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A1 JUNCTIONS PHASE 2 ROAD IMPROVEMENT SCHEME

STAGE 3 SCHEME ASSESSMENT REPORT

168014-RPSB-GEN-XX-SAR-PM-00001

RPS SWECO

A1 Junctions Phase 2

Stage 3 Scheme Assessment Report

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A1J2	-	A1 Junctions Phase 2
AADT	-	Average Annual Daily Traffic
AEP	-	Annual Exceedance Probability
ANPR	-	Automatic Number Plate Recognition
AONB	-	Area of Outstanding Natural Beauty
AST	-	Appriasal Summary Table
ATC	-	Automatic Traffic Counters
BCR	-	Benefit to Cost Ratio
Bgl	-	Below ground level
BGS	-	British Geological Society
BMAP	-	Belfast Metropolitan Area Plan
BT	-	British Telecom
CBR	-	Californian Bearing Ratio
CCTV	-	Closed-circuit Television
CFA	-	Continuous Flight Auger
CGSJ	-	Compact Grade Separated Junction
COBA	-	Cost Benefit Analysis
COBALT	-	Cost and Benefit to Accidents – Light Touch
CRTN	-	Calculation of Road Traffic Noise
CSM	-	Conceptual Site Model
DBFO2	-	Design Built Finance and Operate Package 2
DCAN15	-	Development Control Advice Note 15
DEM	-	Director of Engineering Memorandum
DETR	-	Department of the Environment, Transport and the Regions
DfC	-	Department for Communities
DfI	-	Department for Infrastructure
DfT	-	Department for Transport
DMRB	-	Design Manual for Roads and Bridges
DVA	-	Driver and Vehicle Agency
ECP	-	Emergency Crossing Point
EEZ	-	Ecological Exclusion Zone
EIA	-	Environmental Impact Assessment
EIAR	-	Environmental Impact Assessment Report
GCC SAP	-	Government Construction Client’s Sustainability Action Plan
GHG	-	Green House Gases
GQRA	-	Generic Quantitative Risk Assessment
GSNI	-	Geological Society of Northern Ireland
HDV	-	Heavy Duty Vehicle
HED	-	Historic Environment Division
HGV	-	Heavy Goods Vehicle

HPG	-	Historic Parks and Gardens
IHR	-	Industrial Heritage Record
ITS	-	Intelligent Transport Systems
KTC	-	Key Transport Corridor
LCA	-	Landscape Character Assessment
LILO	-	Left in/Left out
LLCA	-	Local Landscape Character Assessment
LLPA	-	Local Landscape Policy Area
LPS	-	Land and Property Services
LVIA	-	Landscape and Visual Impact Assessment
MCV	-	Moisture Condition Value
NIE	-	Northern Ireland Electricity
NILCA	-	Northern Ireland Landscape Character Assessment
NIRAUC	-	Northern Ireland Road Authority and Utility Committee
NIRCLA	-	Northern Ireland Regional Landscape Character Assessment
NIW	-	Northern Ireland Water
NMC	-	Natural Moisture Content
NMU	-	Non-Motorised User
NPV	-	Net Present Value
NRTF	-	National Road Traffic Forecasts
NTS	-	Non-Technical Summary
OD	-	Ordnance Datum
OS	-	Ordnance Survey
PIA	-	Personal Injury Accident
PIA/mkm	-	Personal Injury Accidents per Million vehicle Kilometres
PVB	-	Present Value of Benefits
PVC	-	Present Value of Costs
QUADRO	-	Queues and Delays at Roadworks
RBD	-	River Basin District
RDS	-	Regional Development Strategy
RQD	-	Rock Quality Designation
RSC	-	RPS-SWECO Consortium
RSTN	-	Regional Strategic Transport Network
RSTN TP	-	Regional Strategic Transport Network Transport Plan 2015
RTC	-	Road Traffic Collision
RTS	-	Regional Transport Strategy
SAR	-	Scheme Assessment Report
SMART	-	Specific, Measureable, Attainable, Relevant and Timed
SMR	-	Sites and Monuments Record
SPA	-	Special Protection Areas
SPT	-	Standard Penetration Test
SRI	-	Strategic Road Improvement

SSD	-	Stopping Sight Distance
SuDS	-	Sustainable Urban Drainage Systems
TEMPRO	-	Trip End Model Presentation Program
TEN-T	-	Trans-European Transport Network
VMS	-	Variable Message Signs
VOC	-	Vehicle Operating Cost
VRS	-	Vehicle Restraint System
WebTAG	-	Web-Based Transport Analysis Guidance
WFD	-	Water Framework Directive
WHO	-	World Health Organisation
WHS	-	World Heritage Site

1 INTRODUCTION

1.1 BACKGROUND TO THE SCHEME

1.1.1 Regional Strategic Transport Policy

The Regional Development Strategy (RDS) for Northern Ireland 2035, published in 2012 superseding RDS 2025, guides the future development of Northern Ireland. The RDS recognised that the Regional Strategic Transport Network (RSTN) has a fundamental role to play in contributing to the achievement of sustainable progress on social, economic and development goals in Northern Ireland.

The Regional Transportation Strategy for Northern Ireland 2002-2012 (RTS), a daughter document of the RDS2025, identifies strategic transport investment priorities and considers potential funding sources and affordability of planned initiatives. The purpose of the RTS is to support the RDS and to make a significant contribution over the ten years towards achieving the longer term vision for transportation contained within the RDS "to have a modern, sustainable, safe transportation system which benefits society, the economy, and the environment and which actively contributes to social inclusion and everyone's quality of life."

The Regional Strategic Transport Network Transport Plan 2015 (RSTN TP), developed by the Department for Regional Development, is based on the guidance set out in the RDS and RTS. The RSTN TP comprises the complete rail network, five key transport corridors, four link corridors, the Belfast Metropolitan Transport Corridors, and the remainder of the trunk road network. The Plan consists of proposals for the maintenance, management and development of this transport network up to the end of 2015. Section 5 of the RSTN TP deals with Highways, recognising the key role that Strategic Road Improvements (SRI's) will play in delivering a modern, safe and sustainable transport system for Northern Ireland. Proportionate effort scheme appraisals were carried out to identify and prioritise the schemes considered necessary to meet the aspirations of the RDS, RTS and RSTN TP.

A document "Expanding the Strategic Road Improvement (SRI) Programme 2015" was launched in July 2006 which proposed additional Strategic Road Improvement Schemes to be added to the Programme (subject to consultation). The A1 Junctions Scheme (described as '4 additional junctions and central safety fence to upgrade the A1 between Sprucefield and Loughbrickland to a higher standard dual with no at-grade crossings') is included in the Expanded SRI Programme document.

A revised strategy document, 'Ensuring a Sustainable Transport Future - A New Approach to Regional Transportation', was published in 2012. This complements the RDS 2035 and aims to achieve its vision for transportation. Two of its main Strategic Objectives are to "improve connectivity within the region" and to "improve safety" by completing the work identified in the current RSTN TP and Strategic Road Improvement Programme.

1.1.2 Current Status

AECOM was appointed by Roads Service (now Department for Infrastructure) to undertake a Design Manual for Roads and Bridges (DMRB) Stage 1 Scheme Assessment (Preliminary Options Report). The Stage 1 Scheme Assessment Report (SAR) was approved by the DRD Roads Service (now Department for Infrastructure) Board and published in October 2011.

Following on from the recommendations of the DMRB Stage 1 Scheme Assessment, AECOM was appointed to undertake a Stage 2 Scheme Assessment (Preferred Options Report). The Stage 2 Scheme Assessment investigated the benefits of a number of different junction options. The findings of the assessment were reported in the 'Stage 2 Scheme Assessment Report' which was approved by the TransportNI (now Department for Infrastructure) Board and published in December 2015.

Following on from the recommendations of the DMRB Stage 2 Scheme Assessment, the RPS-SWECO Consortium (RSC) was appointed to undertake a Stage 3 Scheme Assessment of the proposed scheme in September 2015 which is reported herein. This assessment also requires the completion of an Environmental Impact Assessment (EIA) in accordance with Article 67 of the Roads (Northern Ireland) Order 1993, as amended by the Roads (Environmental Impact Assessment) Regulations (Northern Ireland) 2017.

1.1.3 Background Information

The A1 (Euro Route 001) is an all-purpose dual carriageway and forms part of the strategically important principal north-south arterial route linking the capital cities and principal gateway ports of Belfast and Dublin. It is identified within the Trans-European Transport Network (TEN-T) Priority Project 13 and is classified as a Key Transport Corridor (KTC) within the Regional Strategic Transport Network as illustrated in Figure 1.1. It is noted that the development stage of this Project is co-financed by the European Union.

The A1 also acts as the key link between the towns and villages that lie within the corridor and as well as being the primary road linking these towns and villages to Belfast, it also provides a key link for communities both east and west of the route corridor. As such it is considered to have economic and social importance both regionally and locally.

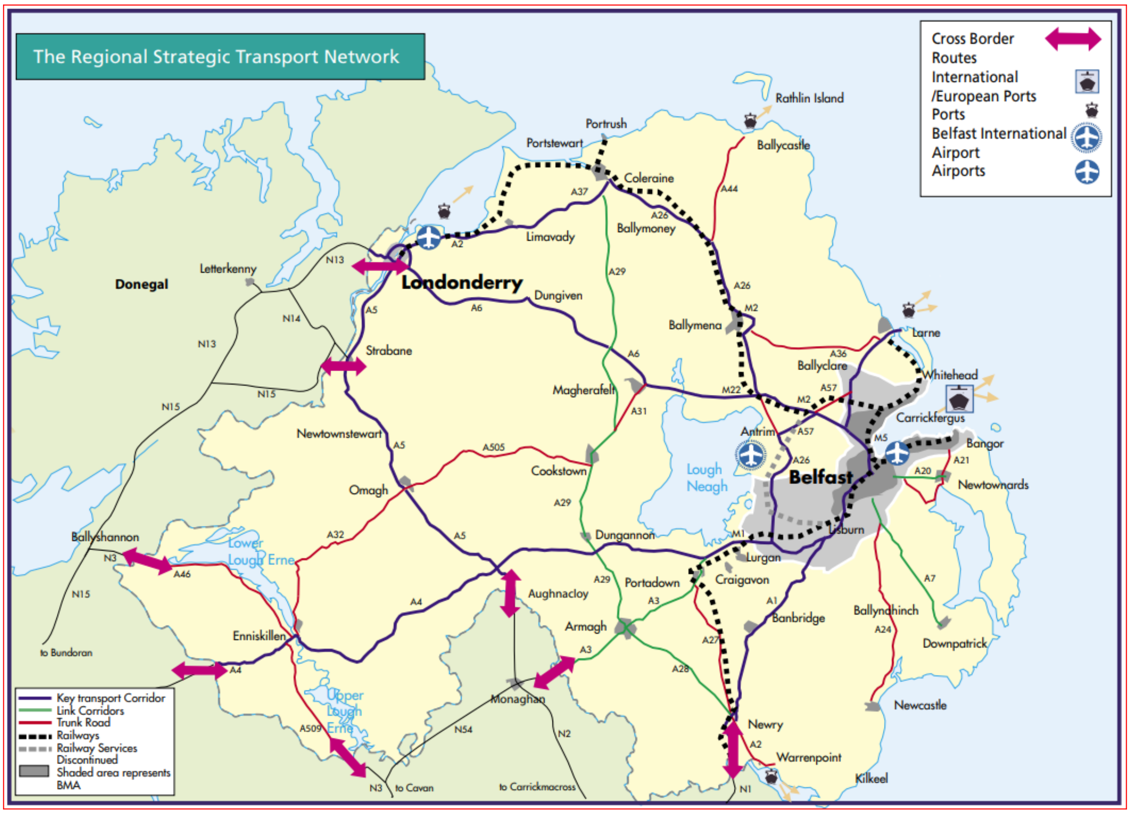


Figure 1.1 – Regional Strategic Transport Network

The A1 Junctions Phase 2 proposal is the current phase of an on-going improvement strategy for the corridor between Hillsborough Roundabout and Loughbrickland and follows on from the A1 Junction Improvements Scheme (Phase 1) completed in 2010, which provided four Compact Grade Separated Junctions (CGSJs) located at Dromore Road, Hillsborough; Banbridge Road, Dromore; Dromore Road, Banbridge; and Dublin Road, Loughbrickland.

The section of the A1 under consideration in Phase 2 is a 25.2km long stretch of all-purpose dual carriageway, extending from the Dublin Road Junction at Loughbrickland in the south to the Hillsborough Roundabout in the north. This section of dual carriageway has undergone staged development over a number of decades since 1971. Currently there is a combination of grade separated and at grade junctions as well as a significant number of private and farm accesses which have direct access onto the A1 dual carriageway. All of which were designed and constructed to different standards, with characteristics that would no longer be considered desirable. The significant number of access points coupled with sections of poor horizontal alignment, vertical alignment, visibility and a narrow central reserve results in the following issues:

- Lack of route consistency;
- Gaps in the central reserve permitting crossing manoeuvres;
- Issues associated with right turning and u-turning vehicles:
    - Sub-standard right turn facilities resulting in vehicles overhanging or encroaching into the offside lane;
    - Weaving vehicles;
    - Vehicles pulling into the offside lane at low speed from side roads;

  - Multiple vehicles waiting within the central reserve; and
  - Steeply inclined accommodation crossings;
- Lack of central reserve barrier along most of the route resulting in errant vehicles crossing the central reserve;
- Inconsistent geometric layout of certain junctions;
- Limited weaving lengths between grade-separated junctions and minor road junctions and accesses; and
- Inconsistent and unreliable journey times.

Due to the nature of the scheme and the improvements being considered, some of the proposals affect the entire route whist others are localised improvements within a defined area. At Stage 2 a number of assessments were carried out on the scheme proposals to permit consideration of the likely environmental, economic, engineering and traffic impacts of potential options. Those assessments were tailored to consider proposals either on a whole scheme basis or focussing at a more localised level for individual junction options, as deemed appropriate. The Stage 3 Scheme Assessment has been progressed on the same basis.

1.1.4 Scheme Objectives

1.1.4.1 High Level Objectives

The A1 Junctions Phase 2 proposal is being assessed and reported against the Government's five high level objectives for transportation which are seen as a 'given' starting point:

- Integration – ensuring that all decisions are taken in the context of the integrated transport policy;
- Safety – to improve safety for all road users;
- Economy – supporting sustainable economic activity in appropriate locations and getting good value for money;
- Environment – protecting the built and natural environment; and
- Accessibility – improving access to everyday facilities for those without a car and reducing community severance.

1.1.4.2 Regional and Local Objectives

The following regional and local objectives fulfil the requirements to 'nest' within the Government's five main objectives. The regional objectives of the study, which are linked to the key objectives of the RTS and RSTN TP, are:

- To improve health, safety and security;
- To support the spatial development strategy in the RDS;
- To develop and maintain the RSTN for all users;
- To protect the natural and built environment;
- To support sustainable economic growth; and
- To improve access to regional gateways.

1.1.4.3 Local Objectives

- To improve safety for all road users;
- To provide a standard of route appropriate to its strategic function;
- To be affordable and provide value for money; and
- To improve journey times and journey time reliability for strategic A1 traffic.

1.2 STAGE 3 SCHEME ASSESSMENT (AREA AND PROPOSALS)

The Stage 3 Scheme Assessment analyses the preferred route in greater detail in order to understand its potential impacts and from there identify its advantages and disadvantages in environmental, engineering, economic and traffic terms. An integral part of this process is to analyse each negative impact and identify potential ways of removing or reducing it by locally realigning the scheme or including additional features. There were many such alterations to the scheme as a result of this; these are discussed in detail in Chapter 3 but some of the more significant ones are summarised below.

When the estimated construction costs were analysed the earthworks were identified as one of the single largest figures. Further investigation showed this to be due to a significant imbalance in the cut to fill ratio which required a significant volume of material to be imported to the site for constructing embankments. This was exacerbated by the need to dispose of a large quantity of poor quality material off-site. In addition to the cost, the significant increase in HGV's needed to transport this material would create a significant impact on the environment and the communities through which they would travel.

Several approaches were necessary to mitigate these issues, the most visible of these is perhaps the widening of the cut slope at Junction 4 - Skeltons / Drumneath to provide additional cut material and thereby reducing the volume of materials imported. The volume of material to be taken off site has been reduced by proposing to treat lower quality materials to make them suitable for reuse in the works and by depositing lower quality material in proposed landscaped areas.

During consultations with local residents it was noted that primarily on safety grounds, but also in terms of detour distances, that given the proximity of the Backnamullagh Road to the proposed CGSJ at Listullycurran Road, there was potential for a link road to be provided from Backnamullagh Road to the compact connector road. This would have the added benefit of allowing closure of the Backnamullagh Road junction and is in line with the principles/objectives of CGSJs, as identified in TD 40/94 which favours "collecting a number of minor roads into a single compact grade separated junction". Consequently, the preferred Listullycurran Road option was altered to provide a road link from Backnamullagh Road directly onto the compact connector road at Listullycurran with closure of the existing Backnamullagh Road junction with the A1.

In addition, the Left In/Left Out (LILO) junction strategy developed during the Stage 2 Scheme Assessment was also reconsidered following consultation with land owners, residents and road users resulting in the following changes:

- Merges are now proposed at 16 of the 21 LILO junctions; and
- Springwell Loanin is now proposed as a LILO (as opposed to Left-In only).

During the development of the design it also became clear that the proposed layout of several affected private access lanes were unacceptable. Consequently, proposed access lanes were further developed to provide acceptable access arrangements where possible through negotiation.

The bus stop strategy for the proposed scheme was also considered and developed during the Stage 3 Assessment. Consequently, a proposed bus stop facility is added at each of the new CGSJ junctions with the proposed closure of all mainline bus stops on safety grounds.

During the Stage 3 Scheme Assessment, the introduction of Intelligent Transport Systems (ITS) was also considered. Consequently, ITS equipment such as Variable Message Signs (VMS), Closed-circuit Television (CCTV) cameras and Automatic Number Plate Recognition (ANPR) systems are proposed at strategic locations along the route.

1.3 STAGE 1 AND STAGE 2 ASSESSMENT RECOMMENDATIONS

1.3.1 Stage 1 Assessment

The Stage 1 Scheme Assessment Report, published by DRD Roads Service (Now Department for Infrastructure) Board in October 2011, recommended the following:

- The Castlewellan Road Northbound On-slip options are retained for consideration at Stage 2 assessment;
- The junction options identified at the workshops and presented in the report should be taken forward to Stage 2; and
- At Stage 2, further investigation, with more sophisticated data analysis, is undertaken to gain a fuller understanding of the likely online and offline traffic reassignment as a result of the median closures.

Whilst noting the recommendation within Stage 1 SAR that more sophisticated data analysis should be undertaken at Stage 2, the need for further analysis was not demonstrated at Stage 2. This decision will be reviewed at Stage 3 when the particular requirements of data analysis will be better understood.

1.3.2 Stage 2 Assessment

The Stage 2 Scheme Assessment Report, published by TransportNI (Now Department for Instructure) Board in December 2015, recommended the following:

1.3.2.1 Whole Scheme – Conclusion and Recommendations

1.3.2.1.1 Minor Road Junction Strategy

Consideration was given to a series of strategies to deal with existing minor road junctions with the A1, with a view to closing up, retaining, or improving these junctions.

The recommendations brought forward from consideration of potential strategies are detailed in Table 1.1 at the end of this section and are summarised as follows:

- Twenty-two junctions to remain open and operate on a LILO basis;
- Eight minor road junctions on the A1 to be closed;
- One of the twenty-two junctions, Springwell Loanin minor road junction, north of Loughbrickland is to be amended to operate as left-in only.
- Construction of a new link road connecting Milebush Road with the existing Hillsborough Road CGSJ, at Dromore.
- The Junction Strategy assessment identified the minor road junctions within the scheme extents to be retained or closed and identified recommended improvements including diverge and/or merge lanes at the reconfigured LILO junction.

1.3.2.1.2 Milebush Road to Hillsborough Road CGSJ Link Road

The Milebush Road southern access to the A1 northbound carriageway was recommended for closure based on its proximity to the existing Hillsborough Road CGSJ, Dromore. It was recommended that a new link road be provided to connect the Hillsborough Road CGSJ to the Milebush Road.

1.3.2.1.3 Central Reserve Barrier

Consideration of barrier options identified the potential for the existing alignment of the A1, and therefore the available stopping sight distance (SSD) to influence barrier selection. The existing and anticipated traffic volumes on the A1 merit consideration of concrete step barrier particularly with respect to life cycle costs. However, the effect of the alignment on sight stopping distance may support the selection of a barrier type that affords a greater degree of visibility (i.e. wire rope safety fence). It was recommended, following the undertaking of a detailed topographical survey of the entire route, that a more detailed assessment of the impacts of any proposed barrier system on visibility be undertaken to further inform any recommendations made in this respect.

1.3.2.2 Junction Options – Conclusions and Recommendations

1.3.2.2.1 Listullycurran Road/Backnamullagh Road

Three options were assessed at Listullycurran Road/ Backnamullagh Road and the assessment concluded the following:

The Amber Option was favoured under the environment objective. However, largely due to the higher traffic levels using Listullycurran Road, the Amber Option was least favourable in achieving a number of other scheme objectives, particularly relating to objectives of accessibility, severance and journey time.

The balance of benefits indicates that the Blue Option was the most favourable in terms of achieving the scheme objectives. It was estimated to be the lowest cost by over £1 million, promotes many of the objectives and other considerations, has lower economic risk than the Brown Option and the engineering layout complements the surrounding topography.

It was recommended that the Blue Option is taken forward as the preferred option.

1.3.2.2.2 Gowdystown Road

Three options were assessed at Gowdystown Road and the assessment concluded the following:

The Purple Option was not preferred under any objective and was least favoured in terms of Economy and Safety.

The Green Option was estimated to be the lowest cost of the options, has the lowest potential for engineering risk and its engineering layout suits the surrounding topography, and whilst the Pink Option may perform better against the Environment objective, the Green Option is considered to perform best overall.

It was recommended that the Green Option is taken forward as the preferred option.

1.3.2.2.3 Skeltons Road/Drumneath Road

Three options were assessed at Skeltons Road/ Drumneath Road and the assessment concluded the following:

The Cyan Option was favoured under the environment objective. However, when considered against the other scheme assessment criteria, the Cyan Option was less preferable, particularly as a result of the significant additional cost of construction, and the sections of cut associated with this option and the potential engineering and economical risks that result.

The Purple Option was considered to have a more balanced impact on local landowners than the Green Option, in that, there was an inconvenience placed upon all properties which was balanced between all parties. The Green Option had a much more severe impact upon the residences in the northwest quadrant. The Purple Option was favoured under the economic objective as it is the lowest cost option

It was recommended that the Purple Option is taken forward as the preferred option.

1.3.2.2.4 Waringsford Road

Three options were assessed at Waringsford Road and the assessment concluded the following:

The Pink Option was favoured under the environment and accessibility objectives. However, it was not preferred from an engineering perspective due to the potential risks and challenges that may result from construction of a new junction within an existing quarry site. The Pink Option was least preferred under the safety objective. In addition, the Pink Option was least preferred as it is not a typical CGSJ layout which would be inconsistent with the remainder of the A1 route.

The Brown Option was favoured under the economic objective as it was the lowest cost option and was more favourable than the Green Option under the environment objective. The Brown Option also required less fill import than the Green Option and was thus favoured from an engineering perspective.

It was recommended that the Brown Option is taken forward as the preferred option.

1.3.2.2.5 Castlewellan Road

Due to the limited nature of proposed improvements at Castlewellan Road and the constrained site, the Stage 2 Assessment at Castlewellan Road considered a single option – Green Option-only. This option achieves the stated objectives and it was therefore recommended that the Green Option be taken forward for further assessment at Stage 3.

1.3.2.3 Economic Conclusions

The cost of the scheme was estimated to be in the range of £40 million to £50 million including Optimism Bias allowances of 25% for construction and 10% for land acquisition.

The Benefit to Cost Ratio of 3.030 for the scheme was considered good value for money.

Collision benefits were calculated for the A1 using the default collision rates within the COBA model. The number and cost of collisions at junctions is predicted to reduce by nearly 50% (976) as a result of closures of the median crossovers and conversion of many of the existing junctions to left-in, left-out arrangements. This generates a £77,267k benefit arising from the junction collision savings. Based on COBA analysis, the number of collisions on links and at junctions is predicted to decrease by 23% (982) over the 60 year appraisal period.

Similarly, the number of casualties is predicted to reduce by 25% (1,730), with 1,521 fewer slight casualties, 187 fewer serious casualties and 21 fewer fatalities. Accordingly, the costs associated with these collisions reduce from £301,825k in the Do Minimum to £223,574k in the Do Something. This produces an overall scheme benefit of £77,710k.

1.3.2.4 Recommended Interventions for Minor Road Junctions

Table 1.1 – Minor Road Junction Interventions

Minor Road Junction (Listed North to South)	Carriageway	Retain/Close	Diverge and/or Merge Lane Provision	
			Diverge Lane	Merge Lane
Moira Road	Northbound	Retain	Yes	Yes
Glen Road	Northbound	Retain	Yes	No
Dromara Road	Southbound	Retain	Yes	Yes
Dromore Road	Southbound	Close	N/A	N/A
Taughblane Road	Northbound	Retain	Yes	No
Backnamullagh Road	Southbound	Retain	Yes	No

Listullycurran Road	Northbound	To be incorporated into proposed CGSJ	N/A	N/A
Milebush Road (north)	Northbound	Retain	Yes	No
Hillsborough Road (north)	Northbound	Retain	Yes	No
Hillsborough Road (south)	Northbound	Close	N/A	N/A
Grove Road	Southbound	Retain	Yes	No
Milebush Road (south)	Northbound	Close – to be incorporated into the existing Hillsborough Road CGSJ, Dromore	N/A	N/A
Milebush Road	Southbound	Close	N/A	N/A
Connellystown Road	Northbound	Retain	Yes	No
Maypole Hill	Southbound	Retain	Yes	Yes
Lower Quilly Road (east)	Southbound	Close	N/A	N/A
Lower Quilly Road (west)	Northbound	Retain	Yes	No
Mackey's Lane	Northbound	Retain	Yes	No
Boal's Lane	Southbound	Retain	Yes	No
Banbridge Road	Northbound	Close – to be incorporated into the proposed Gowdystown CGSJ		
Gowdystown Road (west)	Northbound	To be incorporated into proposed CGSJ	N/A	N/A
Gowdystown Road (east)	Southbound			
Mt Ida Road	Southbound	Retain	Yes	No
Halfway Road (north)	Northbound	Close	N/A	N/A
Halfway Road (south)	Northbound	Retain	Yes	No
Drumneath Road	Southbound	To be incorporated into proposed CGSJ	N/A	N/A
Skeltons Road	Northbound	To be incorporated into proposed CGSJ	N/A	N/A
Kilmacrew Road	Southbound	Retain	Yes	No
Graceystown Road	Northbound	Retain	Yes	No
Waringsford Road	Southbound	To be incorporated into proposed CGSJ	N/A	N/A
Lisnaree Road	Southbound	Retain	Yes	No
Old Manse Road	Southbound	Retain	Yes	Yes
Springwell Loanin	Northbound	Retain as left-in only	Yes	No
Old Banbridge Road (north)	Southbound	Close	N/A	N/A
Old Banbridge Road (south)	Southbound	Retain	Yes	No
Banbridge Road	Northbound	Retain	Yes	Yes

1.4 STRUCTURE OF THE REPORT

The Stage 3 Scheme Assessment has been carried out in accordance with DMRB TD37/93 “Scheme Assessment Reporting” and RSPPG_E030 “Major Road Improvements – Inception to Construction" and has followed on from the Stage 1 Scheme Assessment Report (October 2011) and the Stage 2 Scheme Assessment Report (December 2015).

The purpose of this Stage 3 SAR is to identify refinements to the Preferred Route following the publication of the Stage 2 SAR and the Preferred Route Announcement and to define the Stage 3 Preferred Route. This report will then identify clearly the advantages and disadvantages, in environmental, engineering, economic and traffic terms, of the Preferred Route. A particular requirement at this stage is an assessment of any significant environmental effects of the project. This appraisal was completed in accordance with the brief using the DTLR/Highway Agency ‘Bridging Document’ for Multi-Modal Appraisal of Highway Schemes.

The appraisal of each of these objectives has also been undertaken using guidance set out in the Department for Transport’s (DfT) web-based Transport Analysis Guidance (WebTAG), which is essentially guidance as to how each objective should be appraised. It sets the context for the assessment process and provides a structured appraisal framework to enable comparison between routes.

Assessment reports are not intended to replace technical reports on matters such as traffic or geotechnical issues. They are intended to act as a summary of the information available at each stage, to permit consideration of likely environmental, social, economic and traffic effects of various proposals and to allow the public and statutory bodies to take account of these effects when commenting on the proposals.

For the purposes of the assessments a junction numbering system was incorporated by RSC. This system provided the main junctions of CGSJ type with a reference number on a North to South basis. The junction numbers are illustrated in Table 1.2 below. It is acknowledged that the proposals at Milebush Link and Castlewellan Road would not be considered full CGSJ type junctions however for the purposes of this assessment they have been provided a full junction reference number.

Table 1.2 – Junction Numbering

Junction Name	Junction Reference No.	Abbreviation
Listullycurran / Backnamullagh	Junction 1	J1
Milebush Link Road	Junction 2	J2
Gowdystown Road	Junction 3	J3
Skeltons Road / Drumneath Road	Junction 4	J4
Waringsford Road	Junction 5	J5
Castlewellan Road On-Slip	Junction 6	J6

The Stage 3 Assessment comprises ten chapters, which are summarised as follows:

- Chapter 1 is the *Introduction*;
- Chapter 2, *Existing Conditions*, considers the existing route conditions in terms of the built environment and traffic conditions;
- Chapter 3, *Description of the Scheme,* provides a description of the proposed scheme including key features and development of the various option;
- Chapter 4, *Cost Estimates*, provides a cost estimate for the scheme;
- Chapter 5, *Engineering Assessment*, provides details of the engineering design, the standards used in the development of the scheme and information on the likely construction process;
- Chapter 6, *Environmental Assessment*, outlines the environmental assessment of the scheme;
- Chapter 7, *Traffic Assessment*, outlines the traffic modelling techniques used to forecast changes in traffic volumes and the benefits.
- Chapter 8, Economic Assessment, outlines the benefits and overall economic assessment of the scheme;
- Chapter 9, *Appraisal Summary Tables*. This chapter summarises the key aspects of the scheme in an appraisal summary table; and
- Chapter 10, *Conclusions and Recommendations* provides a summary of the Stage 3 assessment and recommendations on how the scheme should be taken forward.

1.5 FOCUS OF THE ASSESSMENT

The primary focus of this assessment is to confirm a Preferred Route that can be developed and progressed through the Statutory Orders.

The scheme objectives will focus on:

- To improve safety for all road users;
- To provide a standard of route appropriate to its strategic function;
- To be affordable and provide value for money; and
- To improve journey times and journey time reliability for strategic A1 traffic.

2 EXISTING CONDITIONS

2.1 DESCRIPTION OF THE LOCALITY

As noted, the A1 forms part of the South Eastern Key Transport Corridor providing access between Belfast and the border with the Republic of Ireland. Currently the A1 caters for 40,000 vehicles per day within the northern end of the scheme. The southern stretch of this route, between Beech Hill and the border, has been upgraded to a high standard dual carriageway with access provided via grade separated junctions and no direct access to adjacent land or property. The A1 Loughbrickland to Beech Hill dual carriageway provides a central safety barrier with right turn crossing of the central reserve restricted to at grade junctions with the local minor road network.

The section of the route within the proposed scheme limits between Hillsborough Roundabout and Loughbrickland generally runs in a south westerly direction from the southern outskirts of Lisburn and is 25.2km in length. This section of the route also serves as a bypass for several local towns and villages including Hillsborough, Dromore, Banbridge and Loughbrickland. The existing road is a 2 lane dual carriageway with a central reserve of varying width and features gaps that permit crossing manoeuvres. The presence of these gaps directly contributes to the number and severity of accidents on this section of dual carriageway.

Amey are currently responsible for maintaining the road on behalf of the Department. Based on guidance within Table 4 of DMRB TD9/93 “Highway Link Design”, the dual carriageway between Hillsborough Roundabout and Loughbrickland would be currently considered a Category 5 dual carriageway. The national speed limit for dual carriageways applies along the A1 except within the environs of Banbridge and Dromore where speed is restricted to a maximum of 60mph.

There are 36 minor road junctions along the 25.2km length of the study area and a total of 111 gaps in the central reserve serving minor roads, residences, commercial premises and agricultural accesses. The 111 gaps allow cross-carriageway access to the minor road junctions, 5 commercial premises, 22 residential properties, 31 agricultural accesses and 17 maintenance crossovers/other use. The gaps are also used by vehicles performing u-turn manoeuvres in addition to right turn manoeuvres across the carriageway.

Most junctions along the A1 operate as simple priority junctions with the exception of:

- the four CGSJ constructed as part of the A1 Junctions Scheme (Phase 1);
- Moira Road at Hillsborough, all right turns are now prohibited;
- the CGSJ at Hillsborough Road, Dromore;
- the compact connector road linking the northbound carriageway of the A1 at Dromore to Lurgan Road;
- Rathfriland Road grade separated junction, Banbridge; and
- the grade separated junction at Newry Road, Banbridge.

There are hard shoulders to both carriageways along the majority of the route with the exception of the Banbridge Bypass section of the A1, which features a 1m hard strip only.

