flows within the City Centre is manifested in the results of the collision benefit analysis where the reduced traffic flows in the City Centre would result in less collisions in the future when compared to the Do-Minimum scenario. With regard to collision reduction, the inclusion of speed restrictions, road markings, traffic signage and street lighting along the proposed route options would generally support collision reduction for both vehicles and NMUs. Street lighting along proposed routes would also improve security for vehicles and for NMUs using the facilities.

However, while all the options would realise reductions in numbers of collisions that generate collision benefits, results for Option 50 indicate an increase in the number of casualties, which would be contrary to the road safety objective of the scheme.

Reduced congestion in the City centre would improve the efficiency of public transport through Armagh. A suitable classification would be ‘Moderate Beneficial’ for Access to the Transport System for all four proposed options.

With respect to Severance, the standard of the pedestrian and cycle links proposed and the provision of a link from the A28 to the A3, along with input from the NMU survey, would mean the scheme is classed as ‘Slight Beneficial’ for Options 12, 16 and 50, however, for the 2007 Preferred Options the scheme would be classed as “Slight Adverse” due to the severance from key facilities at the Ardmore Road residential area.

The proposed improvements to the road network on the Armagh East Link and the bus route network means that the Options Value conclusion is ‘Slight Beneficial’.

10.7 Public Accounts Assessment

The aim of the Public Accounts Assessment was to outline the overall costs for each Option taking in consideration losses due to increased benefits of the scheme. *Table 10.6* below sets out the scoring matrix for the public accounts option performances.

Table 10.6 – Public Accounts Option Performances

Topic Area	Route Options			
	2007 Preferred Option	Option 12	Option 16	Option 50
Cost to Broad Transport Budget (Economic Performance)	✓✓	✓	✓	x
Indirect Tax Revenues	x	x	x	x
Overall Public Accounts Ranking	+1	0	0	-2

The option that provides the highest return for every pound spent (inclusive of collision benefits) is the 2007 Preferred Option with a BCR of 2.162. This is followed by Option 12 (1.665), Option 16 (1.277) and Option 50 (0.580).

Indirect tax revenues would be negatively impacted through journey times reducing and average speeds increasing means both personal commuters and business users would use less fuel, therefore pay less fuel tax to the government. This would be classed as “Slight Adverse”.

10.8 Overall Scoring Assessment

The overall assessment sets out the overall scores from each of the main assessment headings and gives an overall ranking of the proposed options. *Table 10.7* below sets out the scoring matrix for the overall option performances.

Table 10.7 – Overall Option Performances

Assessment Area	Route Options			
	2007 Preferred Option	Option 12	Option 16	Option 50
Engineering	-3	-6	-5	-10
Economic	+10	+10	+10	+10
Environmental	-10	-8	-10	-8
Social	+15	+16	+17	+14
Public Accounts	+1	0	0	-2
Overall Ranking	+13	+12	+12	+4

From Table 10.7 above it can be seen that the option with the highest overall score is the 2007 Preferred Option (+13) followed by Option 16 (+12), Option 12 (+12) and Option 50 (+4).

11 Conclusions

The preliminary forecasts indicate that continued traffic growth, in the absence of the proposed Armagh East Link scheme, would have a severe impact on the existing conditions in the city. Armagh City Centre and surrounding roads would come under increased pressure, as higher flows in the future would cause increased congestion and would reduce journey times.

Preliminary forecast results show that any of the four proposed route options will help in relieving congestion in Armagh City Centre and will provide increased capacity which will improve journey times within and through the City Centre.

The traffic forecasts indicate that the proposed link options are all favoured by traffic travelling between the A3 Portadown Road and the A28 Markethill Road. The alignments closer to the City Centre, the 2007 Preferred Option and Option 16, also attract a proportion of local traffic movements and as a result there is a further reduction of demand on some of the main intersections passing through the City Centre.

When examined from an economic perspective, the 2007 Preferred Option is the option that presents the highest return on investment. Option 50 has a BCR less than 1, which indicates that it would not offer a favourable return on investment. While Option 50 generates positive collision benefits, results indicate a slight increase in the number of casualties with Option 50 that would be contrary to the road safety objective of the scheme.