2.2 EXISTING HIGHWAY NETWORK

2.2.1 Whole Scheme

The minor road network surrounding the A1 within the study area ranges from rural lanes and thoroughfares up to A class roads. The A and B class roads which link into the A1 within the study area are as follows:

- A26 Newry Road/Dromore Road, Banbridge
- A50 Castlewellan Road
- B177 Dromore Road;
- B2 Hillsborough Road/Banbridge Road/Lurgan Road, Dromore;
- B25 Gowdystown Road;
- B10 Rathfriland Road; and
- B3 Grovehill Road/Main Street Loughbrickland.

These A and B roads within the minor road network provide transport links to the A1 for a number of towns and villages, local businesses as well as the wider local community.

There are also numerous C class roads and unclassified roads serving various hamlets, farms and individual dwellings in the area. The standard of the minor road network in the vicinity of the A1 varies significantly. Localised issues are present within the minor road network including sections of reduced visibility, inconsistent horizontal and vertical alignments and carriageway cross sections. Traffic volumes on the minor road network also vary significantly, however current traffic survey data indicates that generally the minor road network is lightly trafficked.

The A1 has undergone a series of improvements over the past 40+ years commencing with the dualling of the A1 carriageway between Hillsborough and Dromore in 1971. The most recent of which were undertaken in 2007-2008 as part of the Design Build Finance and Operate Package 2 (DBFO2) contract with the construction of four new compact grade separated junctions of which two were underpass type junctions and the other two flyover type junctions. These were constructed to address high accident rates and the comparatively high number of right turn manoeuvres being undertaken at these locations. The four new junctions are as follows from North to South;

- Dromore Road, Hillsborough;
- Banbridge Road, Dromore;
- Dromore Road, Banbridge; and
- Dublin Road, Loughbrickland.

2.2.2 Left-In / Left-Out Junctions (LILOs)

2.2.2.1 Banbridge Road, Loughbrickland

The B3 Banbridge Road, Loughbrickland junction (LILO 01) is located on the northbound carriageway of the A1 at the northern limit of the town of Loughbrickland at approximately mainline scheme Ch.

0+870. The existing at grade T-junction with the A1 is lit and has dedicated diverge and merge lanes for northbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling southbound. Adjacent to the junction is a Northern Ireland Driver and Vehicle Agency (DVA) weighbridge which operates a one-way system of working. The DVA weighbridge is accessed directly from B3 Banbridge Road with exiting vehicles merging onto the northbound carriageway of the A1 approximately 160m north of the existing LILO 01 junction via a dedicated slip.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and theB3 Banbridge Road in the vicinity of the junction.

2.2.2.2 U4484 Banbridge Road (South)

The U4484 Banbridge Road (south) junction (LILO 02) is located on the southbound carriageway of the A1 approximately 1km north of the town of Loughbrickland at approximately mainline scheme Ch. 1+215. The existing at grade T-junction with the A1 has a simple diverge and a dedicated merge lane for southbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling northbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and the U4484 Banbridge Road (south) in the vicinity of the junction.

2.2.2.3 U4206 Springwell Loanin

The U4206 Springwell Loanin junction (LILO 03) is located on the northbound carriageway of the A1 approximately halfway between the town of Loughbrickland and the Outlet/Newry Road junction at approximately scheme Ch. 1+725. The existing U4206 Springwell Loanin width is substantially substandard, quickly narrowing to one lane, whilst the existing at grade T-junction with the A1 has a simple diverge and a give way merge for northbound traffic. A gap in the central reserve facilitates right turning vehicles travelling southbound and adjacent to the junction is culverted land drain which flows under the existing road.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and the U4206 Springwell Loanin in the vicinity of the junction.

2.2.2.4 A50 Old Manse Road

The A50 Old Manse Road, junction (LILO 04) is located on the southbound carriageway of the A1 at the eastern limit of the town of Banbridge at approximately mainline scheme Ch. 5+550. The existing at grade T- junction with the A1 is lit and has a dedicated direct taper diverge lane and a give way merge for southbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling northbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard strips and a central reserve that permits crossovers. The A1 has a reduced speed limit of 60mph whilst the national speed limit applies to the A50 Old Manse Road in the vicinity of the junction.

2.2.2.5 U4192 Lisnaree Road

The U4192 Lisnaree Road junction (LILO 05) is located on the southbound carriageway of the A1 approximately 2.9km east of the town of Dromore at approximately mainline scheme Ch. 6+450. The existing at grade T-junction with the A1 is a simple junction with a simple diverge and a give way merge for southbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling northbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard strips and a central reserve that permits crossovers. The A1 has a reduced speed limit of 60mph whilst the national speed limit applies to the U4192 Lisnaree Road in the vicinity of the junction.

2.2.2.6 U4074 Graceystown Road

The U4074 Graceystown Road junction (LILO 06) is located on the northbound carriageway of the A1 approximately 3.9km from the town of Banbridge at approximately mainline scheme Ch. 8+330. The existing at grade T- junction with the A1 has a simple diverge and a give way merge for northbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling southbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and U4074 Graceystown Road in the vicinity of the junction.

2.2.2.7 U4192 Kilmacrew Road

The U4192 Kilmacrew Road junction (LILO 07) is located on the southbound carriageway of the A1 approximately 4km from the town of Banbridge at approximately mainline scheme Ch. 8+410. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge for southbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling northbound whilst adjacent to the junction is the Gibson Bros Ltd Quarry who have a long and well established business with operational facilities close to the existing road network.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and the U4192 Kilmacrew Road in the vicinity of the junction.

2.2.2.8 U4066 Halfway Road (South)

The U4066 Halfway Road (south) junction (LILO 08) is located on the northbound carriageway of the A1 approximately 7.1km from the town of Banbridge at approximately mainline scheme Ch. 10+510. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge for northbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling southbound and an existing open drain runs north to south crossing under U4066 Halfway

Road (south) and later passes under the A1.The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and the U4066 Halfway Road (south) in the vicinity of the junction.

2.2.2.9 U40109 Mount IDA Road

The U40109 Mount Ida Road junction (LILO 09) is located on the southbound carriageway of the A1 approximately 7.1km from the town of Banbridge at approximately mainline scheme Ch. 11+175. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge for southbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling northbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and the U40109 Mount Ida Road in the vicinity of the junction.

2.2.2.10 U4045 Boals Lane

The U4045 Boals Lane junction (LILO 10) is located on the southbound carriageway of the A1 approximately 3.4km from the town of Banbridge at approximately mainline scheme Ch. 12+975. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge for southbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling northbound. Connected to the U4045 Boals Lane is a private access which heads north to an agricultural underpass under the A1 which connects to the U4061 Mackeys Lane junction (LILO 11) on the northbound carriageway. Approximately 150m north of the junction on the southbound carriageway is a property with a direct access onto the A1 dual carriageway.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and the U4045 Boals Lane in the vicinity of the junction.

2.2.2.11 U4061 Mackeys Lane

The U4061 Mackeys Lane junction (LILO 11) is located on the northbound carriageway of the A1 approximately 3.4km from the town of Banbridge at approximately mainline scheme Ch. 12+975. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge for northbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling southbound. Connected to the U4061 Mackeys Lane is a private access which head north to an agricultural underpass under the A1 which connects to the U4045 Boals Lane junction (LILO 10) on the southbound carriageway.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and the U4061 Mackeys Lane in the vicinity of the junction.

2.2.2.12 U4027 Lower Quilly Road (West)

The U4027 Lower Quilly Road (west) junction (LILO 12) is located on the northbound carriageway of the A1 at the western limit of the town of Dromore at approximately mainline scheme Ch. 15+290. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge whilst a gap in the central reserve facilitates right turning vehicles travelling southbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The A1 has a reduced speed limit of 60mph whilst the national speed limit applies to the U4027 Lower Quilly Road (west) in the vicinity of the junction.

2.2.2.13 U4450 Maypole Hill

The U4450 Maypole Hill junction (LILO 13) is located on the southbound carriageway of the A1 at the north western limit of the town of Dromore at approximately mainline scheme Ch. 16+200. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge whilst a gap in the central reserve facilitates right turning vehicles travelling northbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The A1 has a reduced speed limit of 60mph whilst the national speed limit applies the U4450 Maypole Hill in the vicinity of the junction.

2.2.2.14 U4017 Connellystown Road

The U4017 Connellystown Road junction (LILO 14) is located on the northbound carriageway of the A1 at the north western limit of the town of Dromore at approximately mainline scheme Ch. 16+290. The existing at grade T- junction with the A1 has a simple diverge and a give way merge for northbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling southbound. An existing open drain runs north to south crossing under the U4017 Connellystown Road parallel with the A1.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The A1 has a reduced speed limit of 60mph whilst the national speed limit applies to and the U4017 Connellystown Road in the vicinity of the junction.

2.2.2.15 U4012 Grove Road

The U4012 Grove Road junction (LILO 15) is located on the southbound carriageway of the A1 approximately 2.7km from the town of Dromore at approximately mainline scheme Ch. 18+475. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge whilst a gap in the central reserve facilitates right turning vehicles travelling northbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and the U4012 Grove Road in the vicinity of the junction.

2.2.2.16 U4023 Hillsborough Road (North)

The U4023 Hillsborough Road (north) junction (LILO 16) is located on the northbound carriageway of the A1 approximately 3.4km from the town of Dromore at approximately mainline scheme Ch. 19+065. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge whilst a gap in the central reserve facilitates right turning vehicles travelling southbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and U4023 Hillsborough Road (north) in the vicinity of the junction.

2.2.2.17 C0360 Milebush Road (North)

The C0360 Milebush Road (north) junction (LILO 17) is located on the northbound carriageway of the A1 approximately 4.8km from the town of Dromore at approximately mainline scheme Ch. 19+520. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge whilst a gap in the central reserve facilitates right turning vehicles travelling southbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and Milebush Road North in the vicinity of the junction.

2.2.2.18 U0403 Taughblane Road

The U0403 Taughblane Road junction (LILO 19) is located on the northbound carriageway of the A1 approximately 3.4km from the town of Hillsborough at approximately mainline scheme Ch. 20+980. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge whilst a gap in the central reserve facilitates right turning vehicles travelling southbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and U0403 Taughblane Road in the vicinity of the junction.

2.2.2.19 U0404 Dromara Road

The U0404 Dromara Road junction (LILO 20) is located on the southbound carriageway of the A1, approximately 3.4km from the town of Hillsborough at approximately mainline scheme Ch. 21+980. The existing at grade T- junction with the A1 has dedicated diverge and a give way merge for northbound traffic whilst a gap in the central reserve facilitates right turning vehicles travelling northbound.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and U0404 Dromara Road in the vicinity of the junction.

2.2.2.20 U0404 Glen Road

The U0404 Glen Road junction (LILO 21) is located on the northbound carriageway of the A1 approximately 2.3km from the town of Hillsborough at approximately mainline scheme Ch. 22+165. The existing at grade T- junction with the A1 is a simple junction with a simple diverge and a give way merge whilst a gap in the central reserve facilitates right turning vehicles travelling southbound. Connected to the U0404 Glen Road is a private access which heads east to an agricultural underpass under the A1 connecting to the U4061 Dromore Road which runs parallel to the A1's northbound carriageway

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers. The national speed limit applies to both the A1 and the U0404 Glen Road in the vicinity of the junction.

2.2.2.21 C0363 Moira Road

The C0363 Moira Road junction (LILO 22) is located on the northbound carriageway of the A1 approximately 2.4km west of the town of Hillsborough at approximately mainline scheme Ch. 23+700. The existing at grade T- junction with the A1 is lit and has dedicated diverge and merge lanes for northbound traffic with a physical island to direct merging traffic. The gap in the central reserve which facilitated right turning vehicles travelling southbound was closed as part of the advanced works undertaken in January 2017 as part of the overall schemes objectives through the removal of the crossing facility and the installation of a continuous central reserve barrier. Adjacent to the junction on the C0363 Moira Road is the Downshire rifle club which has facilities which are below the level of the A1.

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that historically permitted crossovers. Following completion of advanced central reserve barrier installation works in 2017 this no longer permits crossover manoeuvres. The national speed limit applies to both the A1 and the C0363 Moira Road in the vicinity of the junction.

2.2.3 Compact Grade Separated Junctions (CGSJs)

2.2.3.1 Listullycurran Road / Backnamullagh Road

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders, and a central reserve that permits crossovers.

The Listullycurran Road forms a simple "T" junction with the A1 northbound carriageway, whilst the Backnamullagh Road forms a "T" junction with the A1 southbound carriageway. The junctions are approximately 400m apart along the A1 and whilst no merge or diverge lanes are provided for vehicles to enter or exit these side roads, right turn lanes are provided within the central reserve for vehicles making right turns into both. Vehicles making right turns out of either road typically traverse the first carriageway to wait within gaps in the central reserve, manoeuvring into the second carriageway when gaps in traffic permit.

Neither the A1 nor the Listullycurran Road or Backnamullagh Road is lit in the vicinity of the junctions although illuminated bollards are provided in the central reserve at the crossings. In addition, there are several direct accesses onto the A1 from residential and commercial properties within the vicinity of the Listullycurran Road/Backnamullagh Road study area

The national speed limit applies to both the A1 dual carriageway in the vicinity of the junctions and the side roads.

The existing sightlines of Listullycurran Road were measured using Ordnance Survey (OS) mapping in accordance with the guidance provided within the DMRB Vol 6, Section 2, Part 6, TD42/95 which recommends minimum sightlines of 9m x 295m. At an 'x' distance of 9m, visibility to the right and to the left of the junction was found to be at or greater than 295m.

The existing sightlines of Backnamullagh Road were measured in the same manner. At an 'x' distance of 9m, visibility to the right of the junction was determined to be at or in excess of 295m, whereas visibility to the left was determined to be 93m. TD 42/95, Para. 7.8 allows for a relaxation from 9.0m to 4.5m for lightly trafficked junctions. At a reduced 'x' distance of 4.5m, visibility to the left was determined to be 113m. The sightline to the right, looking towards the approaching southbound traffic is more critical and achieves a 'y' distance that meets the standard. TD 42/95, Para. 7.8 allows for further relaxation to 2.4m in exceptionally difficult circumstances. At a reduced 'x' distance of 2.4m, visibility to the left was determined to be 212m.

2.2.3.2 **Milebush Link Road**

The Milebush Road South (east) and Milebush Road South (west) form a staggered crossroad junction with the A1. Gaps in the central reserve facilitate right turn manoeuvres and right turn lanes are provided within the central reserve. A short nearside diverge lane is present on the northbound carriageway. Merge lanes are not provided at either junction. The junctions are located on a section of carriageway which is currently lit. A CGSJ was constructed at Hillsborough Road in 2005 to provide an underpass beneath the A1 carriageway with link roads to both sides of the A1 carriageway (via Hillsborough Road on the southbound carriageway. This CGSJ is approximately 160m north of Milebush Road South (West).

Milebush Road South (West) runs in a north easterly direction for a length of approximately 1.66km and intersects with the A1 at the Milebush Road North junction. The existing cross section of the Milebush Road varies however it is typically narrow with widths around 3.7m. The verge width varies between 1m and 1.5m and some gradients are in excess of 10%.

The speed limit on the compact connector road at Hillsborough Road, Dromore is 30mph. The national speed limit applies on the Milebush Road.

2.2.3.3 **Gowdystown Road**

The existing A1 within the junction study area is a 2 lane Category 5 dual carriageway with hard shoulders and a central reserve that permits crossovers.

B25 Gowdystown Road (east) and Gowdystown Road (west) form a staggered crossroad junction with the A1. Gaps in the central reserve facilitate right turn manoeuvres and right turn lanes are provided within the central reserve. Short nearside diverge lanes are present in both carriageways. Merge lanes are not provided at either junction.

Neither the A1 nor the side roads are lit in the vicinity of the junctions.

The existing sightlines at Gowdystown Road were measured using OS mapping in accordance with guidance provided within the DMRB Vol 6, Section 2, Part 6, TD42/95 which recommends minimum sightlines of 9m x 295m for this location. It was not possible to achieve the required y-distance of 295m from a distance of 9m back from the give-way line at either the eastern or western Gowdystown Road junctions.

At an ‘x’ distance of 4.5m, the existing sightlines from Gowdystown Road (West) were measured to provide 295m visibility to the right of the junction and 222m to the left. The sightline to the right, looking towards the approaching northbound traffic is more critical and achieves a ‘y’ distance that meets the standard. At a reduced ‘x’ distance of 2.4m, visibility to the left was determined to achieve a ‘y’ distance that meets the standard.

At an ‘x’ distance of 4.5m, the existing sightlines from Gowdystown Road (East) were measured to provide 295m visibility to the right of the junction and 295m to the left. The more critical sightline, to the right looking towards the approaching southbound traffic has a ‘y’ distance that meets the standard.

The national speed limit applies to both the A1 dual carriageway in the vicinity of the junctions and the side roads.

2.2.3.4 Skeltons Road / Drumneath Road

Skeltons Road and Drumneath Road form a staggered junction with the A1 Hillsborough Road. Access at Skeltons Road is restricted, permitting only left turn manoeuvres out of the road onto the A1 utilising the nearside merge lane. Manoeuvres from the A1 into Skeltons Road are made via a short section of Halfway Road, with right turning vehicles availing of the right turn lane within the central reserve. This arrangement permits a right turn lane to be provided within the central reserve for vehicles turning into Drumneath Road. There is no diverge lane for southbound traffic turning into Drumneath Road, however a wide merge is provided for A1 southbound carriageway. This wide merge also accommodates u-turning vehicles heading southbound from the Skeltons Road junction.

The existing sightlines from Skeltons Road on the western side and Drumneath Road on the eastern side of the A1 were measured using OS mapping. Guidance provided within the DMRB Vol 6, Section 2, Part 6, TD42/95, recommends minimum sightlines of 9m x 295m based on the conditions at this location.

At the Skeltons Road junction, it was not possible to achieve the required y-distance of 295m from a distance of 9m back from the give-way line; however from a reduced x-distance of 4.5m, the recommended y-distance was achieved in both directions.

Similarly, it was not possible to achieve the recommended 9m x 295m sightlines from Drumneath Road access. However from an 'x' distance of 4.5m, visibility of 295m is achieved to the right of the junction and 169m to the left. The sightline to the right, looking towards the approaching southbound traffic is more critical and achieves a 'y' distance that meets the standard. At a reduced 'x' distance of 2.4m, visibility to the left was determined to be 192m.

Neither the A1 nor the side roads are lit in the vicinity of the junctions.

The national speed limit applies to both the A1 dual carriageway in the vicinity of the junctions and the side roads.

2.2.3.5 **Waringsford Road**

Waringsford Road forms a T-junction with the A1, where a right-turn lane is provided within the central reserve. No diverge lane is provided for access to Waringsford Road from the north. Quarry Road meets Waringsford Road within 40m of its junction with the A1. Right turn movements out of Waringsford Road are achieved by crossing the southbound A1 into the refuge of the central reserve and from there completing the right turn manoeuvre when sufficient gaps in the approaching northbound traffic permit. The existing A1 at this location is a 2-lane dual carriageway with hard shoulders and a central reserve that permits crossovers.

Neither the A1 nor Waringsford Road is lit in the vicinity of the junction.

The national speed limit applies to both the A1 dual carriageway in the vicinity of the junctions and the side roads.

The existing sightlines from Waringsford Road on the eastern side of the A1 were measured using OS mapping and in accordance with the guidelines provided within the DMRB Vol 6, Section 2, Part 6, TD42/95. It was not possible to achieve the required y-distance of 295m from a distance of 9m back from the give-way line on the Waringsford Road; however from a reduced x-distance of 4.5m, the recommended y-distance was achieved in both directions.

2.2.3.6 **Castlewellan Road On-Slip**

The location of the proposed slip-road junction from the A50 Castlewellan Road onto the northbound carriageway of the A1 Dromore Road is approximately 1km east of Banbridge town centre on the outskirts of the town. The proposed slip-road is bound by a residential area to the northwest of the A1, Chinauley Park. Access to the A1 from the Castlewellan Road is currently via the Old Manse Road with all movements permitted. There is no merge or diverge lane at this junction, however a right turn lane is provided within the central reserve for vehicles turning into the Old Manse Road from the A1.

The A50 Castlewellan Road is a category 1, standard urban single S2 carriageway and crosses the A1 via an overbridge. The existing road width is approximately 9.5m which facilitates the provision of a right turn ghost island for vehicles making right turn manoeuvres into the existing Chinauley Park junction. The footway width varies however it is typically 2m and widens to 6m along the length of the overbridge on the A1.

Chinauley Park is located approximately 25m from the North West corner of the existing overbridge on the A1. It forms a simple “T” junction with the A50 Castlewellan Road and meets the A50 Castlewellan Road at approximately 90 degrees. The width of Chinauley Park varies however it generally has a minimum width of 7.3m. The junction also has a segregated left slip lane on the eastbound approach from Banbridge which is separated from the main junction by a splitter island. The left slip lane is approximately 33m long and has a simple give way junction with Chinauley Park.

The existing sightlines of Chinauley Park were measured using OS mapping in accordance with the guidance for private access roads provided within Development Control Advice Note 15 (DCAN15) which recommends minimum sightlines of 4.5m x 120m. At an ‘x’ distance of 4.5m, visibility to the right and to the left of the junction was found to be at or greater than 120m.

The A1 is lit at the Old Manse Road junctions and street lighting is provided on the overhead Castlewellan Road Bridge.

The speed limit on the A1 in the vicinity of the works location is restricted to 60mph. The speed limit on the Castlewellan Road at the A1 overbridge is 40mph.

2.3 EXISTING TRAFFIC CONDITIONS

2.3.1 Traffic and Vehicle Data

The extent of the traffic assessment is between Hillsborough Roundabout, to the north and Dublin Road, Loughbrickland to the south.

The DfI maintains a number of permanent Automatic Traffic Counters (ATC) sites throughout Northern Ireland and publish the data annually via their website. Within the study area there are several ATC sites from which data is available, illustrated in Figure 2.1. These sites are:

- 522 Lisburn
- 530 Hillsborough
- 410 Dromore
- 411 Banbridge
- 419 Loughbrickland

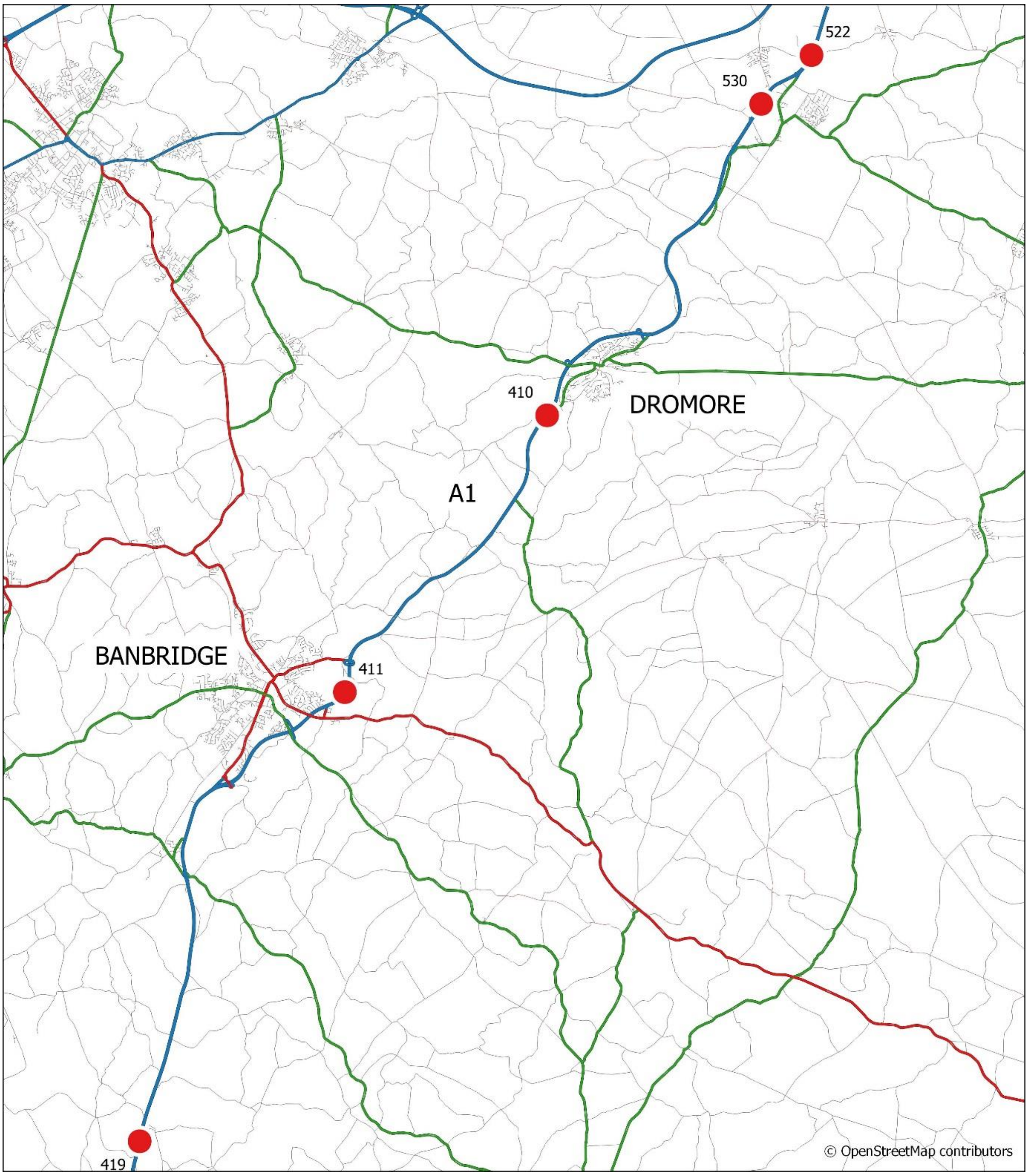


Figure 2.1 – ATC Sites

The ATC data was used to determine growth rates, seasonality adjustments and 12 to 24 hour factors which were applied to recently surveyed traffic counts.

Annual Average Daily Traffic (AADT) flows from the local ATC sites are presented in Table 2.1 below.

Table 2.1 – AADT flows from local ATC Sites

Site No.	Location	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016*
Site 522	Lisburn	33695	37320	37550	39510	34910	40190	39230	39200	40980		39780	41820	39815
Site 530	Hillsborough	27160	28050	29820	30790	31870	0	30000	32020	31720	30630	33860	33430	32122
Site 410	Dromore	24540	24750	25750	27280	27470	0	0	0		27110	28150	28980	30278
Site 411	Banbridge	19790	19550	20410	22160	22660	23060	22380	23170	23930	25670	25570	26180	25707
Site 419	Loughbricklan d	18100	18210	0	19060	19880	19790	20400	21650	22230	23530	23820	25280	26338

Source: Department for Infrastructure 2015 Annual Traffic Census Report
**Processed from raw data supplied by the Department for Infrastructure*

As shown in Table 2.1, the 7 Day AADT flows are higher at the northern end of the study area compared to the southern end. To the north, located around Hillsborough the AADT as recorded by counters 522 and 530 showed a flow of between 39,820 and 32,120 vehicles in 2016. To the south of the A1 located at Banbridge counters 411 and 419 recorded AADTs of between 25,710 and 26,340 vehicles in 2016.

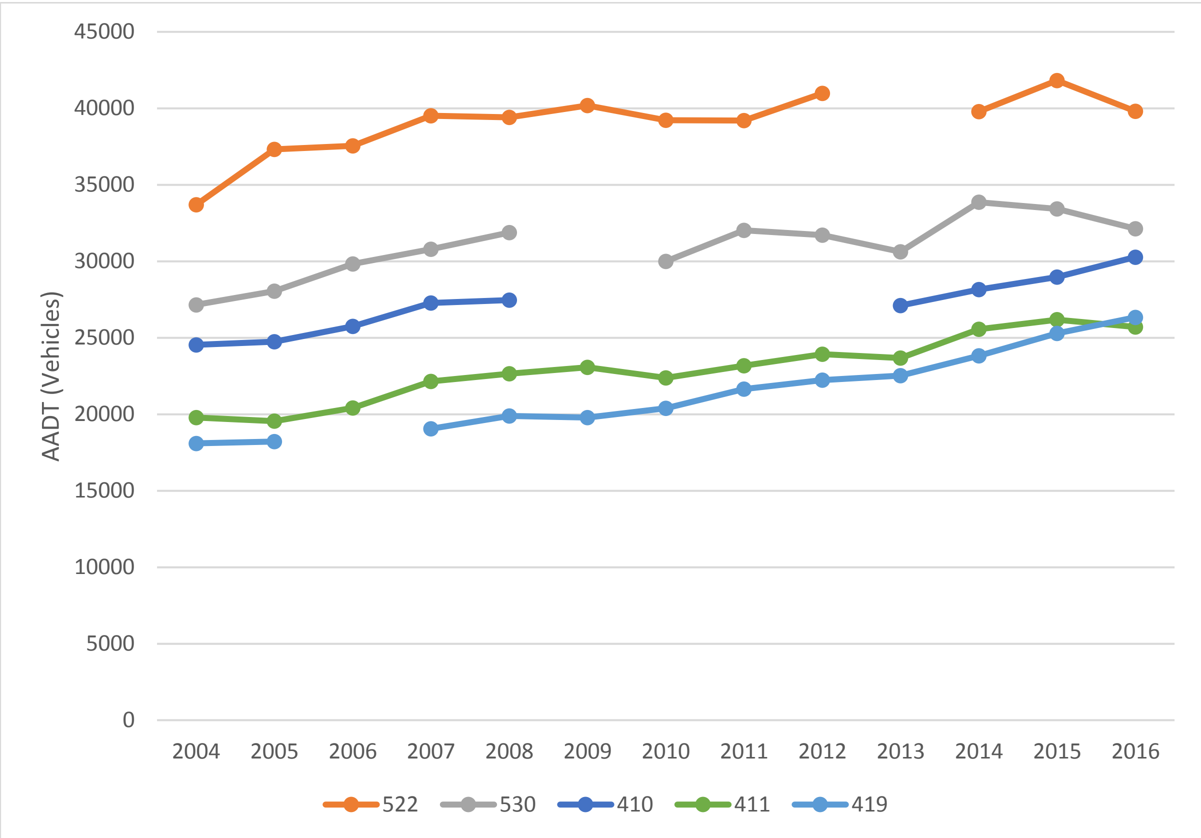


Figure 2.2 – A1 Annual average daily traffic flows (2004 to 2016)

Figure 2.2 illustrates traffic growth from available ATC data from 2004 to 2016 and the increasing level of flow observed at counters from south to north in the study area.

Figure 2.3 below shows annual profile by month for counters at Loughbrickland and Dromore in 2015. These sites have been used as they provide the most recent complete data set available from ATC data. The graph shows higher flows in August at both sites and lowest flows in January.

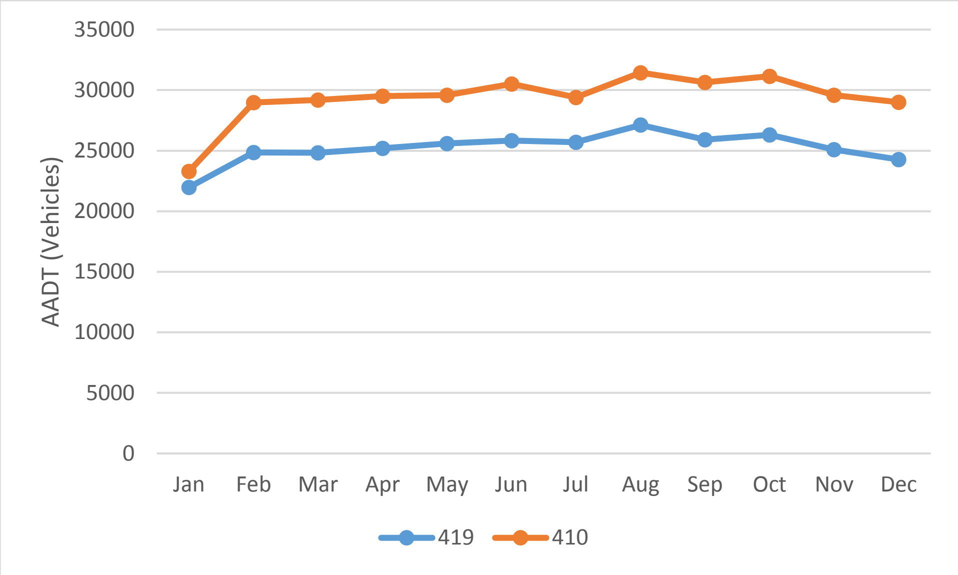


Figure 2.3 – A1 Monthly average daily traffic flows (2015)

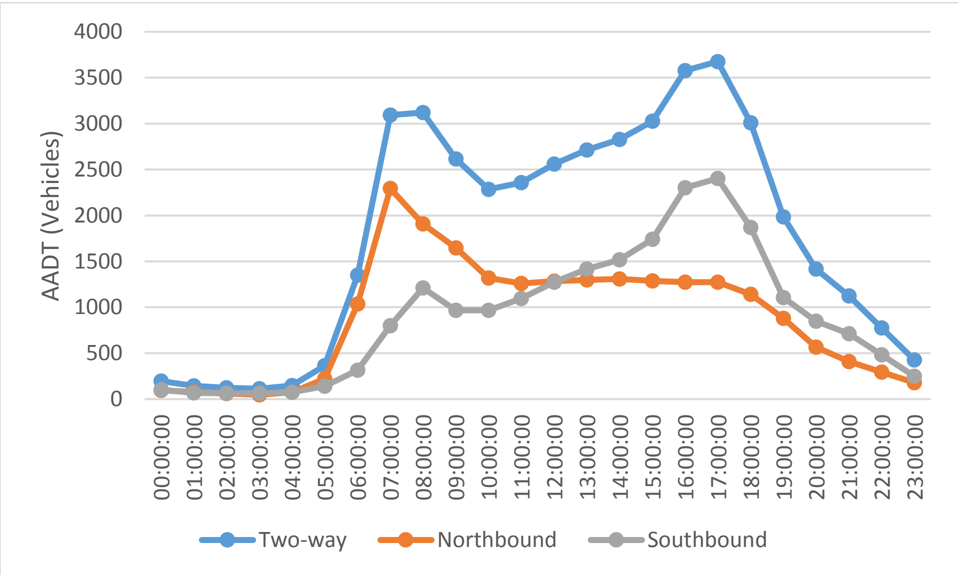


Figure 2.4 – Average Weekday Daily Profile 2016 – A1 Site 522 Lisburn

Figure 2.4 to Figure 2.8 present daily profiles in 2016 for northbound, southbound and two-way traffic at the ATC counters. The graphs illustrate an AM peak between 8:00 – 9:00 and a PM peak between 17:00 and 18:00 at all sites. Northbound AM flows are higher at all sites with inverse flows travelling southbound in the PM. This trend is more pronounced at the sites further north.