Having undertaken a simple comparative exercise on the four options with regard to engineering, economic, environmental, social and public accounts considerations, the 2007 Preferred Route was identified as the option with the highest ranking, followed by Options 12 and 16 with similar rankings, and then Option 50.

12 Recommendations

Given that there is now evidence to suggest that alternative routes to the 2007 Preferred Route also provide value for money a DMRB Stage 2 scheme Assessment should be carried out on Options 16, 12 and the 2007 Preferred Route.

The potential to tie a route option into the Drumman Heights Roundabout by reconfiguring the roundabout to provide a fifth arm for the Link Road should be investigated in more detail.

Appendix A: Scheme Assessment Reports Summary

Stage 1 Scheme Assessment Report Summary

In August 2006 a preferred route corridor was identified in the *Stage 1 Scheme Assessment Report* from three alternatives:

- An Inner Option that would extend northwards to the west of the Armagh Baptist Church, following the course of the Ballynahone River before crossing the A51 by the Kingston Memorial Playing Fields, then utilising the existing Victoria Road and Drumadd Road corridors to connect to the A3 at an existing mini-roundabout;
- A Central Option which utilises the existing Ardmore Road from its junction with the A28 Markethill Road, which then heads northwards to meet the Ballynahonemore Road, crossing the A51 Hamiltonsbawn Road adjacent to the city's barracks, before continuing northwards alongside the barracks to meet the A3 Portadown Road at Linsey's Heights;
- An Outer Option which would run northwards from an improved junction of the A28 and Edenaveys Road. The existing Edenaveys Road would be widened, forming the southern section of the East Link, and extended via a short section of new road to join the A51 at a new four-way junction. The northern section would be new road from the A51 to join the A3 at an improved five-arm roundabout with Drumman Heights and Killuney Road.

The *Stage 1 Scheme Assessment Report* concluded that the Central Option for the proposed scheme was the most feasible of those proposed.

The Inner Option was found to be the least feasible because of the adverse impact on the Ballynahone River and the extensive retaining walls which would be required beside it, and because of the potential for large-scale disruption owing to the construction of the new road on the existing road network. While the Outer Option would be less disruptive to construct and would have an environmental impact comparable to the Central Option, due to the greater distance between the A3 and the A28 at this location together it would require accommodation bridges between

severed parcels of land and the extensive earthworks, with the additional construction costs of this option making it infeasible.

Stage 2 Scheme Assessment Report Summary

During the Stage 1 process three alignment options were also looked at within the Central Route Corridor Option:

- The Blue Alignment Option
- The Purple Alignment Option
- The Red Alignment Option

During the *Stage 2 Scheme Assessment* the Blue Alignment Option was ruled out as it had a moderate adverse effect on the properties at Bannvale Villas. The Purple Alignment and Red Alignment Options consisted of different options for the alignment between the Ballynahonemore Road and the A51 Hamiltonsbawn Road.

The Red Alignment Option aligns the road to the east of the corridor and was developed to identify how far away from residential areas the alignment of the proposed scheme could be situated. Following the termination of the Ardmore Road the alignment swings north-east to pass to the east of 22 Ballynahonemore Road, before turning north-west to join the A51 Hamiltonsbawn Road.

The Red Alignment Option was found to sever more land parcels than the Purple option and as the route lies further east towards existing high ground, the level of earthworks required would also be increased.

The Purple Alignment Option tries to follow the existing topography of the area therefore limiting the level of earthworks. Following the termination of the Ardmore Road this alignment passes along the rear of Bannvale Villas and to the west of 22 Ballynahonemore Road. The route then turns slightly north-east towards the proposed junction with A51 Hamiltonsbawn Road.

Whilst the Environmental Assessment slightly favours the Red Route, the Traffic and Economic and the Engineering Assessments both favoured the Purple Route. The adverse aspects of the Purple option in Environmental terms could be mitigated

within the land available. As a result the *Stage 2 Scheme Assessment Report* recommended that the Purple Alignment Option was developed further as the design for the Armagh East Link.

The *Stage 2 Scheme Assessment Report* also recommended that Signalised Junctions are developed for the design for the Armagh East Link junction with the both the A28 Markethill Road and the A51 Hamiltonsbawn Road. A Roundabout was recommended for the East Link junction with the A3 Portadown Road.