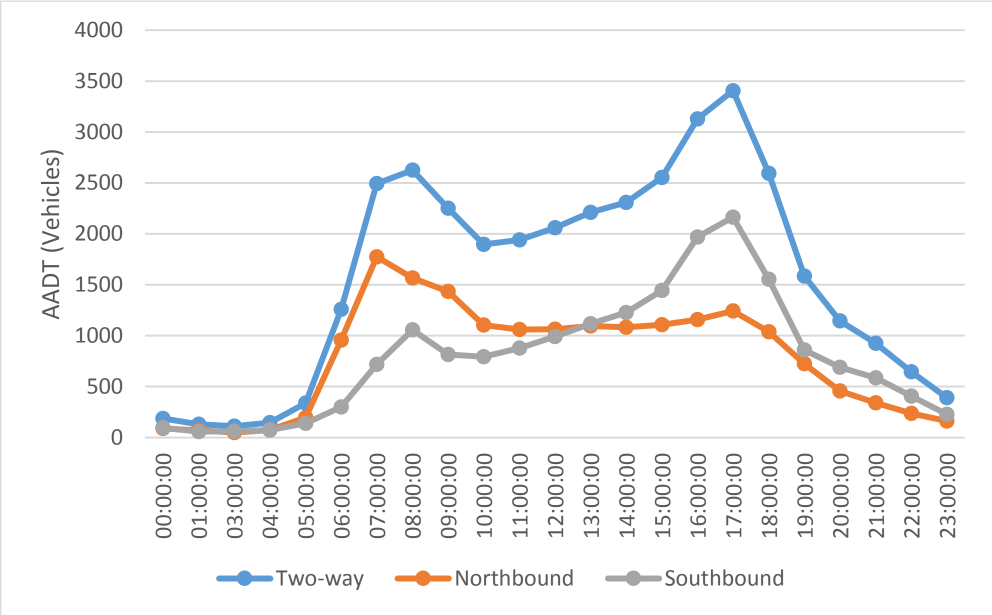


Figure 2.5 – Average Weekday Daily Profile 2015 – A1 Site 530 Hillsborough

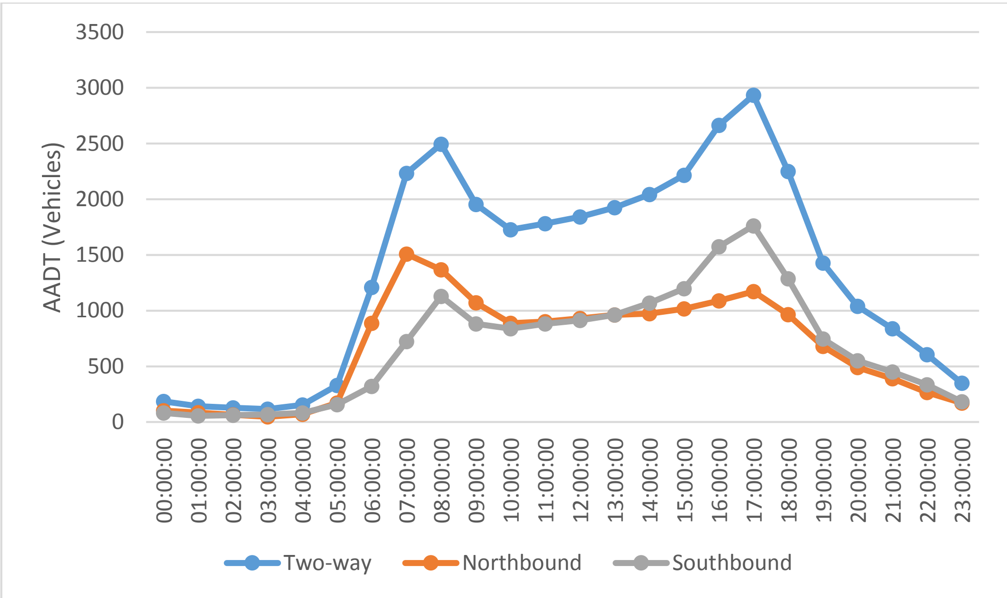


Figure 2.6 – Average Weekday Daily Profile 2016 – A1 Site 410 Dromore

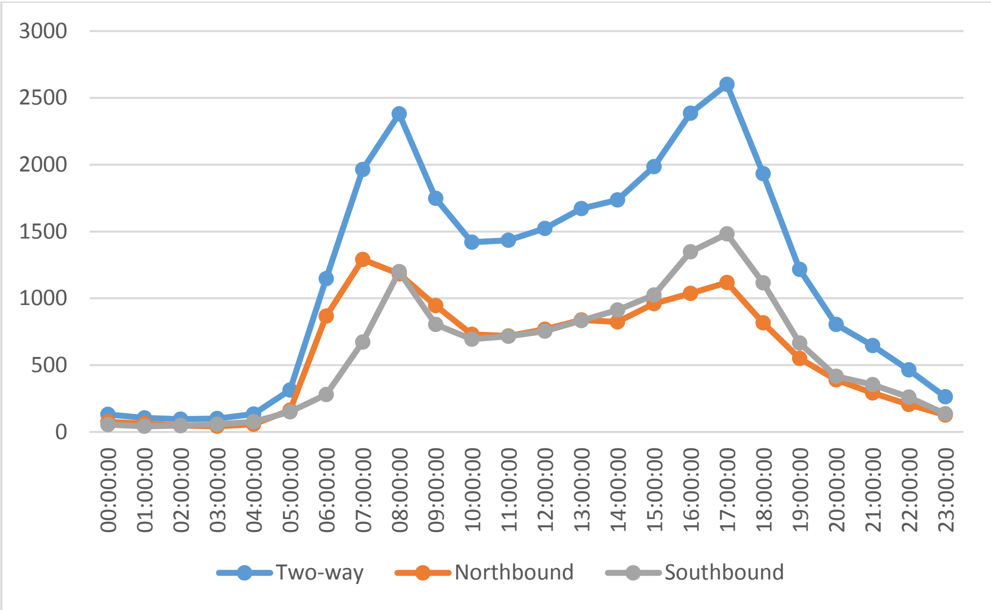


Figure 2.7 – Average Weekday Daily Profile 2016 – A1 Site 411 Banbridge

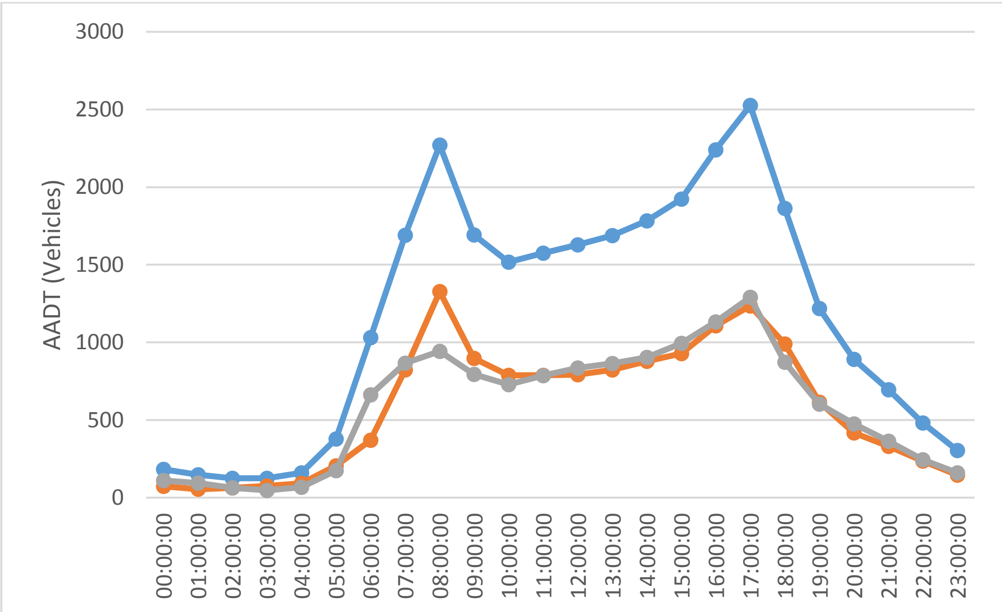


Figure 2.8 – Average Weekday Daily Two-way Profile 2016 – A1 Site 419 Loughbrickland

Table 2.2 presents observed journey times between the grade-separated junction at Loughbrickland to the Hillsborough Roundabout, a distance of approximately 25km. With the exception of northbound journeys in the AM peak, journey times are broadly consistent for both directions in all peaks with all average journey times between 15 and 16 minutes. Northbound journey times in the AM peak exceed 17 minutes. This is due to congestion at the Hillsborough Roundabout in the morning peak.

Table 2.2 – Average Journey Times: A1 Hillsborough Roundabout to Loughbrickland Grade-separated Junction

Average Journey Times (mins)		
	Northbound	Southbound
07:00 – 10:00	17:08	15:15
11:00 – 14:00	15:05	15:05
16:00 – 19:00	15:28	15:42

Table 2.3 presents the percentages of heavy vehicles observed in proximity to the ATC site locations. The percentage ranges from 8% to 12% with a slightly higher composition in sites at the southern end of the study area.

Table 2.3 – A1 Heavy Vehicle Percentages

Area	% HV
Lisburn	8%
Hillsborough	9%
Dromore	10%
Banbridge	12%
Loughbrickland	11%

2.3.2 Public Transport

Figures provided by Translink show that there are very low passenger numbers on the local service on the A1 with an average of 1-2 patrons at the more frequented bus stops per day. There are some bus stops on the route that do not see any regular use. The bus stop usage is shown in Table 2.4 below.

Table 2.4 – Bus Stop Usage Data

Location	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Average Use Daily
Stanfields / Dromore Road Lower	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	5	0	5	0	4	0	6	0	4	0	n/a	n/a	n/a	n/a	4.8
Southbound	0	5	0	5	0	2	0	5	0	3	n/a	n/a	n/a	n/a	4.0
Dromara Road / Dromara Road Middle	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	3	0	3	0	3	0	3	0	3	0	n/a	n/a	n/a	n/a	3.0
Southbound	0	3	0	3	0	3	0	3	0	3	n/a	n/a	n/a	n/a	3.0
Edentrillick Upper	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Southbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Edentrillick	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	4	0	4	0	4	0	4	0	3	0	n/a	n/a	n/a	n/a	3.8
Southbound	0	4	0	4	0	4	0	4	0	3	n/a	n/a	n/a	n/a	3.8

Dromore / Listullycurran	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	2	0	2	0	2	0	2	0	2	0	0	0	0	0	1.4
Southbound	1	2	1	2	1	2	1	2	1	2	0	0	0	0	2.1
TK Diner	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Southbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Listullycurran Corner	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Southbound	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0.3
Listullycurran Upper/Lower	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	2	0	2	0	2	0	2	0	2	0	0	0	0	0	1.4
Southbound	1	2	1	2	1	2	1	2	1	2	0	0	0	0	2.1
Milebush Road	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	3	0	4	0	3	0	2	0	3	0	3	0	0	0	2.6
Southbound	0	3	0	4	0	3	0	2	0	3	0	2	0	0	2.4
Dangerous Corner	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Southbound	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0.7
Grove Road	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	2	2	2	2	2	2	2	2	1	2	0	0	0	0	2.7
Southbound	1	2	1	2	1	2	1	2	1	2	0	0	0	0	2.1
Cherry House	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Southbound	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Quillyburn	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0.7
Southbound	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0.7
Cunginhams Hill	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Southbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Boals Lane	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	0	2	0	2	0	2	0	2	0	1	0	0	0	0	1.3
Southbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Mullans Corner	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	0	4	0	4	0	4	0	4	0	3	2	0	0	0	3.0
Southbound	4	0	4	0	4	0	4	0	3	0	0	2	0	0	3.0
Mullans / Dromore Road	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Southbound	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Mount IDA Road	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0.7
Southbound	2	0	2	0	2	0	2	0	2	0	0	0	0	0	1.4
Halfway House	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	0	2	0	1	0	1	0	2	0	1	0	0	0	0	1.0
Southbound	2	0	1	0	1	0	2	0	1	0	0	0	0	0	1.0
Edenordinary Road / Edengarry Road	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	

Northbound	0	1	0	1	0	1	0	1	0	1	0	0	0	0	0.7
Southbound	1	0	1	0	1	0	1	0	1	0	0	0	0	0	0.7
Browns Planting	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	3	3	3	4	3	3	3	4	3	4	0	0	0	0	4.7
Southbound	3	3	4	3	3	3	4	3	4	3	0	0	0	0	4.7
Agnews	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Southbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Kilmacrew Road	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	2	2	2	2	2	2	2	2	1	2	0	0	0	0	2.7
Southbound	1	2	1	2	1	2	1	2	1	0	0	0	0	0	1.9
Spratts Turn	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Southbound	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Ivy Cottage	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	Board	Alight	
Northbound	2	0	2	0	2	0	2	0	2	0	0	0	0	0	1.4
Southbound	0	2	0	2	0	2	0	2	0	2	0	0	0	0	1.4

Source: Translink

2.4 PUBLIC UTILITIES

Details of existing public utilities within the study area were obtained through liaison with the various owners. This information was provided in relation to the whole scheme as well as the preferred locations of the proposed CGSJs and associated side roads.

Details of existing services within the study area are illustrated on drawings 168014-RPSB-VUT-ML-DR-HE-100-(00001-00014) which are provided within Appendix E.

The existing utilities are noted as follows:

2.4.1 Northern Ireland Water (NIW)

NIW is responsible for water supplies and sewers within the study area.

A water main is present along the A1 throughout the study area. This is shown as being in the verge, it regularly switches between the northbound and southbound verge. A water main is also shown in the verge of most of the public side roads.

The existing sewer network appears to be confined to the built-up areas. At Banbridge the sewer is shown to be in the verge of the Castlewellan Road crossing the A1 and outside of Loughbrickland the sewer is shown to run along the A1 in the verge of the northbound carriageway from Newry Road, Banbridge to the junction at Banbridge Road, Loughbrickland where it returns into the built up area of Loughbrickland.

2.4.2 British Telecom (BT)

BT apparatus is present throughout the study area. Typically this is shown as a buried duct within the verge of the A1, but at times it switches to being an overhead cable. The cable regularly switches between the northbound and southbound verge apart from the section between Glen Road and Hillsborough Road where cables are present in both verges. Most of the apparatus within the A1 verge/hard shoulder is of fibre optic type.

In addition BT apparatus is present in most of the public roads joining the A1. These are typically overhead cables but in the more densely populated areas, such as Hillsborough, Dromore, Banbridge and Loughbrickland, the apparatus is shown as a buried duct.

2.4.3 Northern Ireland Electricity (NIE)

There is a range of NIE services shown throughout the study area. Typically these from part of the local distribution network and are rated at 11kV or less but there is a 33kV overhead transmission route that crosses the existing Waringsford Road and travels alongside the A1 for a distance of approx. 500m. There is also a 33kV underground transmission route in the northbound verge of the Castlewellan Road, Banbridge where it crosses the A1.

A 33 kV route is also present in the southbound verge of the A1 between Old Manse Road, Banbridge and the off-slip for ‘The Outlet’ (recently rebranded as ‘The Boulevard’ but shall be referred to as ‘The Outlet’ throughout this report for consistency) at Newry Road, Banbridge.

The local distribution network is generally outwith the existing A1 road boundary except where the two cross; these crossings being a mixture of overhead and buried cables. In built-up areas such as within Hillsborough, Dromore, Banbridge and Loughbrickland the local distribution network is typically provided by buried cables in the footways or verges.

2.4.4 Phoenix Gas

Phoenix Gas apparatus is present on the Moira Road, Hillsborough. The gas main currently crosses the A1 at the Moira Road. It is noted that Phoenix Gas are currently planning to extend their services east towards Hillsborough and Dromore utilising the local road network.

2.4.5 Firmus Gas

Firmus Gas apparatus is present within the study area. The gas main currently runs from the Rathfriland Road Junction in the verge of the northbound carriageway to Lisnaree Road. The gas main then follows Lisnaree Road, crossing the Dromore Road before returning to cross the A1 just north of the existing Dromore Road CGSJ. The gas main continues north in the southbound verge to Kilmacrew Road. A local spur serving the Old Manse Road, Banbridge also crosses the A1 at the Old Manse Road junction with the A1.

2.4.6 Street Lighting and Other Department for Infrastructure Apparatus

Along the existing A1 a street lighting system is provided at a number of the existing junctions as follows:

- Hillsborough Roundabout;
- Moira Road Junction;
- Dromore Road Junction, Hillsborough (Pantridge Link);
- Hillsborough Road Junction, Dromore;
- Lurgan Road Junction, Dromore;
- Banbridge Road Junction, Dromore;
- Dromore Road Junction, Banbridge;
- Old Manse Road Junction, Banbridge;
- Rathfriland Road Junction, Banbridge;
- Newry Road Junction, Banbridge;
- Banbridge Road Junction, Loughbrickland; and
- Dublin Road (Loughbrickland).

2.5 GEOLOGY AND SOILS

A desktop review of the geology and soils has been carried out using the available published data. In addition, an intrusive ground investigation was undertaken in the autumn / winter of 2016 which has provided further, site specific, information. The results of this ground investigation are reported in the following factual reports:

- A1 Junctions – J1 Listullycurran Road – Site Investigation – Report No. 16-1109, Causeway Geotech March 2017;
- A1 Junctions – J2 Milebush Road – Site Investigation – Report No. 16-1110, Causeway Geotech April 2017;
- A1 Junctions – J3 Gowdystown Road – Site Investigation – Report No. 16-1111, Causeway Geotech March 2017;
- A1 Junctions – J4 Skeltons Road – Site Investigation – Report No. 16-1112, Causeway Geotech March 2017; and
- A1 Junctions – J5 Waringsford Road – Site Investigation – Report No. 16-1113, Causeway Geotech April 2017.

This information has been interpreted with a further report produced to summarise the results, *Geotechnical Interpretive Report*, November 2017. The geology and soils are discussed in greater depth in the Environmental Impact Assessment Report (EIAR) but are summarised below:

2.5.1 Bedrock Geology

The bedrock geology of the area was obtained from a desktop study of the Geological Survey of Northern Ireland (GSNI) website. The predominant bedrocks beneath the study area are sandstone, siltstone and mudstone, from the Wacke Formation. The ground investigations also recorded the presence of shale and basalt.

The most predominant rock in the area is a Rhuddanian - Telychian sandstone from the Gala Group Formation. The ground investigations primarily recorded the presence of shale and this is indicated below in Figure 2.9 in purple. The shale is from the Moffatt Shale Group Formation, consisting of Caradoc – Llandovery age mudstone formation. A number of igneous intrusions are also identified on, or in close proximity to, the study area. These Palaeogene dykes consist of either Felsite or Microgabbro.

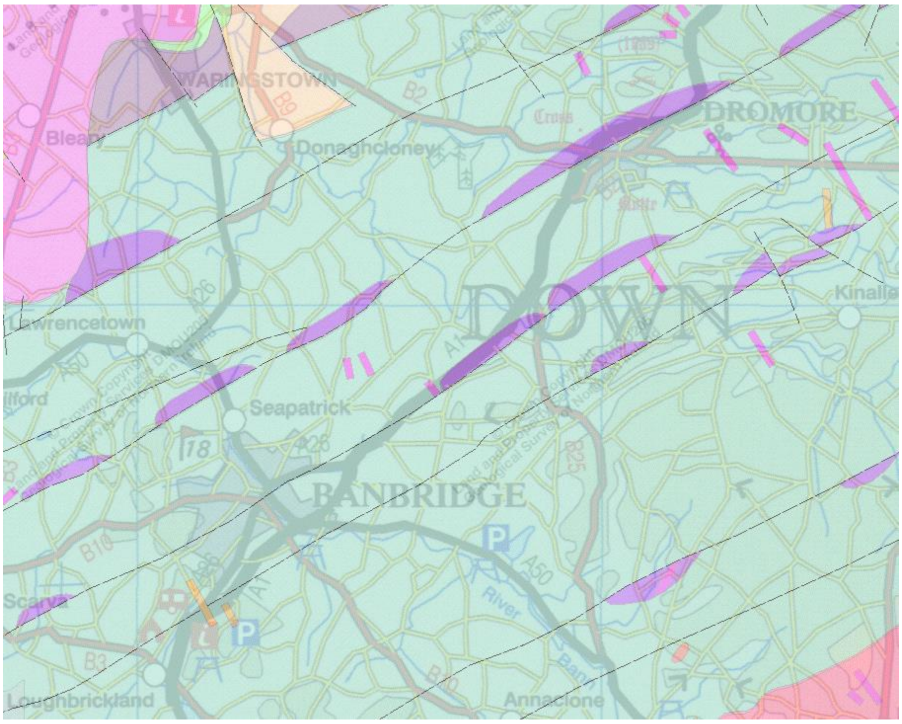


Figure 2.9 – Bedrock Geology (BGS, 2018)

Bedrock was encountered in over 26% of boreholes and trial pits. It has been described as highly weathered shale, with sections of weathered basalt. The deepest rock head recorded is in BH06 at the J4 Skeltons Junction where bedrock was encountered at 13.8m below ground level (bgl). The shallowest rock head encountered is at BH02 in the Waringsford Road Junction (J5) at 1.10m bgl.

In general, the rock encountered can be described as highly weathered shale, with a rock strength classification typically being weak.

2.5.1.1 **Listullycurran Road / Backnamullagh Road Bedrock Geology**

The predominant bedrock at the location of the Listullycurran Road / Backnamullagh Road Junction is Gala Group wacke formations as shown in Figure 2.10 below.

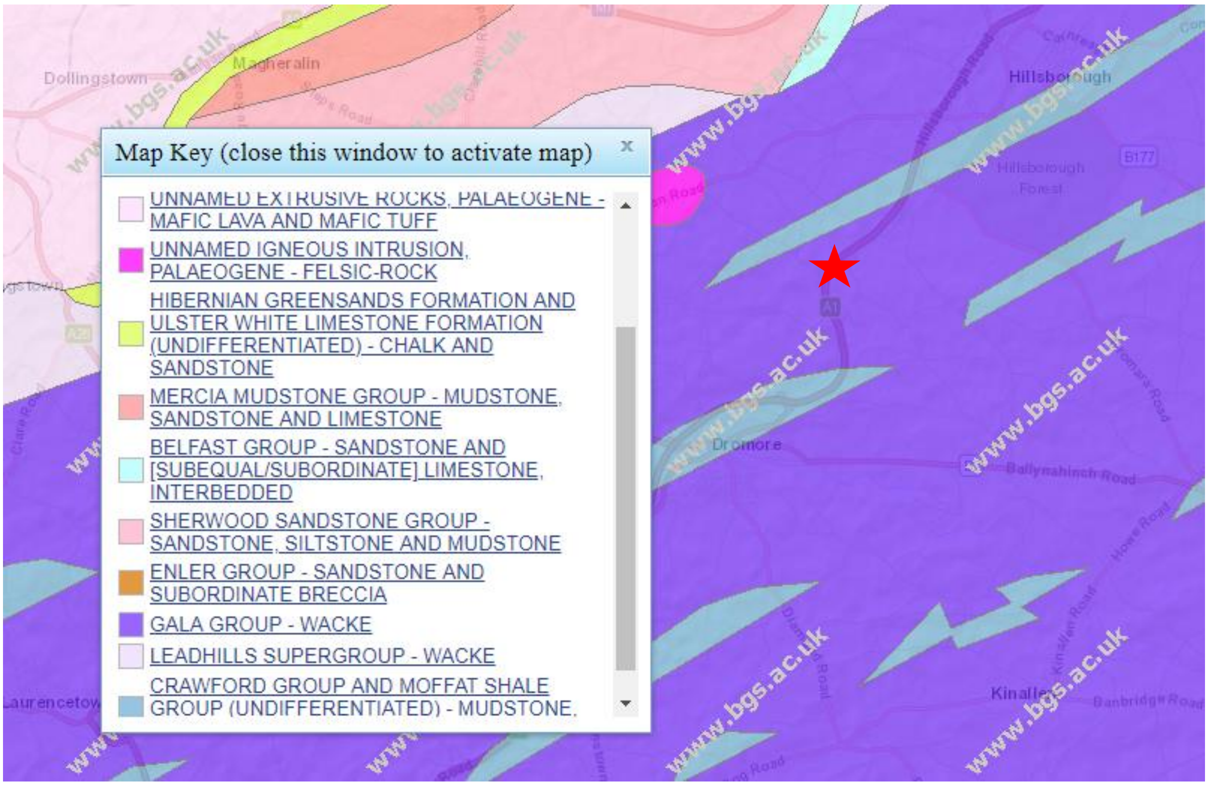


Figure 2.10 – Listullycurran Road / Backnamullagh Road Bedrock (BGS, 2018)

Wacke from the Gala Group is described as Graded beds that may include wacke sandstone, siltstone and mudstone in variable proportions, interpreted as turbidites. Rare interbedded graptolite-bearing beds.

Ground investigations were conducted at the Listullycurran Road / Backnamullagh Road junction in November and December of 2016. Three cable percussion boreholes with rotary follow on were conducted at the junction. Bedrock was encountered at the depths shown in Table 2.5 below.

Table 2.5 – Listullycurran Road / Backnamullagh Road Bedrock

Listullycurran Road / Backnamullagh Road Rock Characteristics				
Test No.	Depth (m) bgl	Elevation (m) OD	Rock Type	RQD (%)
PBH01	1.8	134.87	Highly weathered shale	19 – 38
PBH02	3.8	131.67	Highly weathered shale	3 -20
PBH03	7.2	135.97	Highly weathered shale	0 – 45

It is evident from the site investigations that the predominant bedrock in this area is highly weathered Shale with rock quality designation in the range of 0-45%. The bedrock was encountered at elevations between 131.67m Ordnance Datum (OD) and 135.97m OD. Rock outcrops were identified on site and rock was encountered at shallow depth on the north side of the A1 mainline at a depth of 1.80m bgl to 2.0mbgl. The Rock Quality Designation (RQD) values determined in the core samples are indicative of very poor to poor rock quality.

2.5.1.2 Milebush Link Road Bedrock Geology

Ground investigations were conducted at this location but bedrock was not encountered as the ground investigations were limited to trial pits. The British Geological Survey was consulted to obtain an indication of the bedrock at this location. The predominant bedrock in this area is described as Wacke from the Gala group and Sandstone and Limestone interbedded from the Belfast Group as shown below in Figure 2.11 below.

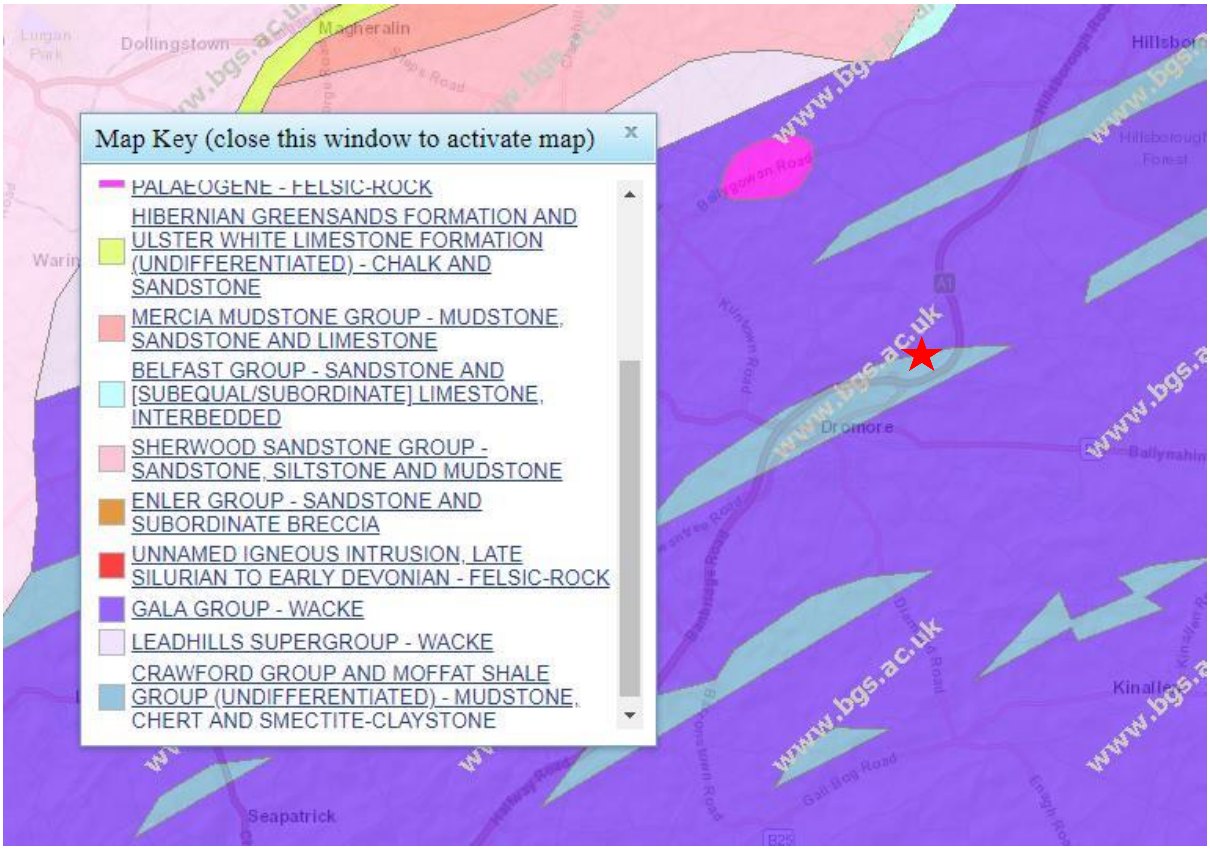


Figure 2.11 – Milebush Link Road Bedrock (BGS, 2018)

2.5.1.3 Gowdystown Road Bedrock Geology

The predominant bedrock geology in the location of the Gowdystown Junction is Wacke from the Gala Group formation shown below in Figure 2.12 below.

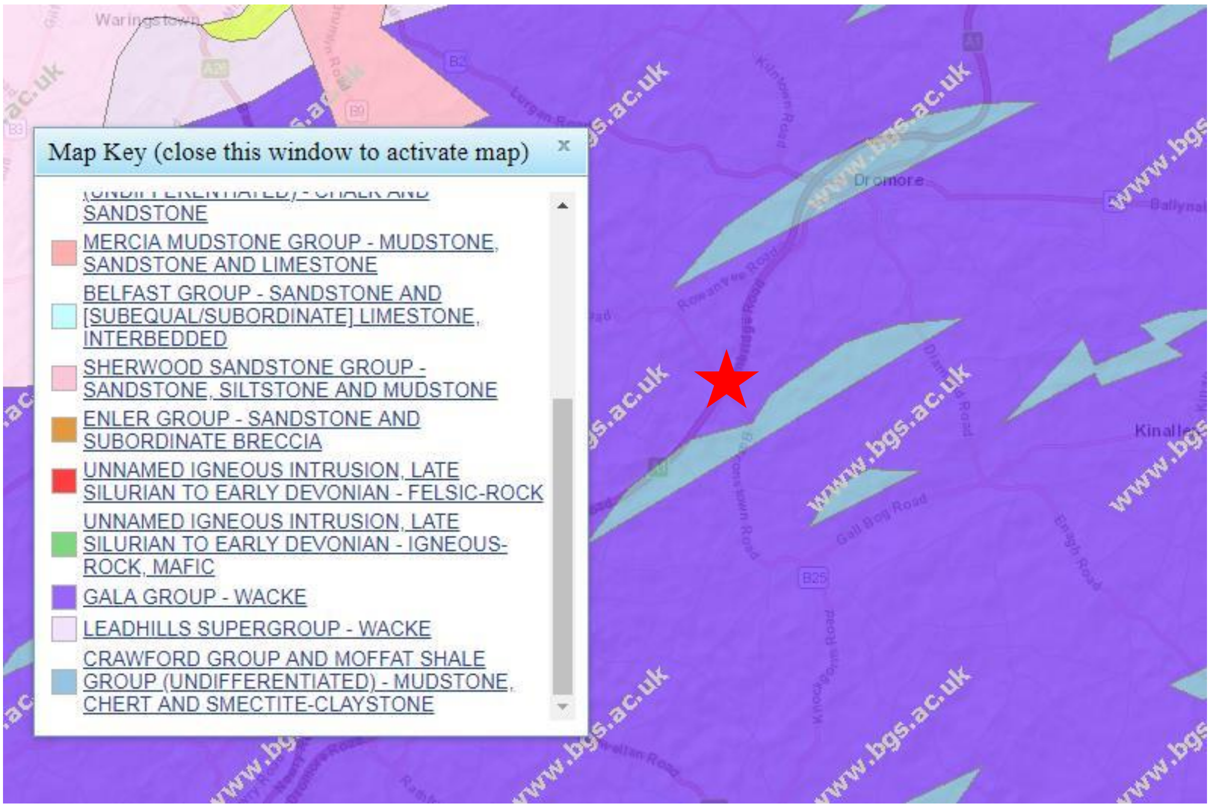


Figure 2.12 – Gowdystown Road Bedrock (BGS, 2018)

Ground investigations were conducted at the location of the proposed Gowdystown Junction in 2013 and 2016 as part of the Stage 2 & Stage 3 processes. In total between the two sets of ground investigations, five cable percussion boreholes with rotary follow on were conducted. The levels and quality of rock obtained in shown below in Table 2.6 below.

Table 2.6 – Gowdystown Road Bedrock

Gowdystown Road Rock Characteristics				
Test No.	Depth (m) bgl	Elevation (m) OD	Rock Type	RQD (%)
BH01	7.3			6 - 20
PBH01	3.4	71.08	Highly weathered fractured shale	6 - 20
PBH02	7.6	73.29	Highly weathered fractured shale	11 - 20
PBH03	5.1	76.76	Highly weathered fractured shale	58 - 81
PBH04	14.5	72.97	Highly weathered fractured shale	-

The bedrock at the location of this junction comprises predominately highly weathered and fractured shale. The elevation of rock head varies from 71.08m OD to 73.29m OD. The RQD values obtained in this junction vary with the majority of the rock encountered designated as poor quality however rock encountered to the east of the mainline can be described as fair quality.

2.5.1.4 Skeltons Road / Drumneath Road Bedrock Geology

The predominant bedrock at the location of the Skeltons Road / Drumneath Road junction is Wacke from the Gala formation as shown in Figure 2.13 below.

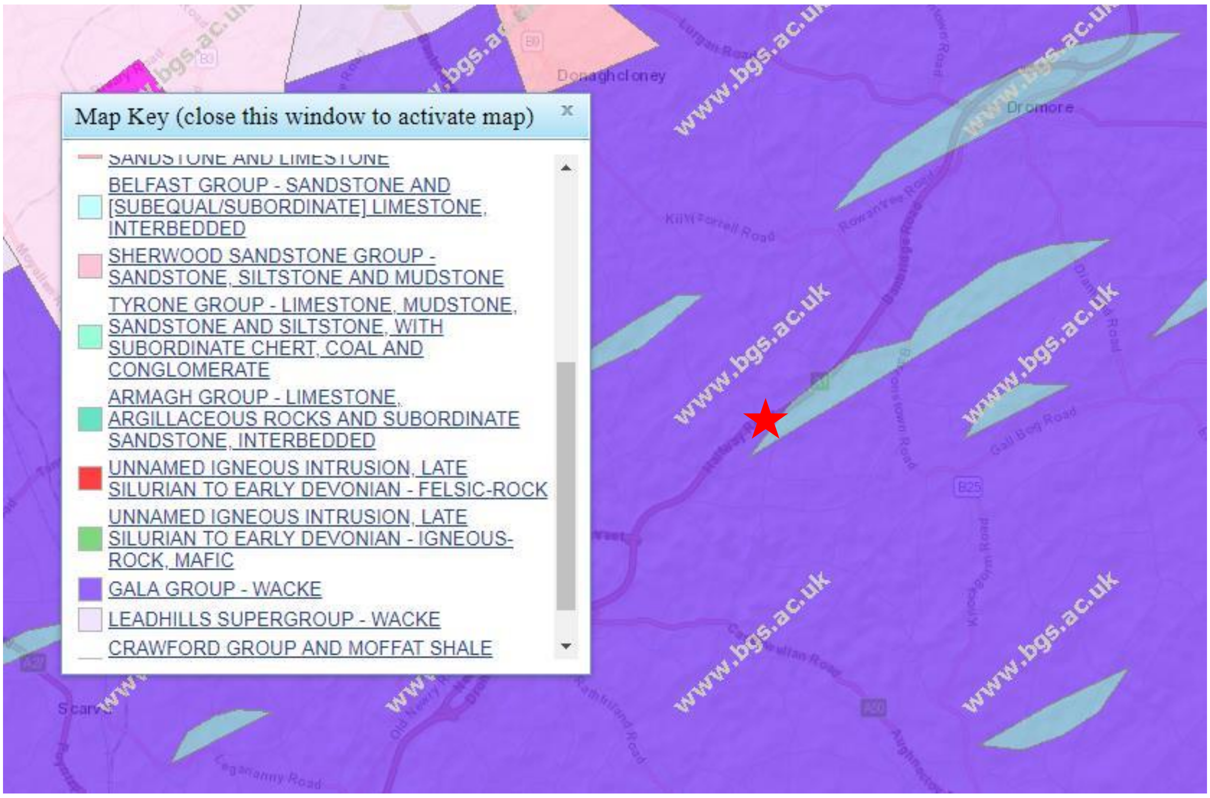


Figure 2.13 – Skeltons Road / Drumneath Road Bedrock (BGS, 2018)

Ground investigations were conducted at the location of the proposed Skeltons junction in 2013 and 2016. The elevation of rock head at each location and the rock quality is shown in Table 2.7 below.

Table 2.7 – Skeltons Road / Drumneath Road Bedrock

Skeltons Road / Drumneath Road Rock Characteristics				
Test No.	Depth (m) bgl	Elevation (m) OD	Rock Type	RQD (%)
BH01	3.6	83.75	Medium strong highly fractured dark grey basalt	0
BH02	4.8	85.23	Shale	-
BH03	4.6	86.29	Shale	0
BH04	12.5	92.96	highly fractured dark grey shale	>20
BH05	13.75	90.52	highly fractured non-intact dark grey shale	-
BH06	13.8	90.02	Highly fractured non-intact dark grey shale	-

The predominant rock encountered at this location was highly fractured dark grey shale and highly fractured dark grey basalt was encountered at to the north of the mainline. The elevation of rock head varies throughout the site. Rock head was encountered close to the existing mainline at an elevation of 83.75m OD to 86.29m OD. The elevation of rock increases to the south of the mainline to an elevation of 90.52mOD. Based on the RQD values obtained the rock in this area can be described as poor.

2.5.1.5 Waringsford Road Bedrock Geology

The predominant bedrock at the location of the Waringsford Road Junctions is Wacke from the Gala Group formation as shown in Figure 2.14 below.

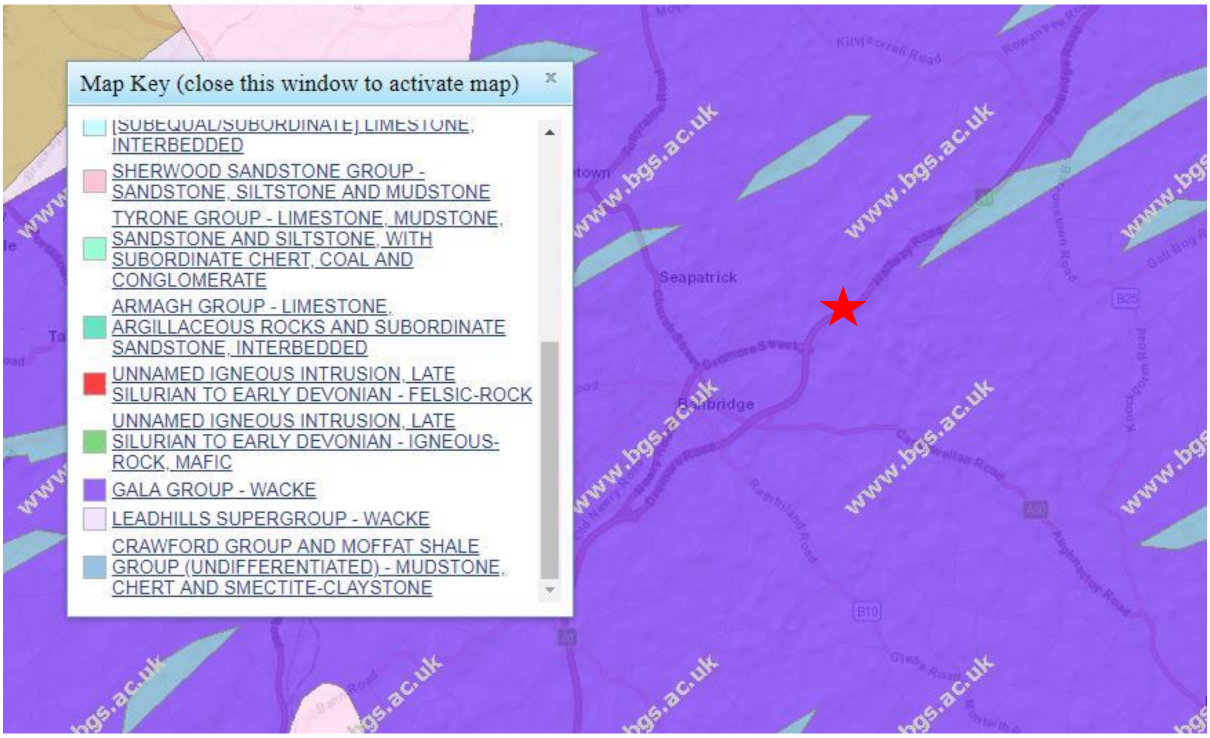


Figure 2.14 – Waringsford Road Bedrock (BGS, 2018)

Ground investigations were completed at this location and rock was encountered in five test locations. The elevation of the bedrock and rock quality is shown in Table 2.8 below.

Table 2.8 – Waringsford Road Bedrock

Waringsford Road Rock Characteristics				
Test No.	Depth (m) bgl	Elevation (m) OD	Rock Type	RQD (%)
BH01	5.7	80.84	Highly weathered highly fractured shale	15 - 20
BH02	1.1	80.21	Highly weathered highly fractured shale	12 - 20
BH03	4.0	77.85	Highly weathered highly fractured shale	9 - 10
BH04	4.5	77.40	Medium strong to strong dark grey shale	9 -20
WS01	1.35	85.44	Highly fractured weathered bedrock (drillers description)	-

The level of rock head at the location of this junction varies in elevation with the rock head to the north of the A1 mainline at an elevation between 80.84m OD and 80.21m OD. The elevation of the rock head to the south of the A1 mainline varies from 77.85m OD to 77.40m OD. The rock encountered in the vicinity of this junction comprises highly weathered highly fractured shale with RQD values varying from 9-20% this is indicative of poor rock that is highly fractured.

2.5.1.6 **Castlewellan Road On-Slip Bedrock Geology**

The predominant bedrock at the location of the Castlewellan Road On-Slip Junction is Wacke from the Gala Group formation as shown in Figure 2.15 below.

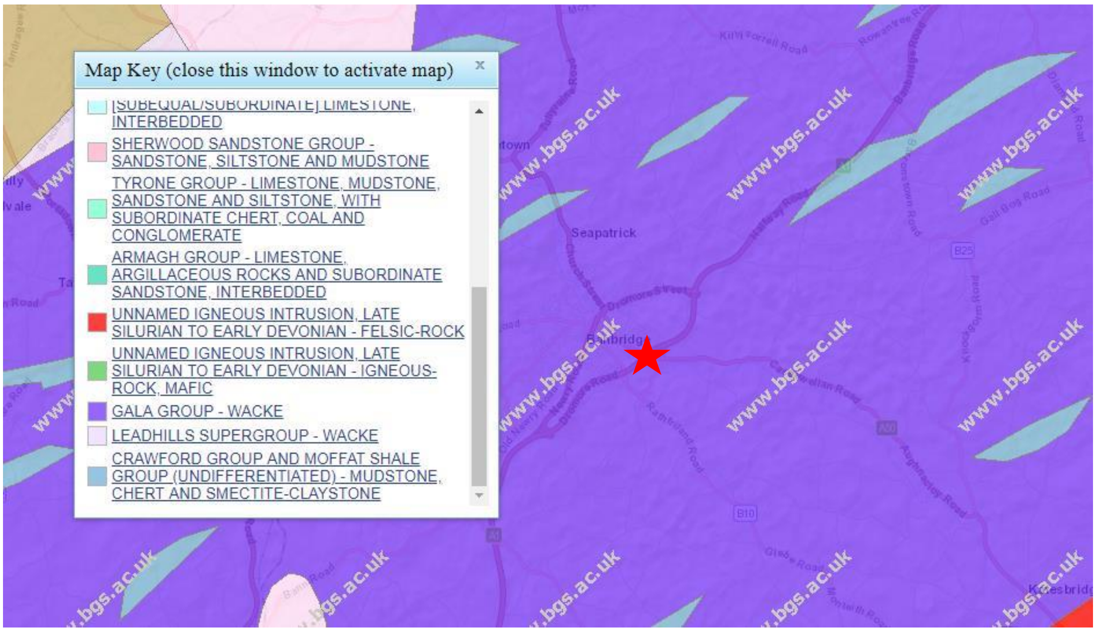


Figure 2.15 – Castlewellan Road On-Slip Bedrock (BGS, 2018)

Ground investigations were conducted at this location and rock was encountered in three boreholes at varying depths as shown in Table 2.9 below.

Table 2.9 – Castlewellan Road On-Slip Bedrock

Castlewellan Road On-Slip Rock Characteristics			
Test No.	Depth (m)	Rock Type	RQD (%)
BH01	8.7	Moderately Weathered grey Shale	-
BH02	6.8	Moderately Weathered grey Shale	-
BH03	3.5	Moderately Weathered grey Shale	-

The rock head was encountered at varying depths across the length of the proposed slip road with an elevation of 77.0mOD to 73.0mOD. The rock encountered comprises moderately weathered grey shale. The logs available don't determine the RQD values of the rock encountered.

2.5.2 Superficial Geology

Throughout the study area the bedrock is overlain by superficial deposits of varying thickness. Exposure of the bedrock at the surface is not common however some outcrops were identified at the northern section of the Listullycurran / Backnamullagh Road Junction.

Generally the superficial deposits throughout the study area are composed of sands and gravels of glacial origin from the Quaternary Period. These deposits also contain clays and silts. Peat deposits are also evident towards the centre of the study area at the Gowdystown junction.

Groundwater was encountered in a number of the borehole and trial pit locations during the Stage 2 and Stage 3 site investigation. Typically, groundwater was encountered between 0.3 and 3.7m and as such it is likely that groundwater will be encountered during the earthworks operation. In particular, a high groundwater table was identified within the major area of soft ground location at the Gowdystown junction.

2.5.2.1 Listullycurran Road / Backnamullagh Road Superficial Geology

The predominant superficial geology at this location is defined as diamicton till as shown below in Figure 2.16 which was extracted from the British geological survey maps.

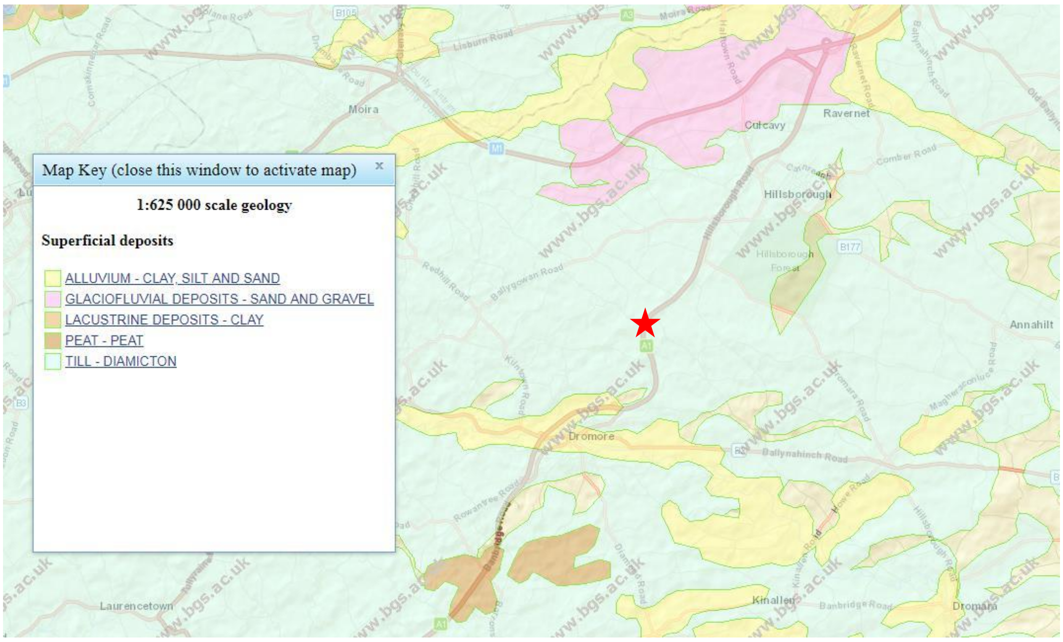


Figure 2.16 – Listullycurran Road / Backnamullagh Road Superficial Geology (BGS, 2018)

Diamicton till is described as a group of sediments laid down by the direct action of glacial ice with variable lithology, usually sandy, silty clay with pebbles, but can contain gravel-rich, or laminated sand layers; varied colour and consistency.

2.5.2.2 Milebush Link Road Superficial Geology

The superficial geology in the location of the Milebush link road junction is defined as a mixture of alluvium clay, silt and sands and diamicton till as shown below in Figure 2.17.

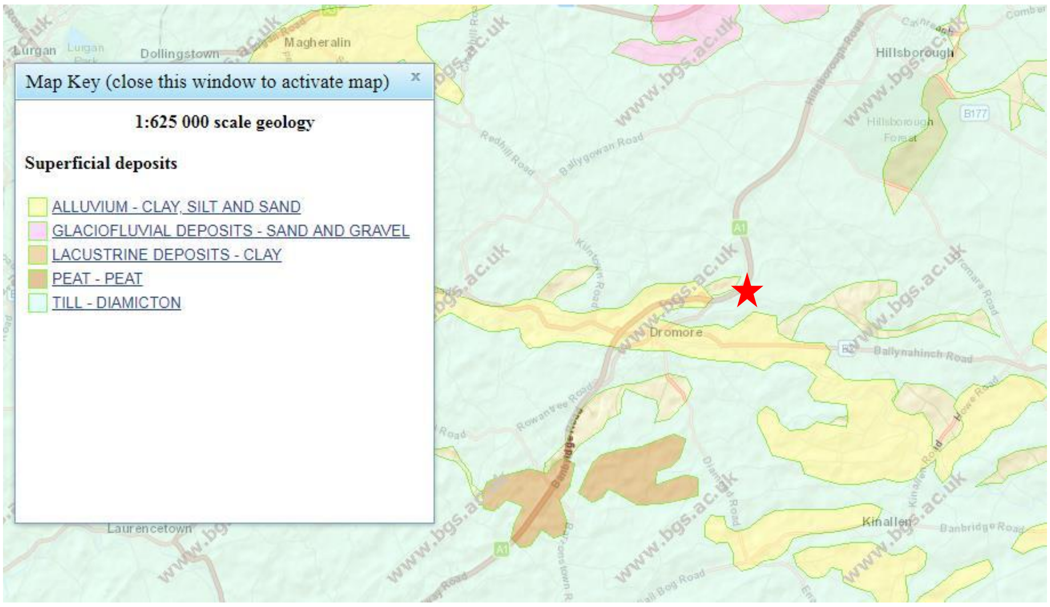


Figure 2.17 – Milebush Link Road Superficial Geology (BGS, 2018)

Clay silt and sand alluvium is described as normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A stronger, desiccated surface zone may be present. The description of diamicton till has been provided above in Section 2.5.2.1.

2.5.2.3 Gowdystown Road Superficial Geology

The most predominant superficial geology comprises peat as shown in Figure 2.18 below.

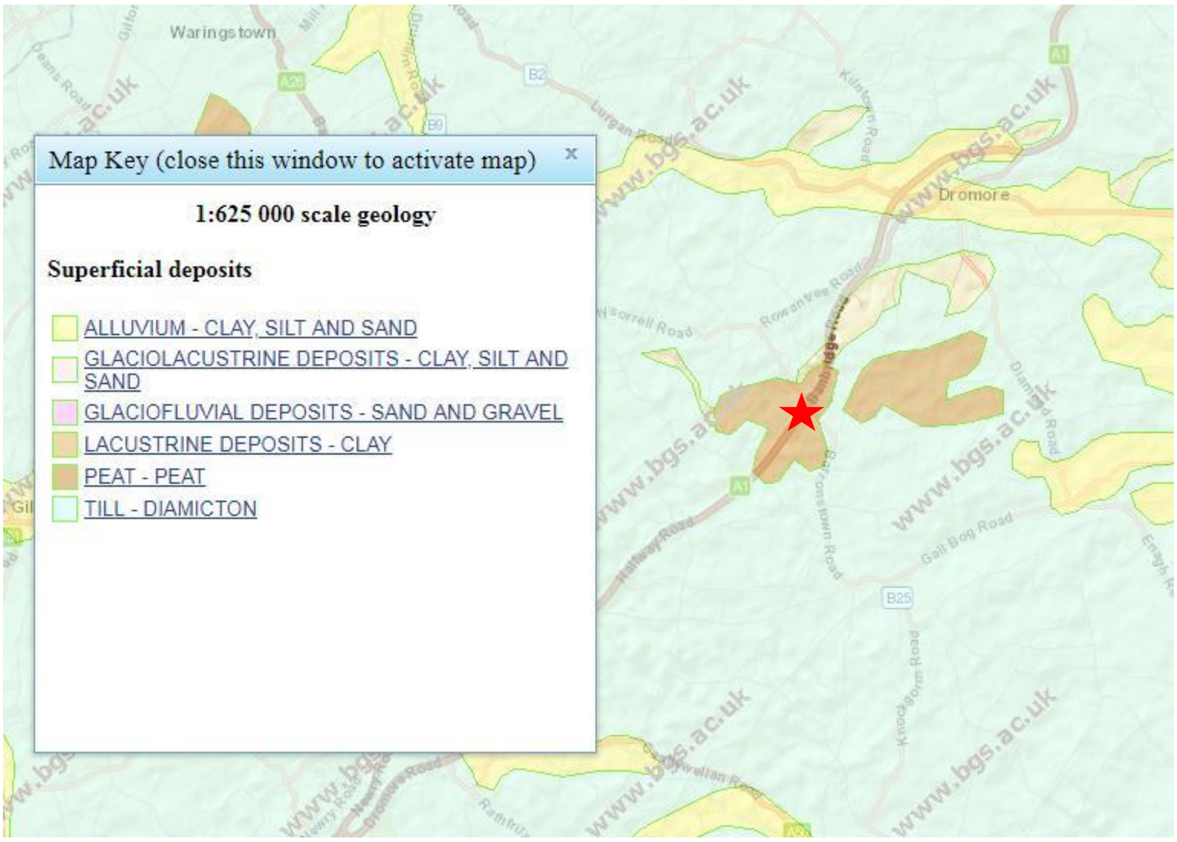


Figure 2.18 – Gowdystown Road Superficial Geology (BGS, 2018)

The peat in this area may be described as an organic-rich clay; humic deposits and accumulation of wet, dark brown, partially decomposed vegetation.

2.5.2.4 Skeltons Road / Drumneath Road Superficial Geology

The most predominant superficial geology at the location of the Skeltons Road / Drumneath Road junction is diamicton till as shown in Figure2.19 below.

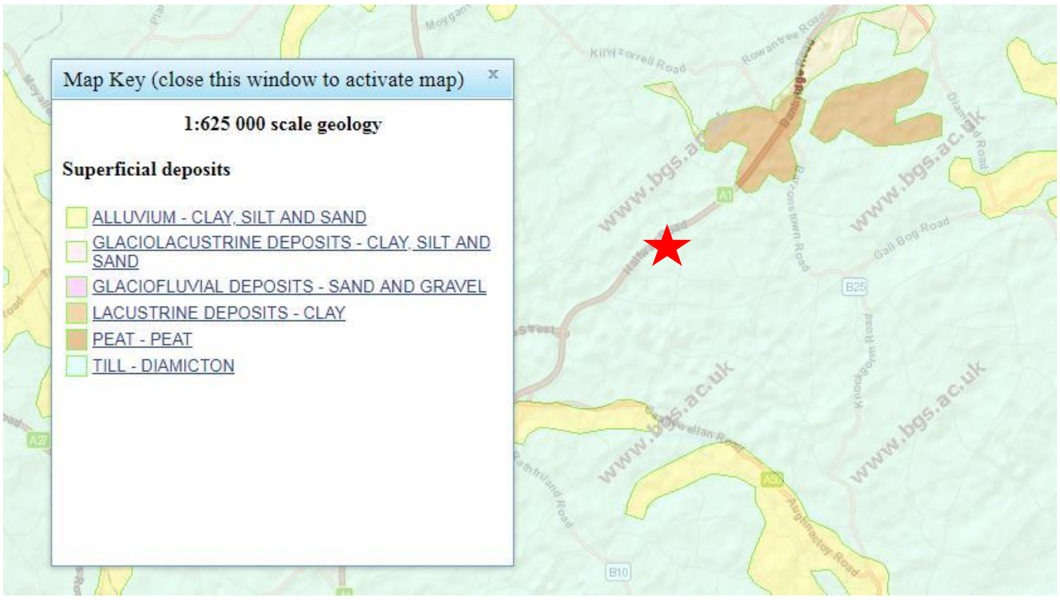


Figure 2.19 – Skeltons Road / Drumneath Road Superficial Geology (BGS, 2018)

The description of diamicton till has been provided above in Section 2.5.2.1.

2.5.2.5 Waringsford Road Superficial Geology

The predominant superficial soil in the location of the proposed Waringsford Road junction is diamicton till as shown in Figure 2.20 below.

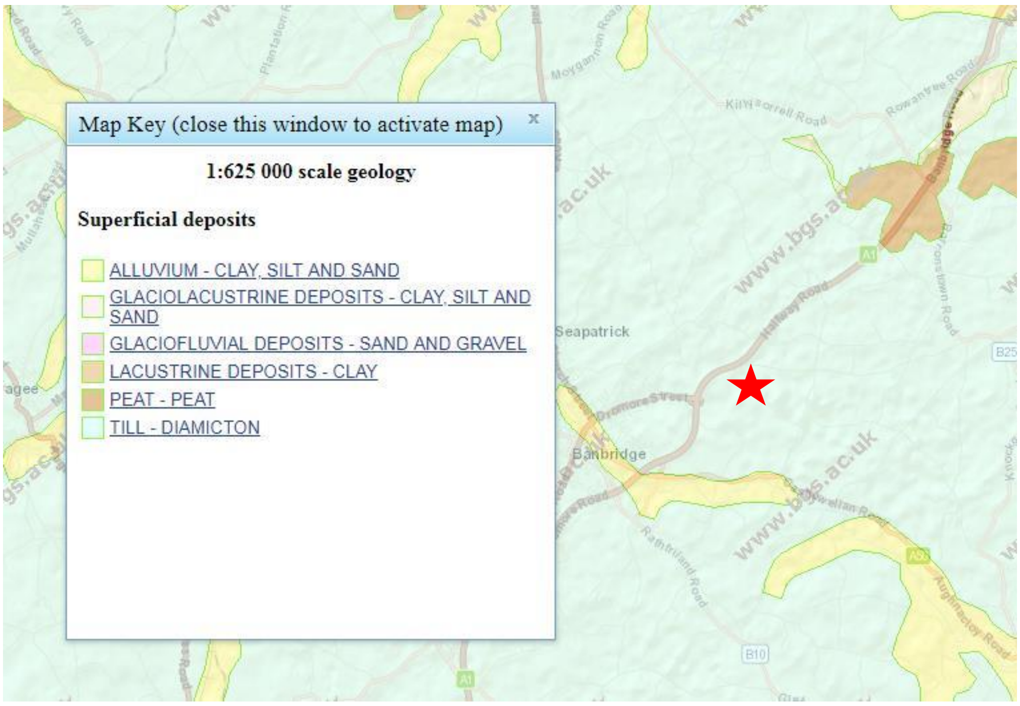


Figure 2.20 – Waringsford Road Superficial Geology (BGS, 2018)

The description of diamicton till has been provided above in Section 2.5.2.1.

2.5.2.6 **Castlewellan Road On-Slip Superficial Geology**

The predominant superficial geology at the Castlewellan Road On-Slip junction is a mixture of diamicton till and clay, silt and sand alluvium as shown below in Figure 2.21.

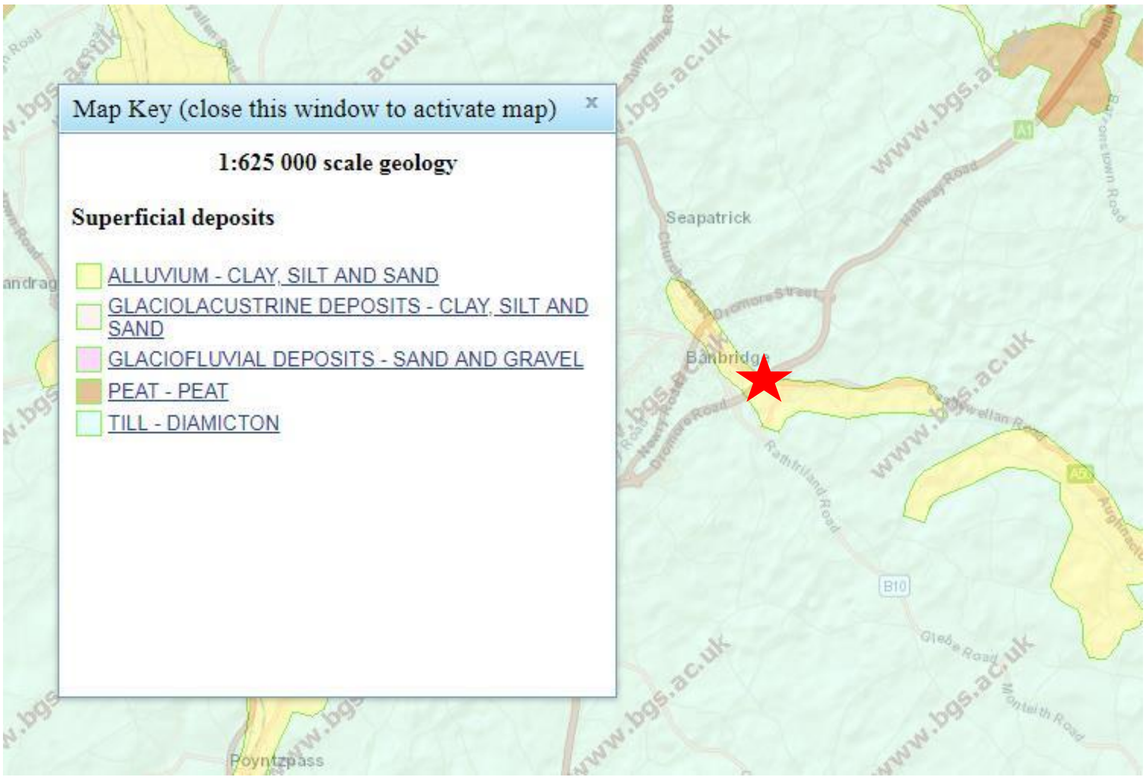


Figure 2.21 – Castlewellan Road On-Slip Superficial Geology (BGS, 2018)

Clay, silt and sand alluvium is described above in Section 2.5.2.2. The presence of alluvium in this area is most likely as a result of the junction being in close proximity to the River Bann.

2.5.3 Soils

The Craigavon 1:50,000 scale Soil Map (Sheet 20), produced by the Department of Agriculture for Northern Ireland and Ordnance Survey of Northern Ireland in 1993, has been consulted to gain a greater understanding of the agricultural potential of the soils at each of the junction upgrade locations.

Typically throughout the study area the soils are classified as surface-water gleys. These are poorly drained soils that remain waterlogged for significant periods. Areas classified as brown earth are also found within the study area. These are free draining soils and their presence indicates that they are underlain by permeable drift deposits.

2.5.3.1 Listullycurran Road / Backnamullagh Road Soils

The Listullycurran Road / Backnamullagh Road junction is located within an area of brown earths derived from gravel. Rock outcrop was identified on site and rock was encountered at shallow depths to the west of the A1 mainline. Some sections of poor soil were identified in the east section of the junction at PTP07. These soft spots mainly comprised soft silty sandy clay. These were generally identified as localised soft spots with maximum depths of up to 2.1m.

At the west side of the A1 mainline the bedrock is overlain with sandy clayey fine to coarse gravels and firm sandy gravelly clays varying in depth from 2.5m bgl to 3.0m bgl. The soil to the east of the mainline junction comprises of silty sandy gravelly clays with cobble and boulder content interspersed with brown silty sandy very clayey coarse gravels.

Groundwater was observed in 8 trial pits at varying depths of 0.7m bgl – 2.5m bgl.

2.5.3.2 Milebush Link Road Soils

The proposed link between the Hillsborough Road junction and the Milebush Road is underlain by surface water gleys with impeded drainage.

The soil type varies with light brown gravelly sand and soft brown gravelly clay interspersed to a depth of 1.5m bgl. This is underlain with soft sandy gravelly clay and brown clayey coarse gravel. The overburden material varies in depth across this area. The depth of soil at the north of junction is 4.5m bgl however the depth of overburden at the southern section of the junction is 2.40m bgl where possible bedrock was encountered.

Groundwater was encountered in one trial pit at a depth of 2.3m bgl.

2.5.3.3 Gowdystown Road Soils

The Gowdystown Road junction is underlain by ground water gley of very poor drainage. Surface water gleys with impeded drainage are present directly east of the junction, with brown earths present to the north.

The soil type varies with different glacial tills; the most predominant soil encountered was brown sandy gravelly silts and clays. There was an extensive area of peat identified to the south west of the A1 mainline. The peat at this location varies in depth from 0.5m bgl to depths greater than 5.8m bgl. The peat is described as fibrous peat with rootles. An area of made ground was also identified to the west of the mainline with a depth of 1.6m bgl. The made ground identified to the north west of the mainline is underlain with firm sandy gravelly CLAY to a depth of 4.5m bgl.

The soil in the area to the east of the A1 mainline comprises firm brown sandy gravelly clays and dark grey gravels to depths of 1.4m bgl to 5.0m bgl. The peat and made ground encountered to the west of the mainline is also present at south east side of the mainline.

Groundwater was encountered in four trial pits at varying depths of 1.1m bgl to 1.8m bgl.

2.5.3.4 Skeltons Road / Drumneath Road Soils

The Skeltons Road / Drumneath Road junction is again located within an area of surface water gleys with impeded drainage. Areas of disturbed ground are present to the north and west of the junction.

The soil to the north of the A1 mainline comprises firm brown sandy gravelly clay to depths of 3.2m bgl. The depth of clay decreases closer to the A1 mainline and is underlain with clayey sandy fine to coarse gravel to depths of 4.5m bgl.

The superficial soils to the south of the A1 mainline comprise of light brown very gravelly fine to coarse sand with medium sub angular to sub rounded cobble content with depth 0.3m bgl to 2.7m bgl. The clay encountered was firm to stiff and very large SPT values were encountered during the ground investigations.

Groundwater was struck in one borehole and three trial pits at varying depths of 2.4m bgl to 3.5m bgl.

2.5.3.5 Waringsford Road Soils

Surface water gleys with impeded drainage are also anticipated to the west of the Waringsford Road junction. To the east of the A1 at this location shallow brown earths (40-60cm) are present with disturbed ground shown where the quarries are located (north east and south east of the Waringsford Road junction).

The soil type varies across the site. The soil encountered to the north of Jubilee House and north of the A1 mainline comprise of firm to stiff grey sandy gravelly silty clay with varying depths of 1.2m bgl to 5.7m bgl.

The soils encountered to the south of the A1 mainline comprises soft to firm sandy gravelly clay to a depth of 4.5m bgl. The clay encountered is soft immediately below ground level but the strength of clay increases with depth with higher SPT values recorded. Further south east towards Waringsford Road, the soil comprises sandy gravelly clays and with sands and gravels interspersed varying depths between 0.8m bgl to 2.8m bgl.

Groundwater was not encountered in any of the trial holes conducted in this location.

2.5.3.6 Castlewellan Road On-Slip Soils

Surface water gleys with impeded drainage are anticipated underlying the proposed northbound on-slip from the Castlewellan Road, with urban soils present just west of the on-slip location.

The soils encountered in the ground investigation conducted at the Castlewellan Road On-Slip junction comprise sandy gravelly silt to a depth of 1.0m bgl. This is underlain with very stiff grey brown sandy gravelly silt with some cobble and boulders 1.0m bgl to 4.0m bgl.

Groundwater was not encountered in any of the test locations conducted in this area

2.6 HYDROLOGY AND HYDROGEOLOGY

2.6.1 Hydrology

A number of watercourses intersect the A1 within the study area. Hillsborough Park Lake Stream, noted to be of poor status, crosses the A1 just south of Hillsborough. The River Lagan, Edenordinary Stream and the River Bann cross the A1 carriageway at Dromore, between Dromore and Banbridge and at Banbridge respectively while Loughbrickland Stream is located in proximity to the scheme end.

All these watercourses are noted to be of moderate status and to contain economically significant species.

2.6.2 Hydrogeology

2.6.2.1 Bedrock Aquifer

A review of the GSNI website was conducted for the study area. The entire route falls over a bedrock aquifer classified as Bl(f). This indicates a limited potential productivity fracture flow bedrock aquifer. Moderate yields from the aquifer are unusual with low yields more common. Flow is mainly shallow and local with limited regional flow.

The proposed junctions are predominantly located in an area with limited shallow groundwater underlain with impermeable rocks. Some sections of the scheme such as the area surrounding the River Bann are within the location of an aquifer with limited or local potential as shown below in Figure 2.22.

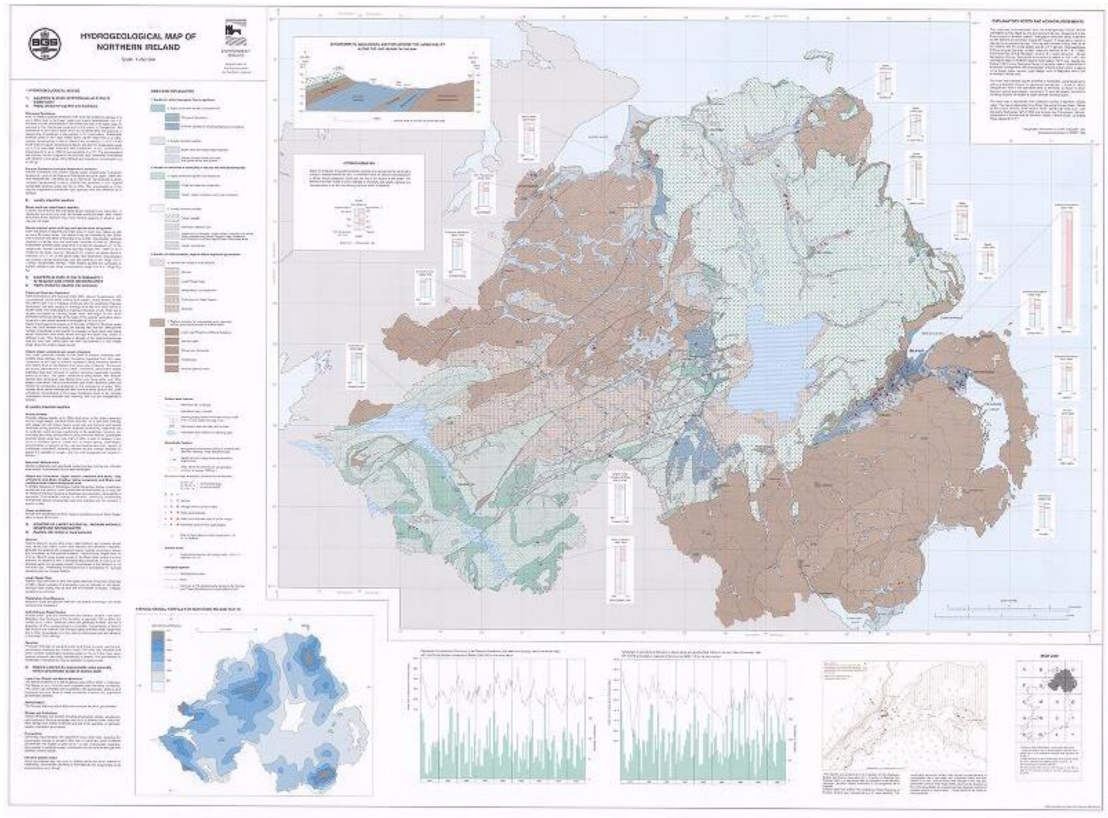


Figure 2.22 Aquifer Classification (BGS, 2018)

2.6.2.2 **Superficial Aquifer**

Areas of superficial aquifer are identified within the study area.

2.6.2.3 **Groundwater Vulnerability**

The majority of the route within the study area falls over class 2 representing a relatively low risk with regard to groundwater vulnerability. Areas of class 4e are identified along the route where the superficial aquifer has been identified, representing higher groundwater vulnerability. Class 5 areas are also identified along the route where bedrock is anticipated to be present at or near the surface, indicating high groundwater vulnerability.

2.7 MINING, MINERAL EXTRACTION AND CONTAMINATED LAND

2.7.1 Mining and Mineral Exploration

The British Geological Survey (BGS) website was consulted to obtain information on past and existing mining activities in the vicinity of the A1 Junctions scheme. The records of mining activities are shown in Figure 2.23 below. There is no recorded history of mining within the A1 study area.

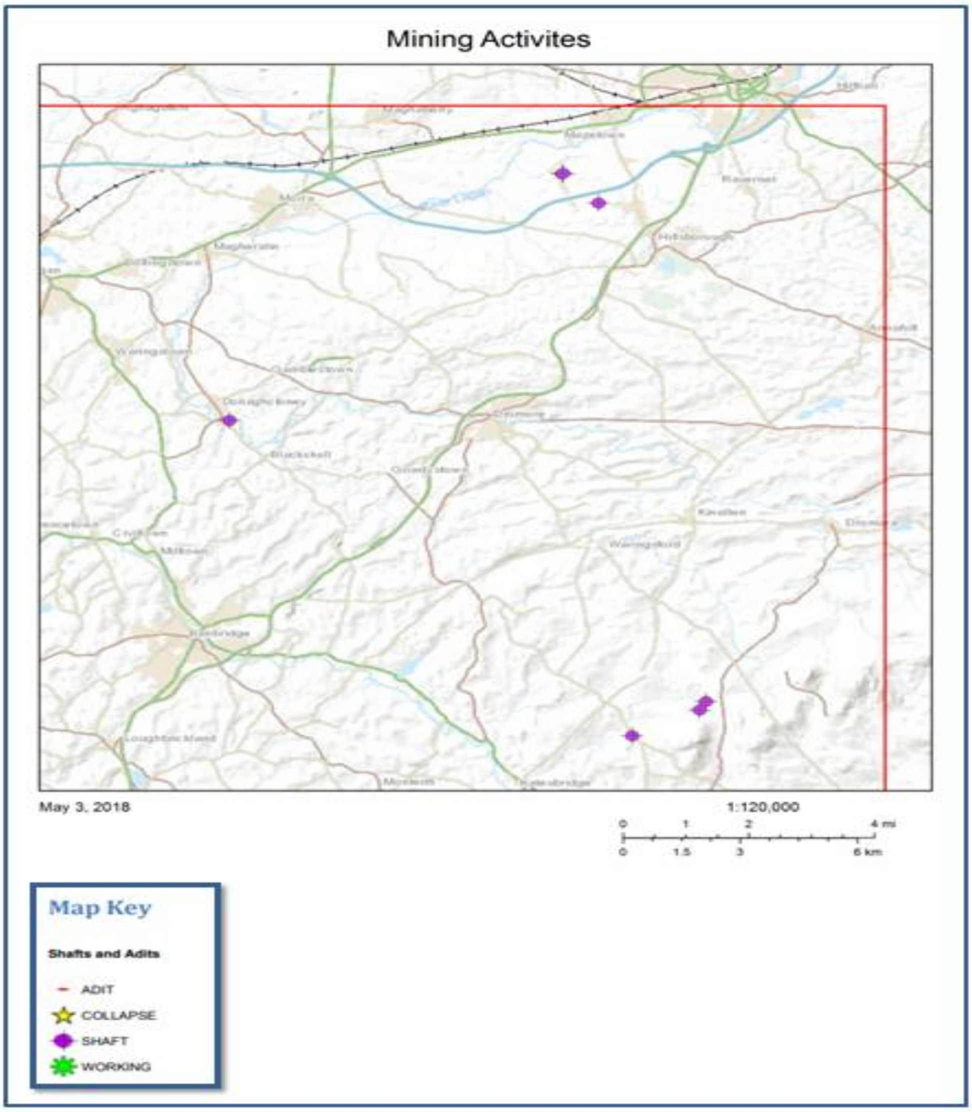


Figure 2.23 – Mining Activities (BGS, 2018)

2.7.2 Active Quarries

At present, there are two existing aggregate quarries located within the study area just north of Banbridge and in close proximity to the proposed CGSJ at Waringsford Road. These are known as Tullyraine Quarries Limited which is located adjacent to the A1 just south of the existing Waringsford Road junction and Gibson Bros Ltd which is located adjacent to the A1 just south of the existing Kilmacrew Road junction. These quarries are illustrated in Figure 2.24 below.

Figure 2.24 – Mining Activities at Junction 5, Waringsford Road

2.7.3 Contaminated Land

A number of potentially contaminating land uses were identified along the length of the proposed A1 upgrade within the Preliminary Risk Assessment. The main source of potential contamination was considered to be the presence of made ground as the existing site is developed. A number of current and historical potentially contaminating land uses were also identified in the area surrounding the site, including an agricultural dairy, a tyre company, petrol filling stations, quarries, mills and a railway line. Chemical analysis of soil samples taken as part of the Generic Quantitative Risk Assessment (GQRA) did not identify any contamination within soils and as such no risk to human health is considered to exist. Leachate analysis of a number of soil samples was used to identify any potential risk to groundwater and surface water receptors. A number of exceedances of the screening values were noted for metals; however these were from samples taken from natural ground. Therefore, these metal exceedances were considered to result from natural concentrations of the metals within the soils and no risk is considered to exist.

Japanese Knotweed has also been identified within the study area at two locations. These locations are:

1. Listullycurran Road / Backnamullagh Junction – Approximately 118m north east of the existing Listullycurran Road junction with the A1. The presence of Japanese Knotweed was discovered approximately 12m east of the southbound verge.
2. Gowdystown Road Junction – Approximately 14m North West of the existing Gowdystown Road (West) junction with the A1. The presence of Japanese Knotweed was discovered at the back of the existing verge.

2.8 ENVIRONMENTAL STATUS

2.8.1 Designated Ecological Sites

The proposed development spans two River Basin Districts; Neagh-Bann River Basin District (RBD) and North Eastern RBD. The scheme is located upstream of Lough Neagh and Lough Beg Special Protection Area (SPA) and Ramsar site via the River Bann and its tributaries, and Belfast Lough SPA, Belfast Lough Open Water SPA, proposed East Coast (Northern Ireland) Marine SPA and Belfast Lough Ramsar site via the River Lagan and its tributaries.

2.8.2 Designated Landscape Areas

A review of the Northern Ireland Regional Landscape Character Assessment (NIRLCA) indicates that the proposed scheme traverses three RLCA's; RLCA 21 – Belfast and Lagan Valley; RLCA 22 – Down Drumlins and Holywood Hills and RLCA 23 – Newry Valley and Upper Bann.

A review of the NILCA 2000 indicates that the proposed scheme traverses a number of Landscape Character Areas (LCA); Armagh / Banbridge Hills LCA (67); North Banbridge Hills LCA (78); Dromore Lowlands LCA (82); Hillsborough Slopes LCA (89); Kilwarlin Plateau LCA (81) and Broad Lagan Valley LCA (108).

The proposed scheme is not located within any of the Local Landscape Policy Areas (LLPA) identified in the relevant Development Plans

Landscape designated areas within the vicinity of the A1 include the following:

- Lagan Valley Area of Outstanding Natural beauty (AONB) is located approximately 5km north-east of the northern extent of the proposed A1 J2 scheme.
- The Strangford and Lecale AONB, designated in 2010, is located approximately 24.5km east of the northern extent of the proposed scheme.
- The Mourne AONB, designated in 1986, is located approximately 12km south-east of the northern extent of the proposed scheme and approximately 15km south-east of the southern extent of the proposed scheme. Land associated with this AONB designation is located approximately 9km south-east of the proposed scheme, where the development occurs to the north of Dromore.
- The Ring of Gullion AONB, designated in 1991, is located approximately 16km south of the southern extent of the proposed scheme.

2.8.3 Designated Cultural Heritage Sites

2.8.3.1 Mainline Corridor

There are four registered Historic Park and Gardens (HPG) located within proximity to the proposed scheme corridor.

- Hillsborough Castle (Registered Site - Area Plan Lisburn 19) - located approximately 100m east of the proposed scheme site corridor at the Moira Road junction. This was the site of a former house and surrounding ornamental grounds, now much altered. It contains a lake, parkland, an artillery fort, mature trees and forest planting. The Small Park, on the west side of the town of Hillsborough, is the site of the present house of c.1797 which along with the grounds is used as the official home of the Secretary of State for Northern Ireland and are private. It is noted that this area also falls within Designation HH12 Historic Park, Garden and Demesne Hillsborough Castle of the BMAP 2015. The western boundary of this HPG lies approximately 60m east of the existing A1 corridor at its closest point.
- Gill Hall (Supplementary Site – Area Plan Banbridge 17) – located approximately 2km north-west of the proposed scheme site corridor at the Banbridge Road junction. This extensive walled demesne of c.160ha no longer has its centre piece dwelling. The demesne is now farmed, with no evidence on the ground of an ornamental garden for the house. The River Lagan flows through the parkland, which still retains early formal landscape features, as well as its informal landscape park, with fine mature parkland trees. A tree-lined depression marks an original straight avenue approach to the house and another straight avenue survives. The eastern boundary of this HPG lies approximately 2km west of the existing A1 corridor at its closest point.
- Brookfield House (Supplementary Site – Area Plan Banbridge 17) – located approximately 2km north-west of the proposed scheme site corridor at the Rathfriland Road junction. The house of 1830 is an enlarged 18th century farmhouse (listed HB 17/5/4 – also gate screen and lodges). It is surrounded by mature shelter belts and some woodland. There are lawns at the house and an ornamental garden. The garden is listed as being private. The southern boundary of this HPG lies approximately 1.7km north-west of the existing A1 corridor at its closest point.
- Loughbrickland House (Supplementary Site – Area Plan Banbridge 17) – located approximately 400m west of the proposed A1 J2 scheme site corridor at the Newry Road / Banbridge Road junction. The house lies in a demesne of 160ha. There are mature shelter trees but the line of Wellingtonias is the most impressive stand at the site. Formal gardens and terracing at the house are grassed at the present time. The walled garden is not cultivated. The garden is listed as being private. The eastern boundary of this HPG lies approximately 300m west of the existing A1 corridor at its closest point.

2.8.3.2 Listullycurran Road / Backnamullagh Road Junction

The landscape surrounding the proposed Listullycurran Road / Backnamullagh Road Junction contains a low to moderate number of cultural heritage sites. Within approximately 1km of the proposed development at the Listullycurran Road / Backnamullagh Road Junction there is one Sites and Monuments Record (SMR) site; three Industrial Heritage Record (IHR) sites and one Listed Building. There are no Scheduled Areas, Historic Parks, Gardens and Demesnes or Defence Heritage sites located within 1km of the proposed development site. There are no Areas of Significant Archaeological Interest located within 5km of the proposed development site.

2.8.3.2.1 Archaeological Sites

There is one recorded archaeological monument listed in the SMR within approximately 1km of the proposed development site. This site, a rath (DOW021:001) is located approximately 1km northwest of the proposed Listullycurran Road Junction site.

2.8.3.2.2 Industrial Heritage Sites

There is a total of three IHR sites within approximately 1km of the proposed development; these include a bridge, a former turnpike toll cottage and bridge & milepost.

2.8.3.2.3 Listed Buildings

There is one Listed Buildings located within approximately 1km of the proposed development site.

2.8.3.3 Milebush Link Road

The landscape surrounding the proposed Milebush Link Road Junction contains a moderate number of cultural heritage sites. Within approximately 1km of the proposed development at the Milebush Road Junction there are six SMR sites; three IHR sites and three Listed Buildings. There are no Historic Parks, Gardens and Demesnes or Defence Heritage sites located within 1km of the proposed development site. There are no Areas of Significant Archaeological Interest located within 5km of the proposed development site.

2.8.3.3.1 Archaeological Sites

There is a total of six recorded archaeological monuments listed in the SMR sites recorded within approximately 1km of the proposed development site. These sites include three raths (one of which has an associated Scheduled Area); one Battle site; one ecclesiastical site and one Holy Well. The proposed development area at the Milebush Link Road Junction is located approximately 450m northeast of the Area of Archaeological potential for Dromore.

2.8.3.3.2 Industrial Heritage Sites

There is a total of three IHR sites within approximately 1km of the proposed development site at Milebush Link Road Junction; these include a bridge, hemstitching factory and chimney associated with a gasworks.

2.8.3.3.3 Listed Buildings

There is a total of three Listed Buildings located within approximately 1km of the proposed development site at the Milebush Link Road Junction. These comprise of two houses and a church.

2.8.3.4 Gowdystown Road Junction

The landscape surrounding the proposed Gowdystown Road Junction contains a moderate number of cultural heritage sites. Within approximately 1km of the proposed development at the Gowdystown Road Junction there are ten SMR sites; three IHR sites and one Listed Building. Both the Industrial Heritage Record sites and the Listed Building are located more than 300m from the proposed development. One of the SMR sites: DOW027:025 (Rath) is located in close proximity to the proposed development.

There are no Historic Parks, Gardens and Demesnes or Defence Heritage sites located within 1km of the proposed development site. There are no Areas of Significant Archaeological Interest located within 5km of the proposed development site.

2.8.3.4.1 Archaeological Sites

There is a total of ten recorded archaeological monuments listed in the SMR within approximately 1km of the proposed development site. These sites include six raths, two crannogs, one enclosure and one findspot for urn burials. There is clearly a strong early medieval presence within this landscape.

2.8.3.4.2 Industrial Heritage Sites

There is a total of three IHR sites within approximately 1km of the proposed development; these include a bridge, a hemstitching factory and a milepost & bridge.

2.8.3.4.3 Listed Buildings

There is one Listed Building, a house located within approximately 1km of the proposed development site.

2.8.3.5 Skeltons Road / Drumneath Road Junction

The landscape surrounding the proposed Skeltons Road / Drumneath Road Junction contains a moderate number of cultural heritage sites. Within approximately 1km of the proposed development at the Skeltons Road / Drumneath Road Junction there are six SMR sites; one IHR site and four Listed Buildings. One of the Listed Buildings is located in close proximity to the proposed development.

There are no Historic Parks, Gardens and Demesnes or Defence Heritage sites located within 1km of the proposed development site. There are no Areas of Significant Archaeological Interest located within 5km of the proposed development site.

2.8.3.5.1 Archaeological Sites

There is a total of six recorded archaeological monuments listed in the SMR within approximately 1km of the proposed development site. These sites include five enclosures and one rath that is also a Scheduled Monument. The scheduled rath is located within 100m of the proposed development.

2.8.3.5.2 Industrial Heritage Sites

There is one IHR site, a bridge located within approximately 1km of the proposed development.

2.8.3.5.3 Listed Buildings

There is a total of four Listed Buildings located within approximately 1km of the proposed development site. These include a house, a church, a mill and a public house. One of the sites, a house (HB1713006) is located within close proximity (less than 100m) to the proposed development.

2.8.3.6 Waringsford Road Junction

The landscape surrounding the proposed Waringsford Road Junction contains a moderate number of cultural heritage sites. Within approximately 1km of the proposed development at the Waringsford Road Junction there are fourteen SMR sites; one IHR site and one Listed Building.

There are no Historic Parks, Gardens and Demesnes or Defence Heritage sites located within 1km of the proposed development site. There are no Areas of Significant Archaeological Interest located within 5km of the proposed development site.

2.8.3.6.1 Archaeological Sites

There is a total of 14 recorded archaeological monuments listed in the SMR recorded within approximately 1km of the proposed development site. These sites include five raths (two of which are Scheduled Monuments), eight enclosures and one Bronze Age/Early Christian site. One of the enclosures (DOW027:107) is located in close proximity to the proposed development.

2.8.3.6.2 Industrial Heritage Sites

There is one IHR site, a brickyard located within approximately 1km of the proposed development.

2.8.3.6.3 Listed Buildings

There is one Listed Building, a house and walling, located within approximately 1km of the proposed development site.

2.8.3.7 Castlewellan Road On-Slip Junction

The landscape surrounding the proposed Castlewellan Road On-Slip Junction contains a moderate to high number of cultural heritage sites. Within approximately 1km of the proposed development at the Castlewellan Road On-Slip Junction. There are eight SMR sites; 11 IHR sites and 53 Listed Buildings. There are no Historic Parks, Gardens and Demesnes or Defence Heritage sites located within 1km of the proposed development site. There are no Areas of Significant Archaeological Interest located within 5km of the proposed development site.

2.8.3.7.1 Archaeological Sites

There is a total of eight recorded archaeological monuments listed in the SMR recorded within approximately 1km of the proposed development site. These sites include five enclosures, 2 raths (one of which is a Scheduled Monument) and one aerial photographic (A.P.) site. The proposed development is located approximately 400m southeast of the Area of Archaeological potential for Banbridge.

2.8.3.7.2 Industrial Heritage Sites

There is a total of 11 IHR sites within approximately 1km of the proposed development; these include bridges, mills, a clay pit and two linen weaving factories.

2.8.3.7.3 Listed Buildings

There is a total of 53 Listed Buildings located within approximately 1km of the proposed development site. These include a number of houses, churches, bridges, shops, offices, etc. The high number of Listed Buildings and Industrial Heritage features are directly associated with the town of Banbridge. One of the sites, a house (HB1707038) is located in close proximity to the proposed development site.

2.9 ENGINEERING ASSESSMENT

2.9.1 A1 Mainline

The section of the A1 under consideration provides varying levels of design standards. A large number of inherent Departures from Standard, related to the primary geometric criteria defined within TD 9/93, have been identified (342 in total based upon a Design Speed of 120A kph). In identifying the inherent departures and their locations on the existing A1 this equates to approximately 49% of the northbound carriageway and 51% of the southbound carriageway having a TD 9/93 primary geometric Departure from Standard located within it.

These findings have been reported in an Inherent Geometric Departures from Standards Report to serve as a fixed point record of the inherent TD 9/93 Departures from Standard that currently exist on the A1 between Hillsborough roundabout and Loughbrickland.

2.9.2 Visibility at Junctions

There are a number of accesses onto the A1 where visibility is less than the current recommended standard. Standards outlined in the DMRB Vol6, Section 2, Part 6, TD42/95 “Geometric Design of Major/Minor Priority Junctions”, state that priority junctions for a design speed of 120kph (70mph), should have sightlines with a desirable ‘x’ distance of 9m and a minimum ‘y’ distance of 295m. Measurement of available sightlines at these junctions shows that the visibility at some junctions falls below these DMRB recommendations; however visibility is generally achieved at a reduced ‘x’ distance of 4.5m with a relaxation from standard for lightly trafficked junctions and 2.4m for exceptionally difficult circumstances.

2.9.3 Structures

2.9.3.1 Whole Scheme

Twenty one structures have been identified within the scheme study area. The majority of structures are road overbridges, underpasses, culverts or accommodation passes i.e. cattle crossings. Table 2.10 details the existing structures identified within the A1 study area.

Table 2.10 – Existing Structures

Structure Name	Location	Function
Hillsborough Road	Hillsborough	A1 Hillsborough Road over Culcavy Road
Millvale Road Bridge	Hillsborough	A1 Hillsborough Road over stream
Hillsborough Road (Millvale Road Subway)	Hillsborough	A1 Hillsborough Road over pedestrian underpass
Dromore Road CGSJ	Dromore Road – A1 Junction, Hillsborough	Compact Grade Separated Junction over A1
Hillsborough Road	A1/Glen Road Intersection	A1 Hillsborough Road over Glen Road accommodation underpass
Titteringtons Bridge	Dromore Road east of A1	177 Dromore Road over stream
Hillsborough Road, Dromore	A1/Grove Road intersection, Dromore	A1 Road over Grove Road accommodation underpass
B2 Hillsborough Road	A1/B2 Intersection, Dromore	A1 Road over B2 CGSJ underpass
Lurgan Road Flyover, A1 Dromore Bypass	A1/Lurgan Road intersection, Dromore	Lurgan Road over A1 Dromore Bypass
Lagan Bridge, A1 Dromore Bypass	Dromore	A1 Dromore Bypass over River Lagan (+pedestrian walkway)
Banbridge Road CGSJ Underpass	Banbridge Road – A1 junction, Dromore	A1 Road over CGSJ underpass
Mackeys Lane Underpass	Mackeys Lane, Dromore	A1 Road over Accommodation underpass
Dromore Road CGSJ	Dromore Road – A1 junction, Banbridge	Compact Grade Separated Junction over A1
Castlewellan Road overbridge, A1 Banbridge Bypass	Castlewellan Road, Banbridge	Castlewellan Road over A1 Banbridge Bypass

Dromore Road, Banbridge	Banbridge	A1 Banbridge Bypass over River Bann
Rathfriland Road Bridge, Banbridge	Rathfriland Road, Banbridge	B10 Rathfriland Road over A1 Banbridge Bypass
Bannview Road Bridge, Banbridge	Bannview Road, Banbridge	Bannview Road over A1 Banbridge Bypass
Cascum Road, Banbridge	Cascum Road, Banbridge	Newry Road over A1 Banbridge Bypass
Dublin Road CGSJ Underpass	Dublin Road – A1 junction, Loughbrickland	A1 Banbridge Bypass over CGSJ Underpass
Grovehill Pedestrian Underpass	Grovehill Road – A1 junction, Loughbrickland	Pedestrian accommodation underpass linking the Grovehill Road and Loughbrickland

2.9.3.2 Listullycurran Road / Backnamullagh Road

Within the study area there are the following structures:

- Retaining wall structures for the front gardens of the properties at 150-152 Hillsborough Road adjacent to the southbound carriageway.

2.9.3.3 Milebush Link Road

Within the study area there are the following structures:

- There is an existing underpass at Hillsborough Road, Dromore located 81.5m from the proposed link road junction with the existing compact connector road;
- A stream culvert is located under the A1 approximately 91.5m from the proposed link road; and
- A residential house and associated outbuildings are located adjacent to the proposed link road. The outbuildings include stables which are located within the footprint of the link road.

2.9.3.4 Gowdystown Road

Within the study area there are the following structures:

- A stream is culverted under the A1 approximately 500m south of the junction;
- A dwelling and garage are located approximately 82m west of the existing Gowdystown Road (East) junction with the A1;
- An accommodation underpass is located approximately 750m north of the junction;
- A watercourse is culverted under the A1 approximately 115m south of the existing Gowdystown Road (West) junction with the A1;
- On the northbound side of the junction a small shed currently used as a stable will be demolished as part of the works.

2.9.3.5 Skeltons Road / Drumneath Road

There are no known road structures within the study area of the Skeltons Road/Drumneath Road junction.

2.9.3.6 Waringsford Road

Within the study area there are the following structures and features:

- A stream is culverted under the A1 in the vicinity of the Waringsford Road junction. The existing culvert is a pipe of 1100mm diameter;
- A residential house and associated outbuildings are located adjacent to the northbound carriageway, south of the Waringsford Road;
- A number of heavy industry structures associated with the Tullyraine Quarry are present at the Waringsford Road junction; and
- Retaining wall structure approximately 36m long along the frontage of Tullyraine Quarries Ltd, adjacent to the southbound carriageway.

It is also noted that the Dromore Road, Banbridge, compact grade separated junction is located approximately 1km to the south of the Waringsford Road junction.

2.9.3.7 Castlewellan Road On-Slip

There is one significant structure likely to be impacted by the construction of any Castlewellan Road On-Slip. This is as follows:

- The Castlewellan Road Bridge over the A1 is the predominant road structure that exists within the Castlewellan Road On-Slip

2.9.4 Roadside Features

2.9.4.1 Listullycurran Road / Backnamullagh Road

Within the study area of the Listullycurran Road / Backnamullagh Road junction a number of road side features exist as follows:

- A section (approx. 125m) of Double Sided Tension Corrugated Barrier is located in the central reserve in the vicinity of the Backnamullagh Road; and
- A section (approx. 450m) of Single Sided Tension Corrugated Barrier is located in the southbound verge. The barrier originates approximately 90m south of the Listullycurran Road junction and extends southward.

2.9.4.2 Gowdystown Road

Within the study area of the Gowdystown Road junction a number of road side features exist as follows:

- There is a short section (approx. 30m) of Single Sided Tension Corrugated Barrier located in the verge of the northbound carriageway approximately 200m north of the Gowdystown Road (West) junction; and
- Two bus shelters are present south of the Gowdystown junction.

2.9.4.3 Skeltons Road / Drumneath Road

There are no known road side features within the study area of the Skeltons Road/Drumneath Road junction.

2.9.4.4 Waringsford Road

There are no known road side features within the study area of the Waringsford Road junction.

2.9.4.5 Castlewellan Road On-slip

Within the study area of the Castlewellan Road On-Slip a number of road side features exist as follows:

- The central pier of the Castlewellan Road Bridge is protected by a section (approx. 100m) of Single Sided Steel Beam Barrier located on both sides of the central reserve pier.
- The abutments of the Castlewellan Road Bridge are protected by a section (approx. 80m) of Single Sided Steel Beam Barrier on both the northbound and southbound carriageways.

2.9.5 Bus Stop Facilities

2.9.5.1 Whole Scheme

Existing bus stop facilities along the A1 serve two bus service routes operated by Translink; these are the 38 and 538 services. In addition the facilities also serve a number of local school bus routes. The facilities range from a simple arrangement of paved area and flag post to covered bus shelters. The locations of the existing bus stop facilities within the scheme extents along the A1 are illustrated in Figure 3.15 - 3.20.

2.9.5.2 Listullycurran Road / Backnamullagh Road

Two bus stops are located in close proximity to the Listullycurran Road junction; approximately 15m beyond the junction on the northbound carriageway and approximately 20m in advance of the junction on the southbound carriageway. Both bus stops feature a flag sign and hard standing area and are served by the Translink 538 and 38 services, as well as school buses.

2.9.5.3 Milebush Link Road

There are no bus stops located in the vicinity of the Milebush Link Road.

2.9.5.4 Gowdystown Road

Two bus stops are located to the south of the Gowdystown Road junction; approximately 80m in advance of the junction on the northbound carriageway and approximately 60m beyond the junction on the southbound carriageway. The bus stops are served by the Translink 538 and 38 services as well as school buses. Informal 'Park and Share' practices already exist at the Gowdystown Road junction.

2.9.5.5 Skeltons Road / Drumneath Road

Two bus shelters are located within the Skeltons Road / Drumneath Road junctions; approximately 90m in advance of the Skeltons Road junction on the northbound carriageway and approximately 50m beyond the junction on the southbound carriageway. The bus stops are served by the Translink 538 and 38 services as well as school buses.

2.9.5.6 Waringsford Road

Two bus stops are located in proximity to the Waringsford Road junction; approximately 35m beyond the Graceystown Road junction on the northbound carriageway and approximately 50m beyond the Waringsford Road junction on the southbound carriageway. The bus stops are served by the Translink 538 and 38 services as well as school buses.

2.9.5.7 Castlewellan Road On-Slip

Two bus stops are located on the Castlewellan Road; approximately 150m in advance of the Castlewellan Road Bridge (eastbound direction) and approximately 200m beyond the Castlewellan Road Bridge (westbound direction).

2.10 ROAD SAFETY

2.10.1 Accident Data

Road Traffic Collision (RTC) statistics were collected and analysed as part of the Stage 2 Assessment Report for the years 2006-2012 which was the most recent available at that time. Although that data is reliable and still relevant, it is considered out of date at the time of the Stage 3 Assessment. Therefore the Stage 3 Assessment involved further data collection in terms of collisions more commonly referred to as accidents.

2.10.2 2010-2017 Accident Statistics

RTC Statistics for the period 2010-2017 were collected and analysed as part of the Stage 3 Assessment. These are shown in Table 2.11 below. The statistics show that for the period 2010-2017, there were a total of 195 Personal Injury Accidents (PIA) on the 25.2 km stretch of the A1 between Hillsborough and Loughbrickland. The accidents include a total of twenty five serious accidents and seven fatal accidents.

Table 2.11 – Breakdown of all accidents along the study area over the period 2010-2017 by severity and year

Year	Number of Collisions	Fatal	Serious	Slight
2010	29	0	4	25
2011	18	0	3	15
2012	33	1	5	27
2013	26	0	2	24
2014	33	2	5	26
2015	26	2	3	21
2016	19	1	3	15
2017	11	1	0	10
Total	195	7	25	163

The DfT provides accident rates for different standards of road for use in COBALT. These theoretical accident rates are given in terms of the number of Personal Injury Accidents per Million vehicle Kilometres (PIA/mKm). The national average is stated as 0.072 PIA/mkm in the 2016 WebTAG dataset, COBALT 3, for a dual two lane (D2) road.

Although Table 2.11 identifies the number of fatal, serious and slight collisions recorded, it is worth noting that during the eight year period from 2010 to 2017 inclusive, there were a total of 9 No fatalities, 31 No serious injuries and 300 slight injuries recorded, along the study area.

The recorded RTC statistics have been compared to the national average at each ATC location (Hillsborough, Dromore and Banbridge) and averaged to produce a value for the section length. This comparison is presented in Table 2.12 below.

Table 2.12 – Average Accident Rate (PIA/mKm) per Section 2010-2017 in comparison to the National Average

Year	Hillsborough	Dromore	Banbridge	A1 Average	National Average
2010	0.079735755		0.1397692	0.10975245	0.072
2011	0.049529034		0.0837953	0.06666219	0.072
2012	0.086859116		0.1487458	0.11780245	0.072
2013		0.1034468	0.1184809	0.11096389	0.072
2014	0.0894793	0.1264471	0.1392056	0.11837733	0.072
2015	0.067059875	0.0967717	0.1071216	0.09031773	0.072
2016	0.051473097	0.0676862	0.0797215	0.06629359	0.072
2017	0.028178051	0.0382099	0.0443958	0.03692789	0.072

The number of PIA/mkm on these sections of the A1 is generally considerably higher than what would be expected for this category of road with the exception of the years 2011, 2016 and 2017.

The total number of accidents incurred on the A1 from 2010 to 2017 (195) have been broken down into Fatal, Serious and Slight respectively. These have then been averaged to compare the percentage of each accident to the National Average which was derived from the WebTAG 2016 Values (base year 2009). This comparison is presented in Table 2.13 below.

Table 2.13 – Average Annual number of Accident by severity in comparison to the National Average

	Fatal	Serious	Slight
A1 Recorded Accidents 2010-2017	7	25	163
A1 Recorded Average Annual Accidents	0.035	0.128	0.835
National Average (WebTAG)	0.023	0.127	0.85

The number of fatal and serious accidents is higher than expected for this category of road which therefore results in a significantly higher proportion of fatalities in terms of the total number of accidents; approximately 3.2% on the A1 compared to 2.3% within the WebTAG rates.

A more detailed review of the information provided for the accident history and type of accidents highlighted the following:

- Over the eight year period a total of 195 accidents were recorded along this 25.2km section of the A1 with seven of these accidents resulting in fatalities;

- In the period 2010-2017 inclusive, 45% of 195 accidents (Fatal, serious or slight) occurred at or adjacent to a gap in the central reserve where manoeuvres such as right turns, u turns, slowing down for private accommodation gaps or vehicle overhang are possible;
- In the period 2010-2017 there were 7 recorded crossover incidents (3.6% of all accidents in that time period) of which 57% have been fatal;
- The overall percentage of recorded central reserve incidents on the A1 is 3.9% compared to 2.2% for the annual average for recorded central reserve incidents (as a total of the total annual accidents on dual carriageways) within Northern Ireland in the period 2011 to 2016;
- The most common type of accident appears to be caused by vehicles with insecure loads;
- The other common types of accidents appear to be vehicles changing lane without care, vehicles merging from minor roads without care, vehicles travelling at excessive speed having regard for conditions, vehicles overtaking on offside without care, rear end shunts due to vehicles driving too close and turning right without care; and
- There would appear to be no significant relationship with the time of day, day of the week or the month that the accidents occurred.

3 DESCRIPTION OF THE SCHEME

3.1 STAGE 2 PREFERRED ROUTE

The Preferred Route was published in November 2015 at the conclusion of the Stage 2 Scheme Assessment. The Preferred Route included the following proposals:

- The closure of central reserve gaps;
- The Installation of central reserve safety barrier within the scheme extents;
- Twenty-two junctions to remain open and operate on a LILO basis;
- All LILO junctions to have diverge lanes with provision for only five merge lanes;
- Eight minor road junctions on the A1 to be closed;
- One of the twenty-two junctions, Springwell Loanin minor road junction, north of Loughbrickland is to be amended to operate as left-in only;
- Construction of a new link road connecting Milebush Road with the existing Hillsborough Road CGSJ, at Dromore;
- Construction of four CGSJs; and
- Construction of a slip road from Castlewellan Road to the northbound carriageway of the A1.

The Preferred Route in the form of the proposed CGSJ layouts, the Milebush Link Road and the Castlewellan Road on-slip are illustrated in Figures 3.1 - 3.6. The layouts of the LILOs were not developed at the time of publishing of the Stage 2 SAR however the overall scheme proposals are illustrated in Figures 3.7 - 3.8.

Subsequent to confirmation of Stage 2 Preferred Route, the scheme has been developed and refined as a result of feedback received from the public and from a more detailed examination of the proposed scheme as part of the Stage 3 Assessment. The changes to the scheme are discussed below and the amended scheme in the form of the proposed CGSJs, Milebush Link Road and Castlewellan Road on-slip are illustrated in Figures 3.9 - 3.14. The layouts of the LILOs have also been developed as part of the Stage 3 Assessment and the amended overall scheme proposals are illustrated in Figures 3.15 - 3.20.

3.2 DEVELOPMENT OF PREFERRED SCHEME

The Preferred Route was the subject of refinement and more detailed assessment following its publication. Community Consultations were held and one of the major concerns to the public was the strategy for provision of merges at LILOs. There was also significant support for a link road from the compact connector road at Junction 1 Listullycurran Road to the Backnamullagh Road. The following sections outline how the scheme as developed from Stage 2 to Stage 3.

3.2.1 Minor Road Junction Strategy – LILOs

The Stage 2 Scheme Assessment identified the preferred strategy for dealing with minor road junctions. The minor road junction strategy identified the minor road junctions within the scheme extents to be retained or closed and identified improvements including diverge and/or merge lanes at the reconfigured LILO junctions. The recommendations are listed in Chapter 1, Table 1.1 but are summarised as follows:

- Twenty-two junctions to remain open and operate on a LILO basis;
- All LILO junctions to have diverge lanes with provision for only five merge lanes;
- Eight minor road junctions on the A1 to be closed;
- One of the twenty-two junctions, Springwell Loanin minor road junction, north of Loughbrickland is to be amended to operate as left-in only; and
- Construction of a new link road connecting Milebush Road with the existing Hillsborough Road CGSJ, at Dromore.

In the original design the provision of diverge and/or merge lanes was based on criteria within TD42 which is:

- The volume of left turning traffic using the junction;
- Percentage of traffic using the junction classed as large goods vehicles; and
- The gradient of the A1 carriageway on the approach to and exit from the junction.

This criteria resulted in provision of diverge lanes at all of the LILO junctions however provision of merge lanes was restricted to Moira Road, Dromara Road, Maypole Hill, Old Manse Road and Banbridge Road (Loughbrickland). Following representations by the public and input from the Road Safety Audit team, the strategy for provision of merge lanes was further assessed. It was decided to increase the number of merge lanes where it was safe to do so. This was largely dictated by the distances between junctions as close proximity of proposed merge and diverge lanes could potentially lead to additional collisions on account of significant substandard weaving lengths. Minimum weaving distances of 1km are required under the DMRB however since a large number of existing side roads are within this proximity of each other, it was decided that a minimum weaving distance of 295m (equivalent to the minimum SSD) would be appropriate in order to facilitate the addition of merge lanes where applicable, therefore making it safer and easier to join the A1 at these locations. Furthermore, the opportunity was taken to reduce the number of side roads to 21 by closing the Backnamullagh Road and connecting it directly to the CGSJ at Listullycurran Road. This has the added benefit of closing an additional public road connection with the A1 mainline, reducing detours within the vicinity, increasing local connectivity and reducing the requirement for local farmers to drive slow agricultural machinery on the mainline.

The revised Stage 3 Assessment minor road junction strategy is illustrated in Table 3.1 below but is summarised as follows:

- Twenty-one junctions to remain open and operate on a LILO basis including Springwell Loanin;
- All LILO junctions to have diverge lanes;
- The provision of 16 Merge lanes;
- The closure of 9 minor road junctions;
- Construction of a new link road connecting Milebush Road with the existing Hillsborough Road CGSJ, at Dromore (Facilitating the closure of Milebush Road South (West) Junction); and
- Construction of a new link road connecting Backnamullagh Road with the proposed Listullycurran Road / Backnamullagh Road CGSJ (Facilitating the closure of the Backnamullagh Road Junction).

Table 3.1 – Stage 3 Minor Road Junction Interventions

Minor Road Junction (Listed North to South)	Chainage (m)	Proposal	Diverge	Merge	Give Way
Moira Road	23,700	LILO	YES	YES	
Glen Road	22,160	LILO	YES	YES	
Dromara Road	21,980	LILO	YES	YES	
Dromore Road	21,040	Full Closure	N/A	N/A	
Taughblane Road	20,980	LILO	YES	YES	
Backnamullagh Road	20,370	Full Closure	N/A	N/A	
Milebush Road North	19,500	LILO	YES	NO	YES
Hillsborough Road North	19,060	LILO	YES	NO	YES
Hillsborough Road South	18,540	Full Closure	N/A	N/A	
Grove Road	18,490	LILO	YES	YES	
Milebush Road West	17,210	Full Closure	N/A	N/A	
Milebush Road East	17,140	Full Closure	N/A	N/A	
Connellystown Road	16,290	LILO	YES	YES	
Maypole Hill	16,200	LILO	YES	YES	
Lower Quilly Road East	15,390	Full Closure	N/A	N/A	
Lower Quilly Road West	15,280	LILO	YES	NO	YES
Mackeys Lane	13,000	LILO	YES	YES	
Boals Lane	12,960	LILO	YES	YES	
Banbridge Road	12,570	Full Closure	N/A	N/A	
Mount Ida Road	11,160	LILO	YES	YES	
Halfway Road North	10,830	Full Closure	N/A	N/A	
Halfway Road South	10,500	LILO	YES	YES	
Kilmacrew Road	8,400	LILO	YES	YES	
Graceystown Road	8,320	LILO	YES	NO	YES
Lisnaree Road	6,450	LILO	YES	YES	
Old Manse Road	5,540	LILO	YES	YES	
Springwell Loanin	1,720	LILO	YES	NO	YES
Old Banbridge Road North	1,680	Full Closure	N/A	N/A	
Old Banbridge Road South	1,210	LILO	YES	YES	
Banbridge Road Loughbrickland	875	LILO	YES	YES	

In the original design the geometric layout of LILO junctions was developed using the standards within TD40 and TD42. It was proposed that both at-grade and grade separated junctions would feature the same geometric layout, with the exception of merge lanes which were only to be provided at specific locations. The junction layouts were to be comparable to the junctions constructed along the scheme route within the A1 Junctions Scheme (Phase 1). By providing a similar LILO junction layout within A1 Junctions Phase 2, it was considered that drivers would experience a more consistent route and consequently driver uncertainty and stress would be reduced.

Following representations by the public and further assessment by DfI, the geometric layout of the merge lanes was further assessed. It was decided that the length of the merge auxiliary lanes would be increased to comply with elements of both TD42 and TD22. The geometry of the merge lanes was increased from 170m (40m Nose & 130m Auxiliary Lane, including 30m Direct Taper) to 225m (40m Nose & 130m Auxiliary Lane plus an additional 55m Taper length). The nose and auxiliary lane length is compliant with TD42 albeit TD42 specifies a merge taper as opposed to auxiliary lane and therefore a departure from standard is required while the 55m taper is compliant with TD22.

Refer to Fig 3.21 for further information regarding the proposed typical geometry of the Left-In Left-Out junctions.

Although the strategy outlined above is being brought forward as the Stage 3 design proposals for this Project, it is acknowledged that in the interests of safety, the A1 will continue to be monitored, in the same way that all roads are monitored, and that there may be a need in the future for further safety measures that may include minor road closures.

It is noted that any future requirement for safety measures, including minor road closures, would require appropriate assessment and consultation at that time.

3.2.2 Compact Grade Separated Junctions

The closure of the central reserve gaps and provision of a central reserve safety barrier along the entire length of the scheme would invariably cause severance issues with properties whose ability to access both the northbound and southbound carriageways of the A1 is affected by the gap closures. In order to minimise the extra distance people might need to travel, the Preferred Scheme includes four compact grade-separated junctions; these are located at:

- Listullycurran Road / Backnamullagh Road;
- Gowdystown Road;
- Skeltons Road / Drumneath Road; and
- Waringsford Road.

In combination with other measures the additional distance for the majority of affected people would be less than the approximate 5km identified in DfI policy guidance.

The Stage 2 Preferred Route identified the CGSJ options to be taken forward to the Stage 3 Assessment. As part of the Stage 3 Assessment, the Preferred Route was developed based on the strategy of closing up private accesses onto the A1 within the vicinity of the junctions where the opportunity presented itself and where there was potential conflict of the private access with the proposed merge and diverge auxiliary lanes. This was combined with the requirement to solve a number of private access issues at each of the CGSJ junctions through development of the design and following detailed consultation with affected landowners.

As identified under the Minor Road Junction Strategy above, following representations by the public and further assessment, the merge lanes at each CGSJ were extended to a total length of 225m.

As part of the Stage 3 Assessment, representations with Translink resulted in consideration of a Bus Stop Strategy. The existing facilities range from a simple arrangement of paved area and flag post to covered bus shelters. There are no dedicated diverge, merge or layby facilities associated with these bus stops – the buses simply stop on the hard shoulder at the designated bus stop locations for pick-up / drop-off. There are a number of undesirable characteristics associated with this practice as follows:

- Patrons may access these bus stops by foot which can mean crossing the dual carriageway on either their outbound or homebound journey; and
- There are no dedicated stopping facilities for buses which can create diverging/merging hazards for mainline traffic.

The existing bus stop usage figures provided by Translink show that there are very low passenger numbers on the local service on the A1 with an average of 1-2 patrons per day at the more frequented bus stops. There are some bus stops on the route that do not see any regular use.

Therefore, through consultation with Translink, it was decided that the bus stops currently located on the mainline would be removed and replaced with bus stop facilities at the four CGSJs. The layout of the proposed bus stop facilities would mimic those recently provided on the A26 and A8 road schemes. These facilities would allow buses to access from either side of the carriageway and would provide a limited number of parking bays for drop-off/patrons. It is considered that the proposed bus stop provisions will provide a safer arrangement than currently exists and will remove these existing hazards from the mainline.

The development of the Stage 3 Preferred Route at each of the main CGSJ junctions is discussed below.

3.2.2.1 Listullycurran Road / Backnamullagh Road

The blue option was selected as part of the Stage 2 Preferred Route for the proposed CGSJ at Listullycurran Road / Backnamullagh Road. The Stage 2 minor road junction strategy identified the Backnamullagh Road to be retained as a LILO junction with a diverge lane with no provision for a merge lane. Following representations by the public and further assessment by DfI, the connection of Backnamullagh Road to the CGSJ at Listullycurran Road was further assessed. In the original design, the southbound side of the carriageway is in the inside of a bend with a number of access points. There is limited forward visibility on the mainline and the junction visibility at the access points is also limited. On this basis, (as well as weaving conflicts between diverge and merge lanes) it was decided to connect all of these access points including the Backnamullagh Road, to the CGSJ connector road in order to provide a safer mainline arrangement at this location. This is consistent with paragraph 2.7 of TD40/94 which advocates the collection of minor roads, accesses etc. onto the connector road for this reason. The main benefit of this refinement was the opportunity to close the Backnamullagh Road junction with the A1 thereby reducing the number of pubic road junctions onto the mainline and to minimise potential detour lengths for the businesses and farmers of Backnamullagh Road which would have potentially exceeded the approximate 5km.

In the original design, the southbound merge lane was located in close proximity to an access to a laneway serving approximately 7 No. residences and 1 No. farm. Due to the increased length of merge lanes, the laneway access was considered to be in conflict. It was therefore decided to connect this laneway to the new junction and close the existing laneway access to the A1. The main benefit of this refinement was removing several private and agricultural turning movements from the A1 mainline. The geometry of this new link to the junction also offered the opportunity to provide a bus stop facility with 6 No. car parking spaces.

In the original design, the northbound merge lane was located in close proximity to the private access to a farm dwelling just north of the junction. Again, this access was considered to be in conflict with the northbound merge lane. Through representations with the residents it was also discovered that large vehicles (milk tankers) were unable to access the property from the northbound lanes of the A1 due to the alignment of the private access and had to continue north, u-turn and enter from the gap in the central reserve from the southbound carriageway. As the gap was to be closed, the property was going to be severely affected by the proposals. It was therefore decided to connect this property to the Listullycurran Road and close the existing private access. Again, the main benefit of this refinement was removing some private and agricultural turning movements from the A1 mainline.

3.2.2.2 **Gowdystown Road**

The green option was selected as part of the Stage 2 Preferred Route for the proposed CGSJ at Gowdystown Road. Following representations with several affected residents, some of the private access provision was further assessed.

In the original design, the private access to No. 14a and No. 16 Gowdystown Road was located approximately 32m from the realigned junction of the Gowdystown Road and the CGSJ compact connector road. It was considered that this private access was too close to the junction and so it was further assessed. It was decided to move the private access to No. 14a and No. 16 Gowdystown Road approximately 68m in a south easterly direction away from the compact connector road to achieve at least 2/3 of the 'Y' distance from the junction. An additional benefit of this option was a reduction in the already steep gradient due to the extended length of the access. It was decided to use the remaining space between the compact connector road and the private access to provide a bus stop facility with 5 No. car parking spaces.

In the original design, the southbound merge lane was located in close proximity to a private access. Due to the increased length of merge lanes, this private access was considered to be in conflict. It was therefore decided to connect this private access to the new junction and close the existing private access to the A1. The main benefit of this refinement was removing some private and agricultural turning movements from the A1 mainline.

3.2.2.3 Skeltons Road / Drumneath Road

The purple option was selected as part of the Stage 2 Preferred Route for the proposed CGSJ at Skeltons Road / Drumneath Road. Following representations with several affected residents, some of the private access provision was further assessed.

In the original design the laneway access to No. 35 Drumneath Road and surrounding fields was proposed to connect to the CGSJ compact connector road along its current alignment. The gradient of the proposed access was considered to be excessively steep, the location of the junction on the compact connector road was not favourable and so it was further assessed. It was also identified that adjacent land parcels of agricultural land would also have access problems due to conflicts with the proposed merge and the installation of central reserve VRS. Following representations with the landowners, it was decided to provide a new laneway access approximately 307m in a south easterly direction along the Drumneath Road to access all these land parcels. The main benefit of this refinement was removing some private and agricultural turning movements from the A1 mainline and removing a potential conflict point from the compact connector road.

The original design did not include alternative access arrangements for agricultural land to the immediate west of the proposed CGSJ which currently has a field gate on the Drumneath Road in close proximity to the existing junction with the A1. It was decided to provide a private access from Drumneath Road to access these lands to avoid adversely affecting the landowner. It is noted that the steepness of the existing field alongside the Drumneath Road causes problems for vehicular access, therefore a sidelong access will be provided.

The original design did not include alternative access for agricultural land to the immediate north west of the CGSJ which currently is accessed via the Halfway Road which is to be closed up. Following consultation with affected parties, it was decided to provide a private access to this field from the private access that was being provided to No.40 and No.42 Halfway Road from the realigned Skeltons Road to avoid adversely affecting the landowner. This private access would become a shared access.

A bus stop facility is proposed to be constructed on the Skeltons Road, utilising the first section of the shared access lane for the private and agricultural accesses. Following representations with Translink, the proposal will contain a bus stop and 10 No. car parking spaces.

At an early stage of the Stage 3 Assessment, the presence of a badger sett located within the proposed footprint of the junction was highlighted. Following consultation with NIEA, it was decided that due to a number of constraints that the badger sett should be translocated to an adjacent parcel of land.

3.2.2.4 Waringsford Road

The brown option was selected as part of the Stage 2 Preferred Route for the proposed CGSJ at Waringsford Road. Following representations with several affected residents, some of the private access provision was further assessed.

In the original design the private access to the Jumpboxx commercial premises was proposed on the realigned Waringsford Road. The gradient of the proposed access was considered to be excessively steep due to the short length provided at the location shown. This was due to the Waringsford Road being re-graded to tie into the compact connector road which is at a raised height to accommodate the overbridge headroom over the A1. This access was further assessed. Following representations with the landowner and to avoid having excessive landtake impacts, it was decided that this private access would be moved in a westerly direction along the Waringsford Road to a location close to the junction with the compact connector road. This would allow a private access with adequate length and gradient to be provided along the bottom of the fill embankment of the compact connector road which would contribute to a more efficient use of the remaining space. It was also proposed to use a retaining wall solution to minimise the impact of fill embankments from the private access onto the remainder of the Jumpboxx site.

In the original design the private access to Tullyraine Quarries commercial premises was proposed to be closed up on the A1 mainline with new private access provided from the realigned and regraded Quarry Road. It was considered that this new private access passed too close to a number of commercial buildings within the quarry making it almost impossible to provide suitable access without impacting on these commercial buildings and required further assessment. Following representations with the landowners, it was decided that Quarry Road should be realigned further east using a larger horizontal radius which would move the junction with the compact connector road further away from the main junction with the A1 and provide sufficient space within the quarry to provide a new private access without impacting on commercial buildings within the quarry.

The original design did not include alternative access arrangements for a number of properties on the western boundary of the A1 within the CGSJ extents. These properties include 3 No. residential properties and 1 No. commercial premises. It is considered that the accesses to these properties would be in conflict with the northbound diverge lane and so this was further assessed. Following representations with landowners, it was decided to provide an additional laneway to collect access to all these properties and provide connection to the CGSJ via the shared laneway which leads to Graceystown Road. The main benefit of this refinement was removing some private and commercial turning movements from the A1 mainline and removing potential conflict points within close proximity to the northbound diverge.

The realignment and re-grading of the Waringsford Road also provided an opportunity to provide a bus stop facility. Following representations with Translink, the proposal will contain a bus stop and 7 No. car parking spaces.

3.2.3 Milebush Link Road

The Stage 2 minor road junction strategy included a link road between Milebush Road and the Hillsborough Road CGSJ, Dromore which would facilitate the closure of the Milebush South (West) Junction.

Following representations by the public and further assessment by DfI, the link road alignment was further assessed. The Stage 2 Preferred Route proposed a ‘T’ junction with the Hillsborough Road CGSJ approximately 104m north east of the existing junction of the CGSJ with the northbound A1 Carriageway. The link road curved in a north westerly direction to a proposed ‘T’ junction with the Milebush Road approximately 369m north east of the existing Milebush Road South (West) junction with the northbound A1 Carriageway. The Stage 2 Preferred Route did not illustrate any private accesses.

During the Stage 3 Assessment, the link road alignment was re-aligned to tighten the radius of the link road and join the Milebush Road at a proposed 'T' junction approximately 352m north east of the existing Milebush Road South (West) junction with the northbound A1 Carriageway. The main benefit of this refinement is the reduction in the size of fill embankments which reduces the landtake requirements and also provides more efficient access arrangements to adjoining lands severed by the proposed link road.

3.2.4 Castlewellan Road On-Slip

The Stage 2 Preferred Route included an On-slip from the Castlewellan Road overbridge to the northbound carriageway of the A1 which would facilitate the modification of the Old Manse Junction with the A1 to a LILO junction and mitigate potential detour lengths for the significant number of right turn movements from Old Manse Road to the northbound carriageway.

As part of the Stage 3 Scheme Assessment and following representations by the public, the alignment of the On-slip was amended to move the On-slip in an easterly direction away from Chinauley Park to minimise the impact. This requires the northbound carriageway to be widened into the central reserve to maintain the required lane widths.

It is also proposed to construct a noise barrier at the top of the slope at a location between the front face of the retaining wall and Chinauley Park to mitigate concerns regarding possible increased levels of noise within Chinauley Park. Significant planting is also proposed along this boundary to replace lost vegetation and mitigate visual impact.

3.2.5 Side Roads

The alignment of side roads has been refined to strike a balance between the standards being provided, impact on adjacent land and the cost of provision. Departures from Standard have been incorporated in the Side Roads where the cost of applying full standards could not be justified or where the impact was considered excessive. It is considered that the Departures incorporated in the Side Road design could be justified without compromising safety.

3.2.6 Private Access

In general, any private accesses affected by the works will either be maintained or have alternative access provided where necessary. A number of private accesses along the mainline will be closed with the remainder operating as left-in / left-out only. Where possible, private accesses onto the A1 within the vicinity of work zone areas have been considered for closure on safety grounds. Accommodation lanes have also been provided at a number of locations in order to mitigate excessive detours for affected farm holdings, which also has the added benefit of reducing the number of slow moving vehicles on the mainline.

3.2.7 Sustainable Urban Drainage Systems (SuDS)

To comply with the Water Framework Directive (WFD) and ensure adequate drainage could be achieved, drainage is to be provided by means of SuDS. This provision allows for surface water draining from the new road to be treated before outfalling to existing watercourses and to ensure that the flow into the watercourse is no greater than the existing flow. A number of levels of treatment are to be provided but the provision of SuDS ponds is the most significant in terms of land take however the shape of the proposed compact connector road creates an area of land within the junction which can be used to facilitate the provision of SuDS ponds. SuDS ponds have been sized to treat the catchment area served by the outfall and accommodate a 1:100 year storm. Maintenance access to these ponds has also been added to the design. Where SuDS ponds cannot be provided, attenuation will be provided by online storage.

3.3 THE AMENDED PREFERRED SCHEME

The Preferred Scheme subsequent to the developments and refinements noted above is illustrated in Figures 3.9-3.18 The Preferred Scheme is also shown in greater detail on the drawings within Appendix A and Appendix B. The following aspects are also included in the amended preferred scheme as noted above:

3.3.1 Drainage

Drainage of new road is proposed as ‘kerb and gully’. This is discharged to existing watercourses through a network of pipes, settling ponds and retention basins. Where practical, preference is given to SuDS type solutions. Regardless of the type of drainage network employed the quality of water discharged to the watercourses is the overriding consideration.

3.3.2 Street Lighting

DfI policy is to keep the extent of lighting to a minimum however street lighting will be required to be provided within the extents of all the CGSJ junctions, the junction of the Milebush Link Road with the Hillsborough Road CGSJ connector road and at the Castlewellan Road On-Slip.

Where LILO junctions are located within lit sections of the existing carriageway, the extent of lighting is required to be maintained. This will include:

- Moira Road;
- Old Manse Road; and
- Banbridge Road, Loughbrickland

3.3.3 Intelligent Transport Systems (ITS)

It is proposed to install enhanced ITS infrastructure. ITS is the collective name given to a range of electronic systems and services which enhance the movement of people and goods by optimising the effective management of the road infrastructure, by providing reliable and timely travel information. Advantages though the provision of ITS on roads such as the A1 can include;

- Enhancing road safety;

- Mitigating the effects of traffic congestion;
- Effective management of incidents;
- Improvements in reliability of journey times;
- Improvements in air quality; and
- Provision of reliable and timely information to road users.

The provision of ITS will consist of three elements, variable message signs, CCTV and Automatic Number Plate Recognition ANPR.

It is proposed that variable message signs 'VMS' are provided on the route at key locations (usually 1km before a major junction/ decision point), to provide advisory speed limits, alternative routes, warning messages, road condition information, safety advice and travel times. These may be located in the verge. A typical type of sign that may be used is a MS4. A MS4 sign is capable of displaying both pictograms and text. A typical VMS is usually mounted within the verge or on a roadside gantry with a display screen 4440 x 3160mm.

CCTV cameras may be installed to monitor traffic at major junctions, locations with significant congestion and collision hotspots. Information from the cameras will be used in conjunction with VMS to inform drivers of unusual road conditions or incidents. It is envisaged, that if installed the cameras will be mounted on posts in the verge in a similar arrangement to those already on the route.

ANPR cameras are usually installed to provide accurate journey time information for the VMS infrastructure and the traffic watch website. They are usually installed on passively safe lattice poles at VMS sites at 10km intervals.

3.3.4 Signage Strategy

Traffic, regulatory and warning signs will be provided in accordance with the Traffic Signs Manual, (February 2017, Department of Transport) and will comply with all statutory requirements. Due to the nature of the A1 dual carriageway it is envisaged that a new signage strategy will be required for the route to provide clarity and consistency for drivers on the mainline. The close proximity of several minor unclassified roads on the route that ultimately connect to each other and 'bunching up' of direction signs are concerns that will be addressed. Current proposals are that signage will be provided at junctions where signage currently exists. Three CGSJs will have new signage provided – only Listullycurran Road will not have new signage provided as signage does not currently exist at this location.

For each CGSJ being signed, Advanced Direction Signs (map-type) will be provided in advance of the junction and at the start of each CGSJ diverge, with Direction Signs being provided on the CGSJ splitter island.

Advanced Direction Signs and Direction Signs at LILO junctions will only be provided to replace those that currently exist.

The provision of new signs on the A1 carriageway may require the vesting of additional pockets of land to accommodate new signs at the required set back from the road in addition to the clearance of any vegetation that may encroach upon the necessary visibility splays. Depending on the type, site, location and set-back of a sign, they may be supported by passively safe posts or non-passively safe posts. In the case of the latter the sign would need to be protected with a vehicle restraint system where it is deemed to be a hazard.

3.4 ROADWORKS

A general description of the scheme is outlined below with more detailed information included in the Technical Appraisal Assessment summarised in Chapter 5.

- Mainline: A total of 111 No. gaps in the central reserve are to be closed along the 25.2km section of the A1 mainline with installation of approximately 17,000m of Vehicular Restraint System (VRS) with classification of N2 W4 in the form of wire rope system.
- LILO Junctions: 21 No. LILO Junctions are proposed along the 25.2km section of the A1 mainline. 16 No. of the LILO Junction have merge and diverge auxiliary lanes with associated tapers while 5 No. are diverge auxiliary lane only with a simple left only give way junction.
- LILO Side Roads: The realignment or re-grading of a number of side roads will be required as these roads tie into the proposed LILO junctions. The Dromara/Dromore Road, Connellystown Road, Boals Lane, Halfway Road, Old Manse Road, Springwell Loanin and Banbridge Road (Loughbrickland) are generally regraded on line while the Moira Road, Glen Road, Milebush Road (North), Hillsborough Road (Dromore), Grove Road, Maypole Hill, Lower Quilly Road, Mackeys Lane, Mount Ida Road, Kilmacrew Road, Graceystown Road and Lisnaree Road are realigned horizontally as they approach the new junctions with the A1.
- CGSJ: A CGSJ is provided at Listullycurran Road / Backnamullagh Road, Gowdystown Road, Skeltons Road / Drumneath Road and Waringsford Road to provide local access and u-turning opportunities.
- CGSJ Side Roads: The realignment or re-grading of a number of side roads will be required as these roads tie into the proposed CGSJs. The Milebush Road in the vicinity of the new link Road to Hillsborough Road CGSJ is generally re-graded on-line while Listullycurran Road, Gowdystown Road (East), Gowdystown Road (West), Old Banbridge Road (Gowdystown), Skeltons Road, Drumneath Road, Tullyhenan Road, Waringsford Road, Quarry Road and the public laneway leading Graceystown Road are realigned horizontally as they approach the new junctions.
- Link Road: A Link Road is to be provided between the Backnamullagh Road and the compact connector road on the Listullycurran Road CGSJ.
- Link Road: A Link Road is to be provided between the Milebush Road South and the compact connector road on the Hillsborough Road CGSJ.
- Slip Road: A Northbound On-slip is provided at the Castlewellan Road overbridge.
- Road Closures: There are 9 No. Roads to be closed to through traffic at their junction with the A1. These roads are; Dromore Road, Backnamullagh Road, Hillsborough Road (South), Milebush Road South (West), Milebush Road South (East), Lower Quilly Road (East), Banbridge Road (Gowdystown), Halfway Road (North) and Old Banbridge Road (North). Turning heads are to be provided.
- Private accesses and accommodation Lanes: a number of Private Accesses along the mainline will be closed with the remainder operating as left-in / left-out only. Private accesses affected by the works will have alternative access provided where necessary. Accommodation lanes

have also been provided at a number of locations in order to mitigate excessive detours for affected farm holdings.

- Bus Stops: all mainline bus stops will be closed with new bus stop facilities provided at the 4no new compact grade separated junctions.
- Intelligent Transport Systems (ITS): there will be provision of a number of driver information and communication systems at strategic locations along the route to improve safety and efficiency
- Drainage: Road drainage is to be provided in the form of SuDS in accordance with Vegetated Drainage Systems for Highway Runoff (DMRB, Volume 4, Section 2, HA103/06). This specifies that, where possible, water containing contaminants from the new road be treated in settlement ponds before outfalling to a natural watercourse. Ponds are provided at each of the main CGSJ junctions.

Although the general description of the scheme as outlined above is being brought forward as the Stage 3 design proposals for this Project, it is acknowledged that in the interests of safety, the A1 will continue to be monitored, in the same way that all roads are monitored, and that there may be a need in the future for further safety measures that may include minor road closures.

It is noted that any future requirement for safety measures, including minor road closures, would require appropriate assessment and consultation at that time.

4 COST ESTIMATES

4.1 INTRODUCTION

Throughout the development of the scheme, cost estimates have been prepared to a level appropriate to the assessment stage being undertaken. During the earlier stages they were broad estimates prepared for use in the Economic Assessment and to allow meaningful comparison of options. During Stage 3, the Preferred Route has been refined and information obtained from site survey and investigations has been used to produce a more detailed estimate of the scheme cost.

The construction costs for the Preferred Scheme have been developed by Chandler KBS who were engaged on a sub-consultancy basis to provide rates that reflect current construction costs in Northern Ireland. The estimate for diversion of public utility apparatus has been obtained directly from the utility providers. Land, property and compensation costs are based on rates provided by Land and Property Services (LPS). Base rates are presented in current prices (Q1 2018) in accordance with TD 37/93 Scheme Assessment Report, Volume 5, Section 1, Part 2. A summary of the scheme costs is provided in Table 4.1.

4.2 COST ESTIMATE ASSUMPTIONS

The following assumptions have been made in the Cost Estimate for the Preferred Scheme:

- Contractor’s preliminaries are assumed to be 15% of construction costs and include traffic management;
- Preparation and Supervision costs have been developed based on known previous expenditure and informed estimations of future expenditure;
- Contractor’s Fees are assumed to be 5% of construction costs
- The ’Optimism Bias' for the construction element of the Cost Estimate is assumed to be 7.5%; and
- The Contingency for the land element of the Cost Estimates is assumed to be 25%;

4.3 RISK MANAGEMENT

Construction schemes contain a number of uncertainties that have the potential to impact upon the scheme costs. Risk Analysis and Management is a structured approach to identifying, assessing and controlling risk that emerges during the course of a project lifecycle. Its task is to ensure that a cost effective use of a risk process that has a series of well-defined steps to support better decision-making through good understanding of the risks inherent in a proposal and their likely impact.

Risk Management Workshops, attended by the scheme stakeholders, identified and assessed the key risks likely to emerge during the construction lifecycle of the scheme. Based on these reviews, Monte Carlo simulation software (@RISK) was utilised to calculate an appropriate risk premium for inclusion in the Cost Estimate to account for those uncertainties.

4.4 COST SUMMARY

A summary of the scheme Cost Estimates can be seen in Table 4.1 below.

Table 4.1 – Summary of Scheme Costs

Element		Cost Estimate (£)
Site Clearance	£	129,594
Fencing	£	870,528
Road Restraint Systems (Junctions 1-6 and LILOs)	£	865,865
Drainage and Service Ducts	£	4,234,931
Earthworks	£	11,034,612
Pavements	£	5,894,020
Kerbs Footways and Paved Areas	£	1,137,348
Traffic Signs and Road Markings	£	591,726
Road Lighting and Electrical Works	£	512,762
Structures	£	4,746,648
Landscape and Ecology	£	433,098
Archaeology / Environmental / Geotechnical	£	323,359
Accommodation Works	£	1,190,708
Contractor Works for Statutory Undertakers	£	396,559
Communications / ITS	£	676,913
Mainline Works inc. central reserve VRS, crossing closures, road closures / turning heads	£	1,548,382
Roadworks Total (excl C3 Estimates)	**£**	**34,587,054**
Preliminaries (15%)	£	5,188,058
Construction Cost Estimate Sub-Total 1	**£**	**39,775,112**
Contractors Fee (5%)	£	1,988,756
Construction Cost Estimate Sub-Total 2	**£**	**41,763,867**
Statutory Undertakers (C3 Estimates)	£	1,551,924
Construction Cost Estimate Sub-Total 3	**£**	**43,315,791**
Preparation and Supervision (Future Costs incl FY 2018)	£	4,813,357
Risk Allowance	£	3,643,336
Construction Cost Estimate including Preparation & Supervision and Risk Allowance	**£**	**51,772,484**
Optimism Bias for Construction (7.5%)	£	3,882,936
Construction Cost Estimate Total including Preparation & Supervision, Risk and Optimism Bias	**£**	**55,655,420**
Lands, Dwellings and Compensation (incl contingency)	£	6,988,003
Costs incurred to date (incl advanced VRS works, Managed Services, Consultants Costs, Site Investigatory Works and Other costs)	£	4,031,000
Scheme Cost Estimate Total	**£**	**66,674,423**

5 ENGINEERING ASSESSMENT

5.1 INTRODUCTION

This chapter provides a summary of the engineering assessment of the Scheme outlined in Chapter 3. These include:

- Closure of all gaps in the central reserve between Hillsborough Roundabout and Loughbrickland and the provision of a continuous central reserve safety barrier
- The construction of 4 new compact grade separated junctions at:
  - Listullycurran Road
  - Gowdystown Road
  - Skeltons Road/Drumneath Road
  - Waringsford Road
- A northbound on-slip to the A1 from Castlewellan Road, Banbridge
- Provision of a link road between Milebush Road and the Hillsborough Road underpass, Dromore
- Closure of 9 selected side roads with improvements to the remainder of the junctions which will operate as left-in/left-out
- Closure of a number of Private Accesses along the route with the remainder operating as left-in / left-out only
- Closure of all mainline bus stops with new bus stops provided at the 4 new compact grade separated junctions
- Provision of Intelligent Transport Systems (ITS) proposals such as Variable Message Signs (VMS), Closed Circuit Television (CCTV) and Auto Number Plate Recognition (ANPR)

5.2 WHOLE SCHEME

5.2.1 Design Standards

The following documents are considered to be particularly relevant to the development of the Preferred Scheme and are relevant to all major and minor road junctions discussed in this Chapter:

Design Manual for Roads and Bridges (DMRB), Volume 6:

- TD 9/93 – Highway Link Design;
- TD 27/05 – Cross-Sections and Headrooms;
- TD 42/95 – Geometric Design of Major/Minor Priority Junctions;
- TD 40/94 – Layout of Compact Grade Separated Junctions;
- TD 22/06 – Layout of Grade Separated Junctions;
- TD 19/06 – Requirement for Road Restraint Systems;

- TD 45/09 – Road Drainage and the Water Environment; and
- TD 41/95 – Vehicular Access to All-Purpose Trunk Roads.

Other Standards:

- DEM118/16 - Director of Engineering Memorandum (DEM): "Design Speed for Roads"

5.2.1.1 Mainline

The section of dual carriageway between Hillsborough and Loughbrickland is 25.2km in length and has a 120Akph design speed. It is classified as a Category 5 in accordance with 'Highway Link Design' (DMRB Volume 6, Section 1, Part 1, TD 9/93) Table 4 – Recommended Rural Road Layouts. It is comprised of a two lane dual carriageway and central reserve of varying widths. It is not proposed to amend the cross section along the entire length of the scheme however amendments will be made at individual junction locations to comply with 'Cross Sections and Headroom' (DMRB Volume 6, Section 1, Part 2 TD 27/05). This is discussed under the headings of each individual junction within this chapter of the SAR. Where central reserve gaps are to be closed, pavement edge details will comprise kerbs and gullies or concrete channels to provide positive drainage and a safety barrier will be provided in the central reserve over the full length of the scheme as discussed in Section 5.2.1.8 below.

Refer to Sections 5.3 – 5.9 of this SAR for details of mainline sections at individual junction locations along the scheme length.

5.2.1.2 Minor Road Junctions - LILOs

Based upon the requirements of TD42/95 and TD22/06, the proposed design for the LILOs are based upon the criteria shown in Table 5.1 below:

Table 5.1 – LILO Design Criteria

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	40m	30m
TD 42/95	Lane Width (kerb-kerb)	6.2m	5.7m
TD 42/95	Lane Length	80m	40m nose +130m auxiliary lane
TD 42/95	Taper	30m	-
TD 22/06	Taper	-	55m

Refer to Section 5.3 of this SAR for a description of the design standards associated with each individual LILO junction.

5.2.1.3 CGSJs

Refer to Sections 5.4 – 5.9 of this SAR for a description of the design standards associated with each individual CGSJ. It is acknowledged that the proposals at Milebush Link and Castlewellan Road would not be considered full CGSJ type junctions, however, it is acknowledged that they do provide a form of grade separation or linkage to an already grade separated junction. Therefore, for the purposes of this assessment they have been included under the CGSJ sections.

5.2.1.4 Side Roads

Refer to Sections 5.3 - 5.9 of this SAR for a description of the design standards associated with side roads at each individual junction location.

5.2.1.5 Access Lanes

Refer to Sections 5.3 - 5.9 of this SAR for a description of the design standards associated with access lanes at each individual junction location.

5.2.1.6 Crossing Closures

There are 111 central reserve gaps within the central reserve on 25.2km stretch of the A1 Mainline between Hillsborough and Loughbrickland which present a hazard to the mainline traffic. It is proposed that each gap will be broken out, the existing hard surfacing perforated, then backfilled with soil and seeded to match the existing central reserve. Pavement edge details will comprise kerbs and gullies or concrete channels to provide positive drainage. It is noted that pavement surfaces at gaps forming Emergency Crossing Points will be retained for future use.

5.2.1.7 Turning Heads

As part of the Preferred Scheme, it is proposed to close 9 No. minor roads at their junction with the A1 mainline. It is proposed that each closure will include perforation of the existing hard surface which will then be backfilled with soil and seeded. Pavement edge details will comprise kerbs and gullies or concrete channels to provide positive drainage.

Where the existing road is to be stopped up, a turning head facility will be provided to allow vehicular traffic to turn around at the dead end. The turning head facility shall be formed using kerbs and gullies or concrete channels to provide positive drainage where required. A landscaped bund which will include an antidazzle fence will be provided between the minor road turning head and the A1 mainline to ensure closure to vehicular traffic.

5.2.1.8 Central Reserve Treatment and Emergency Crossing Point (ECP) Facilities

A double sided vehicle restraint system (VRS), typically Brifen wire rope, as consistent with other central reserve VRS across the road network in N. Ireland, will be installed. Where existing geometry dictates, bifurcated VRS may be required. Specific VRS arrangements will be used around existing structures where there is limited working width. There will be approximately 17,100m of VRS to be installed within the scheme extents.

It is proposed that all central reserve VRS posts will be placed in concreted socketed foundations for easier maintenance. On bridge decks and existing structures such as underpasses the central reserve may have a concrete plinth cast and the barrier posts either attached to a cast in situ cradle or post-anchored depending on bridge deck cover and construction sequencing.

As part of advanced works on the grounds of improving safety along the A1, sections of VRS have been installed between the Hillsborough Roundabout and Pantridge Link and another section between Springwell Loanin and the Castlewellan Road overbridge as noted in Table 5.2. In each case the existing gaps were broken out, kerbed and grassed to match the existing, with the exception of the emergency cross over points which have been retained to ensure flexibility for routine maintenance and road closures. (It is noted that any gaps closed as part of the advanced works are included within the total figure of 111 gaps identified in Section 5.2.1.6)

Table 5.2 – Schedule of VRS Installed to date

Section	Section Description	Length (m)
PA1	Hillsborough Roundabout to Pantridge link	1975
PA2a	Springwell Loanin to Bannview Road Bridge	1525
PA2b	Bannview Road Bridge to Castlewellan Road bridge	1575

Approximately 20 Emergency Crossing Points (ECP) will be retained along the route, which will enable flexibility in the management of incidents along the route, in addition to facilitating online maintenance without having to detour traffic for excessive distances off the mainline. The ECPs will be located at existing locations and will have removable safety barrier installed to allow for the conversion to contra-flow of traffic in the event of an emergency. Table 5.3 below lists the locations of each of the ECPs.

Table 5.3 – Schedule of Emergency Crossing Points(ECP) along A1 Mainline

ECP No.	Mainline Chainage	Location
1	1,360	Banbridge Road, Loughbrickland
2	1,925	South of The Outlet (The Boulevard), Banbridge
3	3,000	North of The Outlet (The Boulevard), Banbridge
4	4,240	South of Rathfriland Road
5	7,180	Tullyraine Quarry
6	8,160	Gibsons Quarry
7	9,250	South of Skeltons Road
8	10,670	Edenordinary Road
9	11,590	North of Mount Ida Road

10	11,950	South of Gowdystown
11	13,020	Mackeys Lane
12	16,180	Maypole Hill, Dromore
13	17,960	South of Grove Road
14	19,080	Hillsborough Road, North
15	19,600	Milebush Road, North
16	20,300	Backnamullagh Road
17	21,430	South of McKee's Dam
18	21,910	North of McKee's Dam
19	23,900	North of Moira Road
20	25,000	South of Hillsborough Roundabout

5.2.1.9 Non-Motorised Users

The use of the existing carriageway by non-motorised users such as pedestrians, cyclists and equestrians was assessed and the impact of the proposed development on these users was considered. It is noted that the construction of the new junctions will reduce the effects of severance created by the road in addition to providing new safer crossing points due to the presence of the new overbridges and associated footpaths. On account of the heavily trafficked, high-speed nature of the existing carriageway, pedestrian and cycling activity is minimal and it is not considered appropriate to encourage any further pedestrian and cycling activity along the mainline. It is also noted that there are no dedicated equestrian facilities within the scheme extents.

5.2.1.10 Public Transport

There are currently 37 bus stops along the mainline within the scheme extents. Existing bus stop facilities along the A1 serve two bus service routes operated by Translink; these are the 38 and 538 services. In addition the facilities also serve a number of local school bus routes. The facilities range from a simple arrangement of paved area and flag post to covered bus shelters. There are no dedicated diverge, merge or layby facilities associated with these bus stops – the buses simply stop on the hard shoulder at the designated bus stop locations for pick-up / drop-off. There are a number of undesirable characteristics associated with this practice as follows:

- Patrons may access these bus stops by foot which can mean crossing the dual carriageway on either their outbound or homebound journey
- There are no dedicated stopping facilities for buses which can create diverging/merging hazards for mainline traffic

The existing bus stop usage figures provided by Translink show that there are very low passenger numbers on the local service on the A1 with an average of 1-2 patrons per day at the more frequented bus stops. There are some bus stops on the route that do not see any regular use.

Therefore, through consultation with Translink, it is proposed that the bus stops currently located on the mainline are removed and replaced with bus stop facilities at the four proposed compact grade separated junctions. The layout of the proposed bus stop facilities would mimic those recently provided on the A26 and A8 road schemes. These facilities would allow buses to access from either side of the carriageway and would provide a limited number of parking bays for drop-off/patrons. It is considered that the proposed bus stop provisions will provide a safer arrangement than currently exists and will remove these existing hazards from the mainline.

5.2.1.11 Road Drainage

The construction of the new junctions, road widening, closure of gaps and provision of access lanes as a mainly greenfield development will increase the contributing hard surface areas when compared with the existing conditions and could potentially increase the loading of receiving watercourses with highway derived pollutants, although this may be offset to a small extent by increased dilution. Greater impacts may occur to those watercourses that will receive runoff from the improved scheme but which do not currently receive any drainage from the existing A1.

A new Government Construction Client's Sustainability Action Plan (GCC SAP) has been developed by the Sustainable Construction Task Group and is now implemented by all Government Clients. The GCC SAP encourages the use of SuDS and these have therefore been incorporated into the A1 Junctions Phase 2 Scheme.

The drainage design has been assessed in accordance with ‘Road Drainage and the Water Environment’ (DMRB, Volume 11, Section 3, Part 10, HD 45/09). This document incorporates a robust surface water impact assessment to determine the level of mitigation measures required with regard to water quality of road drainage discharges. The process involves carrying out calculations to estimate pollutant concentrations in the receiving watercourse and also the spillage risk from the proposed road scheme. Where mitigation is required it is proposed to incorporate SuDS into the design. These usually take the form of ponds to attenuate and treat the runoff where possible. Where sufficient land is not available to provide ponds, other forms of attenuation such as online pipe and manhole storage will be provided. Infiltration trenches may be required to provide sufficient treatment at these locations.

DfI policy currently forbids the use of filter drains adjacent to the carriageway as a means of providing surface water drainage. In keeping with this policy, positive road drainage is to be provided by means of kerbs and gullies or concrete channels on the main line, by kerbs and gullies for the side roads, and by over the edge drainage leading to ditches or soakaways for the laneways. A piped network leading from these drainage systems transports the untreated water towards a SuDS pond where pollutants are treated before being transported by a pipe to the watercourse. The outfall from the SuDS ponds will be fitted with a system to allow containment of a spillage thereby preventing contamination of the watercourse.

Refer to Sections 5.3 - 5.9 of this SAR for a description of the drainage at each individual junction location.

5.2.2 Departures from Standards

The ultimate aim in any design is to comply fully with the Desirable Minimum Standards specified in the DMRB. However it is normal practice to adopt Relaxations and Departures from Standards where useful cost savings can be achieved, environmental impacts reduced or operational advantages can be gained without significantly affecting safety.

Relaxations are a reduction from the Desirable Minimum Design Standards. The limit for Relaxations is defined by a given number of Design Speed steps below a specific bench mark usually the Desirable Minimum.

Departures from Standards are generally required where there is a combination of Relaxations or where the standard provided is well below that which is considered desirable. Both Departures from Standards and Relaxations require the authorisation of the DfI before being incorporated in the design.

Refer to Sections 5.3 - 5.9 of this SAR for a description of the Departures from Standard associated with each individual junction.

It is noted that a number of Departures will be required for weaving distances between junctions as a result of the provision of diverges and merges along the route length. As a result, a total of 27no Departures from Standard will be required for substandard weaving length between junctions. The location of these Departures are shown on the drawings in Appendix C.

5.2.3 Geotechnical Features

Refer to Sections 5.4 - 5.9 of this SAR for a description of the geotechnical features for each CGSJ junction. It is noted that the geotechnical features associated with the LILO junctions are not included at this stage due to the availability of targeted ground investigation only.

5.2.4 Geology

Refer to Section 2.5 of this SAR for a description of the existing geology.

5.2.5 Geomorphology

Refer to Sections 5.4 - 5.9 of this SAR for a description of geomorphology for each CGSJ junction. It is noted that the geomorphology associated with the LILO junctions are not included at this stage due to the availability of targeted ground investigation only.

5.2.6 Climate, Topography and Land Use

5.2.6.1 Climate

Figures and statistics quoted within this section are taken from Met Office data based on records from the years 1981 to 2010.

In general, Northern Ireland is cloudier than the rest of the United Kingdom, because of the hilly nature of the terrain and the proximity to the Atlantic Ocean. Even so, the coastal strip of County Down has an annual average total of over 1,300 hours of sunshine. The dullest parts of Northern Ireland are the more mountainous areas of the north and west, with annual average totals of less than 1,100 hours. Mean daily sunshine figures reach a maximum in May or June, and are at their lowest in December. The key factor is, the variation in day length through the year, but wind and cloud are major controlling factors as well. Annual mean sunshine duration for the study area would typically be approximately 1,300 hours.

Rainfall in Northern Ireland varies widely, with the highest average annual totals being recorded in the Sperrin, Antrim and Mourne Mountains, where the annual precipitation is approximately 1,200mm compared with just less than 800mm of rainfall per annum to the south of Lough Neagh and the east of the Province. Annual rainfall for the study area would typically be approximately 900mm.

Seasonal rainfall variation in Northern Ireland is not large, but the wettest months are generally between October and January. This is partly a reflection of the relatively low frequency of thunderstorms in the Province and the high frequency of winter Atlantic depressions.

The occurrence of snow is closely linked to temperature and altitude. It is comparatively rare near sea level but more frequent over the hills. The average number of days when snow falls varies between 10 near the east coast to over 35 in the mountains of Sperrin, Antrim and Mourne. Although it has been known outside these times, snow rarely falls before December or after March.

Throughout Northern Ireland, mean annual temperature varies little at low altitudes, averaging between 8.5°C to 9.5°C with the higher mean values occurring nearer to the coasts. As would be expected, the lowest mean annual temperatures are recorded with increasing height; therefore, Slieve Donard (Northern Ireland’s highest mountain) would have an average annual temperature of about 4.5°C. Due to the influences of the surrounding sea, Northern Ireland’s winter temperatures are relatively mild, therefore inland areas generally experience colder temperatures than the coast, with the opposite being the case in the summer months. On average the study area can expect a mean annual temperature of 8.5°C to 9.5°C.

Inland, generally January or February are the coldest months of the year with mean daily, minimum temperatures being between 0.5°C in upland areas and about 2.0°C on the coast. July is the warmest month, with the mean daily maximum temperatures being between 17.0°C in upland areas to almost 20.0°C.

In general, wind speed increases with height, with the strongest winds being observed over the summits of hills and mountains. The coastal fringes of County Antrim and Down have about 15 gales per year, while the number of days decreases inland to five days or fewer. These are associated with the passage of deep depressions across or close to the British Isles and most frequently occur in the winter months. In comparison with the rest of the British Isles, the frequency of gales experienced in Northern Ireland is relatively low, due to the shielding effect that the rest of Ireland and some parts of Scotland has on decreasing wind speed.

5.2.6.2 Topography and Land Use

Refer to Sections 5.3 - 5.9 of this SAR for a description of topography and land use at each individual junction location.

5.2.7 Hydrology, Hydrogeology and Drainage

5.2.7.1 Hydrology

The watercourse crossings will potentially impact on flooding and therefore a flood risk assessment has been undertaken.

5.2.7.2 Drainage

Refer to Sections 5.3 - 5.9 of this SAR for a description of the drainage proposals associated with each individual junction.

5.2.7.3 Pre-earthworks Drainage

The DMRB promotes the use of either filter drains or open ditches to intercept run-off from adjacent land to prevent it from reaching the road infrastructure. Open ditches are less expensive, can support a greater flow capacity and are easier to maintain than filter drains; therefore, where possible, open ditches have been adopted. Only where levels do not permit the use of open ditches have filter drains been included. Run-off flow rates will be similar to existing flows and therefore in some instances are proposed to discharge directly to watercourses however these will be collected and connect to the proposed drainage system where possible.

The locations of drainage outfalls are shown on drawings included within Appendix G.

5.2.7.4 Outline Road Drainage Design

The outline drainage design for the project has been considered in accordance with the requirements of the DMRB HD 33/16: “Design of Highway Drainage Systems”, which are as follows:

- Quick removal of surface water to improve safety and minimise nuisance;
- Provision of effective sub-surface drainage to maximise longevity of the pavement and its associated earthworks; and
- Minimisation of the impact of the run-off on the receiving environment.

In developing the road drainage outfall design, a number of criteria were considered, including:

- Locations of high and low points in the vertical alignment;
- Vertical gradient and carriageway cross-fall;
- Location of structures (it is preferable to locate drainage discharge facilities upstream of bridge structures to avoid the need to incorporate drainage pipes within structures);
- Opportunities to discharge to watercourses;
- Run-off area;
- Floodplain levels, ensuring sufficient clearance is provided to finished road levels; and
- Proposed outfall levels.

Following consultation with DfI, a gully and carrier drain network is proposed to collect surface run-off. The carrier pipes will then convey flow toward SuDS retention ponds prior to release into existing watercourses.

The drainage design also considered the impact the proposed works will have on the drainage infrastructure of existing side roads. Where existing side road outfall discharge rates are minimal and similar to the existing discharge rate, they will not be attenuated and will discharge direct to watercourses, as is currently the case.

5.2.7.5 Attenuation and Treatment

Refer to Sections 5.3 - 5.9 of this SAR for a description of attenuation and treatment at each individual junction.

5.2.7.6 Greenfield Runoff

A hydrological assessment has been carried out in order to determine the greenfield runoff from the area the proposed scheme will occupy. It has been assumed that the appropriate greenfield runoff rate should be 10 litres per second per hectare. This has allowed for the development of appropriately sized ponds to detain the flow from the highway drainage network and outfall to the nearest watercourse at the greenfield runoff rate.

5.2.7.7 Retention Ponds

Refer to Sections 5.3 - 5.9 of this SAR for a description of retention ponds at each individual junction. It is noted that in order to avoid excessive impact on land and property take, retention ponds will not be provided at the LILO junctions. Attenuation and treatment will be provided by online storage within pipes and manholes with treatment being provided by infiltration ditches where required.

Retention ponds have been modelled in WinDES with the outlet flows limited to greenfield runoff rates from the contributing road surface and embankment/grassed areas. These models take account of all criteria stated above and have been used to establish throttle controls at pond outlet structures.

5.2.7.8 Culvert Design

The culvert design and assessment works have been undertaken in accordance with the requirements set out in the DMRB and by DfI. The design process which has been undertaken in establishing the junction proposals comprised hydrologic analysis of catchments to determine design flows and hydraulic modelling to determine appropriate culvert dimensions that would meet a variety of criteria including the passing of flood flows.

Culvert dimensions have been established using the C689 report and the DMRB HA107/04: “Design of Outfall and Culvert Details”, and include a minimum 300mm freeboard during the 100-year return period storm event +20% for the potential additional flow due to climate change

Refer to Sections 5.3 - 5.9 of this SAR for a description of proposed culverts at each of the individual junction.

5.2.7.9 Drainage Approvals

The culvert and road drainage outfall design proposals have been prepared using best practice guidance however further consultation with the appropriate statutory bodies will be required, in particular, any structure constructed in or near a watercourse and any discharge to a watercourse is subject to agreement from DfI under Schedule 6 of the Drainage (Northern Ireland) Order 1973.

5.2.8 Earthworks

5.2.8.1 Overview

The developed scheme design will require the removal of material in cuttings and areas of known poor ground and the placement of material to construct the new road design profiles. Due to the nature of the works, this will create a cut-fill imbalance for the construction of the proposed works.

The preliminary estimate of the earthworks cut/fill volumes indicate that the total gross volume of cut material i.e. material to be excavated is approximately 552,220 m3. This material includes areas of poor or soft ground, largely consisting of peaty and alluvium rich soils. This material may need to be disposed of at suitable locations in a manner as to ensure no impact on the receiving environment. However it is envisaged that subject to more detailed testing, some of this material may be able to be reused or processed into suitable material for potential use in landscaped areas. There may also be potential for improving existing areas of poor ground by preloading or soil stabilisation instead of replacement.

The preliminary estimate of the total gross volume of fill material required is approximately 352,522 m3. Approximately 42% of this material will be sourced from areas of cut along the proposed scheme, whilst a further 265,635 m3 of material will have to be imported to site from other sources. It will be the responsibility of the contractor appointed to identify suitable locations from which to source materials, for example local borrow pits or construction sites with excess materials, and locations for disposing excess unsuitable spoil. The breakdown of current cut and fill quantities is given in Table 5.4.

Table 5.4 – Approximate Earthwork Volumes

Material Description	Volume (m3)
Total Quantity of cut material	552,220
Total Quantity of Fill material	352,522
Total Quantity of materials to be exported	344,280
Total Quantity of materials to be imported	265,635

Apart from the material to be disposed off-site or imported, the remainder of the materials will be transported within the construction site. The estimates of material quantities presented here are the best estimate available at the time of completing the Stage 3 SAR.

Due to the disjointed nature of the earthworks locations it is likely that each location will be managed in isolation. Any opportunity to manage the cut and fill balance between junctions will be explored by the Contractor, but it is envisaged that this will be minimal.

It is expected that any import or export of material will predominantly use the public road network since there is little scope for the use of haul routes.

Refer to Sections 5.3 – 5.9 of this SAR for a description of the earthworks associated with each individual junction.

5.2.8.2 Earthworks Quantification

To accurately calculate the earthworks volume within the junction, the alignments have been designed using MX Road design software. The cut and fill slopes were created at a 1V:3H slope for the purposes of design and earthworks quantification, although it is recognised that slopes of up to 1V:2H may be feasible in certain locations. For the purposes of stability assessment, slopes are modelled at 1V:2H initially to consider their feasibility.

In terms of each junction, the volumetric analysis has been carried out for the entire junction including side roads, subdivided where necessary. The following has been assumed:

- Existing carriageways have been assumed to have a construction depth of 250 millimetres.
- Average topsoil depth of 0.35m for the entire junction; and
- For the present, traffic islands have been assumed to be treated as areas of footway.

The acceptability of any excavated soft material, which does not include topsoil, has been calculated using detailed values. Using these values and carrying out further volumetric analysis within the junction area, an acceptability percentage was calculated for each type of material encountered. A summary of the Earthworks Volumes is provided in Sections 5.3 to 5.9 of this SAR for each individual junction.

5.2.8.2.1 Slope Stability

Slope stability assessments are considered as part of the earthworks design at this stage, and are included for each major cut and fill encountered at each junction.

It is envisaged that all side slopes in fills will be constructed at a maximum gradient of 1V:2H. It is considered that all cut slopes can either be constructed at 1V:2H or 1V:3H.

A stability analysis was completed for the largest CUTS and FILLS at each junction as a worst-case scenario. The values adopted for the analysis are based on in-situ results and parameters.

A drained and un-drained analysis was conducted, representing the long-term and short-term stability respectively. Note that c' is taken as 0kPa in the drained analysis and ϕ' is taken as 0^{o} in the un-drained analysis.

The analyses were carried out to Eurocode 7 (EC7) design, with partial factors applied to the geotechnical parameters. Based on EC7 a minimum factor of safety of 1.0 is required for each analysis.

It is considered that the most likely mechanisms of slope instability would be rotational or translational failure within the clays and silts and internal erosion or seepage induced failures within the granular layers. Seepage induced surface slope failures could be a significant aspect in these variable glacial soils. Where this is found to be persistent and problematic, fin drains or herringbone drains may need to be installed.

For fill sections, materials should be compacted in accordance with Table 6/4 of Series 600 of the Specification for Highway Works and achieve a CBR value of 2% or greater.

The material properties were determined within the Ground Investigation Report. The values adopted for the existing ground in each analysis are based on in-situ SPT N-values, drained and undrained Triaxial tests, and direct shear tests carried out as part of the GI works.

5.2.8.2.2 Settlement

5.2.8.2.2.1 *Consolidation Tests*

One dimensional Oedometer tests were undertaken on 12 samples taken as part of the Stage 2 & 3 Ground Investigation campaigns. For each test the applied pressure range was 0kPa to 560kPa. For the 12 tests carried out the coefficient of volume compressibility (m_v) was in the range from 0.011 – 1.02m^2/MN. The lowest value recorded, 0.011 was from BH02 at the Gowdystown Junction. This value was significantly greater than the other values recorded.

A prediction of total embankment settlement has been based on 1D Oedometer consolidation test results where available and dynamic probe results converted to SPT N values. These are shown in Table 5.5 below. Settlement is expected to be immediate and complete within the construction period. However it is generally good practice to leave all embankments for at least 1 month following completion to allow for potential unforeseen settlement (due to potential soft spots) to occur prior to pavement construction.

Where 1D Oedometer test results are available, settlement predictions are based on the following equation:

Equation 1: **Settlement = $m_v\ \Delta\delta' dz$**

Where no 1D Oedometer results were available, settlement predictions are based on the following correlations from SPT (N) and PSD (D_{10}) results:

Equation 2: **$E = N \times 0.8$, $E = 1/m_v$, $k = 10^{-2} D_{10}^{2}$(m/s) *(Hazen 1892),* $k = c_v m_v \gamma_w$**

Based on Stroud, 1989 and Craig, 1997.

The effect, rate and amount of settlement will depend on the construction program in relation to the amount of consolidation settlement remaining after pavement construction. Areas of soft soil if encountered by the Contractor during construction should be excavated and replaced with engineered fill.

It should be noted that settlement analysis is based on the assumption that peats and topsoil are removed at construction stage.

Table 5.5 – Settlement of Fill Areas

Junction	Fill	Chainage		Max height (m)	Test No.	Minimum SPT (N)	Max Settlement (mm)
		From	To				
J1 Listullycurran	Fill 1	30	220	6.751	BH01, PTP01, PTP02,PTP03, PTP05, PTP05	40	11
J1 Listullycurran	Fill 2	260	300	6.5	PBH02, PTP06PTP11	12	46
J1 Listullycurran	Fill 3	400	470	4.5	PTP09	12	505
J2 Milebush	Fill 4	70	240	6.3	PTP01, PTP02, PTP03, PTP04	4	172
J3 Gowdystown	Fill 5	40	230	5.6	PTP01,PTP02,PBH01,PTP03,PTP04,BH02, WS01, PBH02, PBH01 (Stage 2)	14	38
J4 Skeltons	Fill 6	40	320	9.55	PTP03, PTP05, BH02	9	85
J4 Skeltons	Fill 7	260	310	7.5	BH03, PTP06, BH04	14	134
J5 Waringsford	Fill 8	250	350	6	BH03, BH04, RP09	6	21

5.2.8.2.3 Material Acceptability

5.2.8.2.3.1 Overview

This section of the report provides an overview of the material acceptability and reuse from a geotechnical perspective. Sections 5.3 to 5.9 of this SAR give a more detailed assessment for each junction. The EIAR covers acceptability and reuse criteria based on chemical testing assessment and waste acceptance criteria, and should be read in conjunction with this chapter.

While the alignment aims to be sympathetic to the overall topography of the area, due to the undulating nature and the presence of drumlins, it is expected that a moderate proportion of material will be available for reuse on the scheme. The majority of material excavated from the various cuts, including cohesive and granular soils, with the exception of soft areas is expected to be reusable in the main, without the need for extensive processing anticipated.

5.2.8.2.3.2 Soil Acceptability

Soil reusability from cut and fill areas has been based on particle size distribution curves, moisture content, Moisture Condition Value (MCV), Californian Bearing Ratio (CBR) and Probe blow values /100mm converted to SPT 'N'. In general an MCV value of at least 8 and a CBR of at least 2% is required (at Natural Moisture Content) for a soil to be deemed suitable for reuse without treatment.

The scheme involves a number of cut sections at the junction upgrade locations. Sections of the junctions involving excavation of material to create cuts will produce excess material that may be reusable as engineering material for fill areas.

5.2.8.2.3.3 Existing Pavement Reusability

For the online sections, it is anticipated that some of the pavement and sub base material may be reusable, provided it meets the requirements of the Specification. Any existing bituminous bound pavement material excavated during the works would most likely be acceptable as a general fill.

5.2.8.2.4 Proposed Engineering Fill Parameters

The following types of fill material are considered to be used predominantly on the scheme: Class 1, Class 2, and Class 6A as fill below the water table. They have been given the following parameters:

Class 1 Fill:	**$C_u = 0$ kN/m^2**	**$\Phi' = 35°$**	**$\gamma = 19 - 20$ kN/m^3**
Class 2 Fill:	**$C_u = 100$ kN/m^2**	**$\Phi' = 33°$**	**$\gamma = 18 - 19$ kN/m^3**
Class 6A Fill:	**$C_u = 0$ kN/m^2**	**$\Phi' = 35°$**	**$\gamma = 20$ kN/m^3**

These are based on published literature, previous site experience and data from soil testing.

5.2.8.3 Excavatability

The excavatability of material encountered on the scheme is described in general terms under each Section 5.4 to 5.9 of this SAR for each individual junction location. Rock is expected to be encountered at certain locations, which is likely to require more robust excavation techniques other than standard digging.

5.2.9 Land and Property Take

Refer to Sections 5.3 – 5.9 of this SAR for a description of land and property take associated with each individual junction.

5.2.10 Public Utilities

As part of the development of the Preferred Scheme, there has been continued liaison with the public utility providers. A summary of the proposed utility diversion/alterations associated with the LILOs are discussed below however the proposed utility diversion/alterations associated with the CGSJs are discussed in further detail under the individual CGSJ headings in Sections 5.4 – 5.9 of this SAR.

5.2.10.1 Minor Road Junctions (LILOs)

Initially all utility providers were contacted to confirm ownership of apparatus within the study area. This allowed the scheme to be developed minimising the potential impact to utility apparatus. At Stage 2 (Preferred Route Selection), details of the apparatus within the study area was requested, in accordance with a Northern Ireland Road Authority and Utility Committee (NIRAUC) C2 request. The undertakers listed below provided details of their infrastructure in the study area:

- British Telecom plc (BT);
- Northern Ireland Electricity (NIE);
- Northern Ireland Water Ltd (NIW);
- Phoenix Gas; and
- Firmus Energy

Further utility companies including Cable and Wireless and Virgin Media were also contacted however their records did not reveal the existence of apparatus within the study area.

Upon appointment of RSC to undertake the Stage 3 Assessment, a NIRAUC C3 request was submitted to each affected utility provider, seeking preliminary details of the effects on their apparatus together with budget estimates for the works and an indication of any special requirements. Details of existing services have been prepared and are provided on drawings 168014-RPSB-VUT-ML-DR-HE-100-00001 to 00014 within Appendix E. A summary of the information received from each statutory undertaker is given below.

5.2.10.1.1 Northern Ireland Electricity

There is a range of NIE services located within the A1 transport corridor consisting of LV, MV and HV overhead and underground lines.

The reconfiguration of the existing at-grade side road junctions and provision of diverge and merge lanes where applicable, will require the relocation of several poles as the road running lanes will now be closer to the pole line increasing the risk to road users. This will be required at locations such as Mount Ida Road, Lisnaree Road and Grove Road. Furthermore, it may be necessary to lower short sections of previously buried cables to maintain cover depths between the proposed road level and cable. It is envisaged that any existing or relocated poles will be protected by safety barrier if a RRRAP Assessment identifies the poles as a risk.

The closure of gaps in the central reserve will require the removal of two existing poles from the central reserve to the north and south of the Milebush Road central reserve gap. (See Drawing 168014-RPSB-VUT-ML-DR-HE-100-00011). These poles have each been struck in the recent past (2016 and 2017), resulting in injury to the car driver in both instances. Where existing NIE services cross the carriageway, NIE have noted that it would be preferable to convert these to underground services rather than raise or extend the overhead line span across the carriageway.

5.2.10.1.2 Northern Ireland Water

Discussions have been held with NIW in relation to the impact to existing infrastructure as a result of the proposed road works. The works associated with the reconfiguration of the side roads will require a combination of localised raising of manhole covers, lowering of existing pipework to maintain adequate cover or relocation of the existing water main from the existing verge to the new verge due to the widening of the existing road corridor to accommodate diverge/merge lanes. Any provision of new / relocation of existing infrastructure will ensure that the pipework and valves can be accessed easily and safely in the vicinity of the new junctions.

Junctions such as Lower Quilly Road where the junction is being widened to accommodate the new splitter island will require the existing main to be lowered and realigned to ensure adequate cover levels and that the valves located at this location have been positioned in the new verge to facilitate safe access.

5.2.10.1.3 British Telecom

BT currently maintains both underground and overhead infrastructure along the A1. The existing BT fibre optic services located in the existing verges will need to be protected for the duration of the works due to the high cost of relocating these services. This was successfully undertaken during the A1 Junctions Phase 1 Project. The conversion of the side road junctions to LILO will require the relocation of manhole covers and conversion of verge type boxes to road boxes where necessary. In addition, to maintain adequate cover to the service, several sections may need to be lowered or routed away from the road. Locations such as Banbridge Road and Springwell Loanin will require existing overhead lines to be lowered and placed in ducts as the pole lines in these locations will present a hazard to traffic, after the improvement works have been completed.

5.2.10.1.4 Phoenix Gas

There will be no effect to Phoenix Gas services as part of the scheme. Currently Phoenix Gas are extending their services east towards Hillsborough and Dromore utilising the local road network, rather than the A1 mainline corridor. The gas Main currently crosses the A1 at, Moira Road, (Drawing No 168014-RPSB-VUT-ML-DR-HE-100-00014) but has sufficient cover that it will not be affected by the reconfiguration of the Moira Road junction.

5.2.10.1.5 Firmus Gas

Firmus Gas infrastructure currently runs from the Rathfriland Road Junction to Kilmacrew Road, with a spur serving old Manse Road in Banbridge. It is not envisaged that any modification will be required to the existing gas line at Old Manse Road, as adequate cover has been provided between road bed and pipe. The provision of a merge lane at Kilmacrew Road will require the relocation of approx. 250m of gas main from the old verge into the new verge to provide adequate cover and safe access to the valves located in this area for maintenance purposes.

5.2.10.1.6 Lighting

Additional lighting will not be provided at the existing LILO junctions. Where lighting has been provided in the past, it will be retained, though there may be some minor relocation of lighting columns required as part of the construction works to suit the proposed layouts. Locations where it is currently provided are listed below:

- Moira Road (Ch 23,700);
- Milebush Link Road (at junction with existing Hillsborough Road CGSJ only, Ch 17,210);
- Old Manse Road (Ch 5,540);
- Banbridge Road, Loughbrickland, (0,875).

5.2.11 Structures

The Preferred Scheme requires four overbridges, two significant retaining structures, a number of minor retaining walls, a number of minor culverts and a number of culvert extensions.

The basic features examined during the Stage 3 Scheme Assessment to ensure that the preliminary design represents a cost-effective solution when choosing the most appropriate form for each structure are:

- Structural Form;
- Type of Foundation;
- Span Arrangements;
- Number and Type of Supports; and
- Choice of materials.

It is usual for several possible solutions to present themselves at each structure, and a balance needs to be achieved between all these items when selecting the most suitable solution. The preferred solution for each structure is influenced largely by the following factors: -

- Appearance;
- Sustainability;
- Safety and ease of construction;
- Foundation conditions;
- Local geometry;
- Future maintenance; and
- Cost.

Using this process, preliminary designs have been considered and costed for each of the structures as discussed in the following sub-sections. The appropriate structural forms and span arrangements for each structure have been priced using a combination of SPON's Civil Engineering and Highway Works Price Book 2016 and current rates to enable a comparison between the options and compilation of a scheme cost estimate.

Based on the Ground Investigation for the highway works, it is not envisaged that any of the structures are likely to require piling and therefore piling has been excluded from the budget costs however this will be subject to further Ground Investigation at the scheme preparation stage.

5.2.11.1 **Overbridges**

The overbridges proposed for J1, J3, J4 and J5 have a deck length between 33m and 44m (between abutment centrelines). Alternative single span bridge options would require similar clear span in range of 40m (up to 43m) for 3 out of 4 overbridges proposed for the junctions. Precast Y beams for two span bridge options would not be able to span over a distance in excess of 40m and W beams would have to be used instead. In detailed analysis of the overbridge at J3 six W19 beams of depth 2.3m with a higher grade of concrete (C57/70) and high level of pre-stress would be required to span distance of 44m. Each beam would weigh over 133t making lifting operation much more complex and requiring a much heavier crane than 20-30t Y beams in the case of the two span bridge option. Lighter lifts of approximately 66t could be achieved with steel multi-girder arrangement. For both, W19 beams and steel girders the structural depth of the deck would be in range of 2.45-2.50m, which is 1.30m deeper than 1.20m in the case of the proposed two span arrangement. This would result in a higher road alignment and ultimately higher road embankments with steeper approaches. Additionally, the structural depth at bridge elevation would be approximately 3m which while the clearance available under the bridge would be no more than 6m. This would result in a very unfavourable ratio of the vertical clearance to the structural depth 2:1 giving appearance of hefty, unproportioned structure. From aesthetic point of view this ratio should be kept above 3:1 to provide visually pleasant, slender appearance of the bridge in its elevation as this would be the most visible part of the bridge for thousands of road users passing under these bridges every day.

Based on comparison of construction costs of the various options the precast W19 beams would be approximately £170,000 more expensive than Y-beams in the two span options (15-20% increase of the overall estimated construction cost). Similarly, the use of steel beams would result in £370,000 increase in construction costs in comparison to the two span option (35-40% increase of the overall estimated construction cost). The savings from omission of the intermediate pier in the median would be in range of £50,000 which is much less than increase costs of bigger beams in the single span option, not to mention the additional costs associated with the requirement to increase the length and/or gradient of the compact connector road on approach to the structure, increasing the height of embankment and requirement for further import of fill material.

Traffic management has not been considered in the budget costs. In the case of the single span option the required traffic management will involve full mainline closure for the operation of lifting of heavy bridge beams. In the case of the two span option although the works will be carried out in the median and local narrowing of the carriageway may be required the mainline traffic could be maintained all the time. For the lifting of beams in one span the traffic under appropriate traffic management could be diverted to the other carriageway maintaining one lane of the traffic in each direction.

Table 5.6 – Summary of Overbridges

Crossing the A1	Approx. Chainage (m)	Special Requirements
J1 – Listullycurran Road / Backnamullagh Road	19950	n/a
J3 – Gowdystown Road	12350	n/a
J4 – Skeltons Road / Drumneath Road	9700	n/a
J5 – Waringsford Road	7900	n/a

It is anticipated that these structures will share a similar form, creating a family of structures. The use of repetition where bridges are seen in succession assists in giving a sense of unity across a scheme. Repetition of structural details has additional sustainability and buildability benefits.

The overbridges will be seen by vehicles using the new A1 and will be some of the most noticeable features on the new alignment so it is important that they are aesthetically acceptable.

Cost estimates have been undertaken for each overbridge on the scheme, looking at 1-span and 2-span alternatives. A summary of these estimates is shown in Table 5.7 below.

Table 5.7 – Overbridge Cost Estimate Summary

A1 Crossing	Single Span, full height abutments (Steel Beam Option)	Single Span, full height abutments (Precast W Beam Option)	2- span, full height abutments (Precast Y Beam Option)
J1 – Listullycurran Road / Backnamullagh Road	£1,170,000*	£970,000*	£850,000
J3 – Gowdystown Road	£1,168,750*	£968,750*	£848,750
J4 – Skeltons Road / Drumneath Road	£1,045,000*	£845,000*	£725,000
J5 – Waringsford Road	£1,351,307.25*	£1,151,307.25*	£1,031,307.25
TOTAL	**£4,735,057.25**	**£3,935,057.25**	**£3,455,057.25**

Notes:

1. Prices exclude the cost of parapets.
2. * denotes additional costs associated with the requirement to increase the length and/or gradient of the compact connector road on approach to the structure, increasing the height of embankment and requirement for further import of fill material have not been included.

Refer to Sections 5.4, 5.6, 5.7 and 5.8 of this SAR for a description of the overbridge structures at each CGSJ junction.

5.2.11.1.1 Indicative Bearing Pressure Requirements at Overbridge Structures

Calculations indicating loading imposed by the bridge foundation onto the suitable strata were provided by the Structures team based on representative structure of Waringsford overbridge. Due to longest spans this bridge will transfer the largest reactions into the ground:

- North Abutment 147kN/m2
- Central Pier 216kN/m2
- South Abutment 150kN/m2

It has been taken that achieving a bearing capacity in the order of 250kN/m^2 at the underside of the foundation pads would be sufficient to resist these loadings, and this will need to be confirmed at the construction stage.

5.2.11.2 Retaining Walls

There are two major retaining structures and a number of minor retaining structures required as part of the Preferred Scheme. These are discussed under the individual junction headings.

Refer to Section 5.9 of this SAR for details of the major retaining structures required for the Castlewellan On-Slip.

Refer also to Sections 5.4 and 5.8 of this SAR for details of minor retaining structures required at the Listullycurran Road/Backnamullagh Road Junction and the Waringsford Road Junction.

5.2.11.3 Culverts

The A1 Dual carriageway crosses two major watercourses, the River Lagan at Dromore and the River Bann at Banbridge. Furthermore there are numerous designated and non-designated watercourses throughout the study section between Hillsborough Roundabout and Loughbrickland. Of these watercourses that intersect the A1 route, Hillsborough Park Lake Stream, crosses the A1 just south of Hillsborough. The River Lagan, Edenordinary Stream and the River Bann cross the A1 carriageway at Dromore, between Dromore and Banbridge and at Banbridge respectively while Loughbrickland Stream is located in proximity to the southern end of the scheme. It is anticipated that around 11 new culverts and 11 culvert extensions will be required on the scheme. The majority of these structures are very minor and a full list of proposed culverts has been provided in Table 5.8 below.

Table 5.8 – Schedule of Proposed Culverts

Location	Description	Approx. Mainline Chainage (m)	Shape / Form	Size (mm)	Length (m)
LILO 03	Springwell Loanin	1600m - 1800m	TBC	TBC	64.6
Turning Head adjacent to LILO 3	Old Banbridge Road (North)	1620m	TBC	TBC	11
Junction 5	Waringsford	7550m - 8100m	Pipe	1500 Dia	37.3
Junction 5	Waringsford	7550m - 8100m	Pipe	1500 Dia	24.5
Junction 5	Waringsford	7550m - 8100m	Pipe	1500 Dia	66.1
Junction 5	Waringsford	7550m - 8100m	Pipe	1100 Dia	70.9
Junction 5	Waringsford	7550m - 8100m	Pipe	1100 Dia	13.4
Junction 5	Waringsford	7550m - 8100m	Pipe	1200 Dia	36.6
Junction 4	Skeltons / Drumneath	9160m - 10300m	Box	1000H x 1500W	18
Junction 4	Skeltons / Drumneath	9160m - 10300m	Box	1500H x 1800W	25.7
Junction 4	Skeltons / Drumneath	9160m - 10300m	Pipe	250 Dia	35.9
Junction 4	Skeltons / Drumneath	9160m - 10300m	Pipe	450 Dia	19.7
Junction 4	Skeltons / Drumneath	9160m - 10300m	Pipe	750 Dia	81.1
Junction 4	Skeltons / Drumneath	9160m - 10300m	Pipe	750 Dia	61.9
LILO 08	Halfway Road	10350m - 10730m	TBC	TBC	27.4

Junction 3	Gowdystown	11970m - 12600m	Pipe	1600 Dia	55.5
Junction 3	Gowdystown	11970m - 12600m	Pipe	1600 Dia	151
LILO 12	Lower Quilly Road	15100m - 15400m	TBC	TBC	20.6
LILO 14	Connellystown Road	16150m - 16540m	TBC	TBC	174
Junction 2	Milebush	17300m - 17500m	Box	1500H x 2100W	61.4
LILO 17	Milebush Road	19300m - 19550m	TBC	TBC	87
Junction 1	Listullycurran	19600m - 20150m	Pipe	900 Dia	74.3
LILO 20	Dromara Road	21790m-22100m	TBC	TBC	50

The watercourses at all of the main CGSJs (J1-J6) have been modelled by hydrologists and the structures sized in order to maintain zero afflux during flood situations. Ecologists, including a fisheries specialist, have been consulted in preparing the proposals for these structures in order to minimise the adverse environmental impact of the scheme. Loughs Agency and NIEA guidelines have also been considered. Where protected species or other species of interest have been found during the ecological surveys, additional provision will be made for mammals to cross while the watercourses are in flood.

These new culverts and culvert extensions have been assumed to be 2000mm diameter precast concrete pipes for the purposes of the scheme cost estimates.

Refer also to Sections 5.3 - 5.9 of this SAR for details of new culverts and culvert extensions at each individual junction location.

5.2.12 Construction Management

5.2.12.1.1 Programme

The overall construction period is anticipated to be in the region of 3 years to construct the entire A1 Junctions Phase 2 Works. It is acknowledged that there is scope to deliver the Works in a phased manner by prioritising sections of mainline works and associated junctions and delivering these as discrete works packages. The advantage of this approach is that discrete works packages would require smaller funding commitments, thereby allowing sections of Improvement Works to commence earlier without having to rely on a larger funding commitment to deliver the entire project as one contract. It is likely however, that if this approach were adopted, the phased construction of the entire project could extend to 10 years or more. The phasing of the construction will be conducted in such a way that the gaps within the central reserve are not closed until the relevant compact grade separated junction has been built. This approach will be followed for either a phased approach or if the Project is let as a single contract. For the purposes of this Report, it is assumed that the Project will not be phased and will be delivered as a single contract.

Once appointed the main Contractor shall be required to provide a detailed programme prior to commencement of the works. This shall set out:

- The overall programme of construction;
- Programming of the key elements and phases of construction;
- Programming of environmental mitigation and monitoring; and
- The duration of each element and phase.

The programme will be regularly updated to reflect any changes in programmed activities and shall provide the basis for notification to residents and local communities where sensitive activities would be likely to involve temporary disturbance to access or non-routine events such as blasting of rock or piling or temporary local road diversions.

The likely principal stages of works that will be employed during the construction of the proposed road project are outlined below.

All on site drainage, erosion and sediment control measures for the construction works must be in place and functioning prior to the commencement of earthworks/site clearance.

Normal working hours are likely to be 07.00 to 19.00 Monday to Friday and 08.00 to 16.30 on Saturdays. Works outside these hours may be permitted in special circumstances. Earthworks operations are assumed to take place from April to October inclusive to avail of the better weather conditions. However it is likely that there will be some earthworks operations ongoing throughout the duration of the construction phases of the development.

5.2.12.1.2 Site Compound and Offices

The construction compound is likely to include stores, offices, welfare facilities, materials storage areas, material processing areas, plant storage and parking for site and staff vehicles. The site is anticipated to remain in place for the duration of the works. The compound will have appropriate levels of security. The Contractor will be required to manage parking and deliveries at the compound and other areas in such a manner as to ensure that there is no obstruction to traffic or sightlines during construction.

While potentially suitable locations may be identified at detailed design stage the final decision regarding locations will be decided by the appointed Contractor, in agreement with local landowners and the client.

Following the completion of the construction phase these areas will be cleared and will be reinstated by the appointed contractor to their original condition prior to occupation.

5.2.12.1.3 Pre-Main Construction Works

It is anticipated that some works may be undertaken as part of an advance works contract prior to the main construction works commencing. Examples of such advance works contracts would include:

- Archaeological surveys and testing in order to resolve archaeological issues;
- Fencing works;
- Site clearance and tree and hedgerow removal works;

- Ecological Surveys and mitigation;
- Demolition works
- Utility and Drainage Diversions;
- Removal of any invasive species within the site;
- Surface water and groundwater quality monitoring; and
- Detailed ground investigation works.

During this stage the site boundary will be fenced off and site access points will be constructed to provide access for construction vehicles from the existing road network. This will involve some works adjacent to existing roads and may require temporary traffic diversions.

All on site drainage, erosion and sediment control measures for the construction works must be in place and functioning prior to the commencement of earthworks/site clearance.

5.2.12.1.4 Main Construction Works

5.2.12.1.4.1 *Drainage*

The Contractor will be responsible for obtaining all necessary temporary discharge consents from DfI Rivers and NIEA Water Management Unit. Pre-earthworks drainage such as top and bottom of slope filter drains and cut-off ditches will be provided in advance of the bulk earthworks. Road drainage and slope drainage (where necessary) will be provided upon completion of earthworks and in advance of pavement works.

5.2.12.1.4.2 *Earthworks Cut/ Fill*

The current conceptual design for the proposed works will require the removal of material in cuttings and areas of known poor ground and the placement of material to construct the new road design profiles. This will create a cut-fill imbalance for the construction of the proposed works.

The preliminary estimate of the earthworks cut/fill volumes indicate that the total gross volume of cut material i.e. material to be excavated is approximately 552,220 m3. This material includes areas of poor or soft ground, largely consisting of peaty and alluvium rich soils. This material may need to be disposed of at suitable locations in a manner as to ensure no impact on the receiving environment. However it is envisaged that subject to more detailed testing, some of this material may be able to be reused or processed into suitable material for potential use in landscaped areas. There may also be potential for improving existing areas of poor ground by preloading or soil stabilisation instead of replacement.

The preliminary estimate of the total gross volume of fill material required is approximately 352,522 m3. Approximately 42% of this material will be sourced from areas of cut along the proposed scheme, whilst a further 265,635 m3 of material will have to be imported to site from other sources. It will be the responsibility of the contractor appointed to identify suitable locations from which to source materials, for example local borrow pits or construction sites with excess materials, and locations for disposing excess unsuitable spoil.

Due to the disjointed nature of the earthworks locations it is likely that each location will be managed in isolation. Any opportunity to manage the cut and fill balance between junctions will be explored by the Contractor, but it is envisaged that this will be minimal.

It is expected that any import or export of material will predominantly use the public road network since there is little scope for the use of haul routes.

5.2.12.1.4.3 *Structures*

The main structures include the following:

- 4no overbridges at the CGSJs (2-span, reinforced concrete piers/abutments most likely on spread footings, reinforced earth abutment walls, pre-cast beams and insitu deck slab);
- Piled retaining walls at the Castlewellan Road On-slip;
- Retaining walls to deal with localised level differences; and
- Culverts and headwalls where existing watercourses/culverts have been affected by the works

5.2.12.1.5 Carriageway Works and Traffic Management

As the majority of the works is online, it is likely that Temporary Traffic Management will be employed at each of the active work locations to facilitate construction activities. It is noted that in the vicinity of the LILO and grade separated junction works zones, 2-lanes of traffic will be provided in each direction at all times except under special circumstances when lane/road closures may be required to facilitate certain activities such as beam lifts, mainline surfacing etc. It is expected that speed restrictions will be enforced when temporary traffic management is employed on the mainline.

For mainline works being carried out away from the LILO and Junction work zones (e.g. installation of central reserve safety barrier) it is envisaged that peak hour working / traffic management restrictions will be enforced to minimise disruption to mainline traffic along these stretches of the mainline during these periods. In that regard, it is likely that the most efficient way to deliver these works is with night-time working. It is noted that DfI have recently delivered sections of central reserve safety barrier along this route whereby night-time working was the agreed method of working. It is noted that the installation of the central reserve safety barrier from the Castlewellan Road overbridge to Dromore Road, Banbridge CGSJ will require night-time working as there are no hardshoulders along this stretch. In that regard, it is expected that this will be the only instance where it will be acceptable for the mainline to be reduced to single lane running in each direction (and only on the basis that night-time working is employed).

As the majority of the public side roads along the scheme route will be affected by the works (either upgraded, closed or connected to the new CGSJs), it is expected that there will be a level of traffic disruption at each of these side roads when works are being carried out. Where possible and practicable, the existing roads will be kept open to traffic during construction. The majority of the side roads are relatively narrow and consequently, in order to keep them open to traffic, it may be necessary to either introduce temporary traffic lights or manual traffic management (e.g. stop/go boards). Where it is not possible or practical to keep a road open it will be closed with traffic diverted via the existing road network. The duration of any temporary road closures will be kept to a minimum.

When constructing the LILO junctions, it is likely that a contraflow system will be employed on the mainline whilst maintaining two lanes of traffic in each direction. This will be straightforward along the majority of the scheme length where hardshoulders are available for use as running lanes. However, there are no hardshoulders along the Banbridge Bypass, therefore lane narrowing and possibly the creation of temporary running surfaces may need to be provided in order to ensure that two lanes in each direction are maintained. This may affect the following works areas in particular:

- Old Manse Road
- Lisnaree Road

When constructing the CGSJs, it is expected that contraflow will be employed to allow for the creation of the slip roads and construction of the overbridge abutments on either side of the carriageway, whilst maintaining two lanes of traffic in each direction at all times. When the abutments and slip roads have been created, there should be sufficient road space to allow a working zone to be created in the central reserve to facilitate the construction of the central pier. It is expected that there may be some night time closures required to facilitate works associated with the overbridge, such as beam lifts etc.

The construction of the Castlewellan Road On-slip will involve significant piling works within a constrained area to accommodate the construction of the On-slip. It is expected that a contraflow system will need to be employed to facilitate these works. It is noted that this section of the A1 does not have a hard shoulder therefore lane narrowing and possibly the creation of temporary running surfaces may need to be provided in order to ensure that two lanes in each direction are maintained.

5.2.12.1.6 Construction Traffic

Due to the online nature of the scheme the majority of all materials will be transported along the public road network, primarily the A1 dual carriageway. Localised haul routes can be used at each of the works site locations but these will be minor given the compact nature of each of the works sites. The appointed contractor will identify suitable locations to source materials (ideally local quarries) and locations for disposing unacceptable materials.

The transport of bulk material (including earthworks materials, capping, sub-base and bituminous materials) is likely to result in approximately 75,000 tipper lorry movements to and from the site over the construction period. It is expected that most of these movements will be primarily along the A1 and will be relatively evenly spread across the 25km route length.

5.2.12.1.7 Stockpile Areas

Areas for the stockpile of material will be identified and agreed by the contractor in conjunction with surrounding landowners. Due to the compact nature of the junctions there will be limited scope within the permanent land take area for the storage of large quantities of materials. As noted it is envisaged that construction materials may be stored offsite locally and delivered to site when required

5.2.12.1.8 Construction Sequencing

The programming of the sequencing of these works will be led by the Contractor and agreed with the Project team. It is expected that there be a limit to the number of concurrent work zones along the length of the mainline in order to minimise the number of Temporary Traffic management arrangements in operation at any one time.

It is expected that at least two of the CGSJs will be under construction at any given time throughout the duration of the Works. Therefore the Contractor will have to plan and programme the construction of the LILO junctions and other mainline works around these whilst complying with any Traffic Management requirements specified by DfI Roads. The physical closure of the central reserve gaps and installation of the central reserve safety barrier is likely to be one of the last tasks to be completed as this infrastructure could act as a constraint to any temporary traffic management proposals if installed earlier in the programme. It is also noted that the CGSJs would need to be functional to facilitate mainline u-turning before the central reserve gaps can be closed.

It is also noted that there is the potential to deliver this project in discrete stages, in which case the construction sequencing of each stage will be dependent upon the extents of each particular stage and the scope of the works therein.

5.2.13 Health and Safety

The construction of the scheme will involve extensive earthworks and structures and it is considered that the majority of operations could be carried out using normal construction practices and in accordance with the requirements of current health and safety legislation, in particular Construction (Design and Management) Regulations (Northern Ireland 2016).

The construction of the structures in the form of overbridges, retaining walls and culverts will, by their nature, involve working at height or over water, however none of the proposed structures pose significant difficulties and hazards that could not be safely overcome by an experienced Contractor.

Areas of soft or weak ground will have an effect on the stability of bulk excavation or trenches. Areas of unsuitable material have been discovered in the vicinity of the scheme and excavation within these areas could potentially be hazardous. Similarly, there is some shallow rock that may require blasting. Once again, although these hazards have been noted, they are relatively common and could be safely overcome by a reasonably experienced Contractor.

Private access to properties would require to be maintained throughout the works. Noise and vibration as well as working hours would be restricted and would have to be monitored vigorously along the entire length of the works to minimise the construction effects on local residents and residences.

Where demolition is required, asbestos surveys (in accordance with the Control of Asbestos Regulations (Northern Ireland) 2012) may need to be carried out in advance of any demolition works.

Working adjacent to a live carriageway creates the hazard of vehicular accidents due to the proximity of site traffic, site staff, public traffic and non-motorised users on the adjacent roads. The bulk of the scheme can be delivered off-line; however particular care will be required for the construction of the Merge / Diverge lanes and also the overbridges which are to be constructed over the existing A1 while maintaining the flow of traffic.

Hazards posed by Public Utilities are considered to be minimal for a scheme of this size. Overhead electricity lines pose the greatest threat to machinery with extending arms such as excavators, but these cables are clearly visible on site and the risk can be minimised using well established techniques.

Refer to Sections 5.3 – 5.9 of this SAR for a description of site specific risks at each individual junction where relevant.

5.3 MINOR ROAD JUNCTIONS - LILOS

5.3.1 B3 Banbridge Road, Loughbrickland

5.3.1.1 Design– Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The B3 Banbridge Road, Loughbrickland junction (LILO 01) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 01 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads, the existing ghost islands will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly and the side road will be enhanced locally within the extents of the junction. Although there is no technical justification for this junction to be lit the existing lighting will be retained to ensure there is no dis-benefit to users.

The LILO 01 auxiliary merge lane clashes with the adjacent existing DVA weighbridge merge point and as such it will be closed as part of the works. To ensure the effective operation of the weighbridge is retained area a new two-way system of working has been agreed with the DVA. This requires the existing exit to be closed, vehicles will enter as they currently do, use a ‘banjo’ turning facility and approach the weighbridge in a southbound direction. Once weighed vehicle can be processed in new parking bays then will exit from the same junction they entered from. Access to the A1 will be in a northbound direction from LILO 01.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.1.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the B3 Banbridge Road, Loughbrickland determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.1.3 **Detailed Engineering Description of the LILO Junction**

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.1.2 above.

A summary of the departures from standard for the B3 Banbridge Road, Loughbrickland LILO junction are illustrated in Table 5.9 below:

Table 5.9 – LILO 01 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	30m	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	6.5m	Criteria Met
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.10 – LILO 01 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Banbridge Road, Loughbrickland	60Bkph	5	1 No. adjustment in vertical sag curvature from 250m to 650m. 2 No. adjustment in vertical sag curvature from 400m to 800m. 1 no. increase in stopping sight distance from 55.7m min. to 61.7m min. 1 no. increase in stopping sight distance from 25.5m min. to 53.6m min.
Mainline	120Akph	6	1 No. 1-step relaxation in stopping sight distance (min 229.2m) which matches existing conditions 1 No. increase in stopping sight distance from diverge around junction from 35m min. to 42m min. 1 No. departure in diverge radius (30m) 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper. 1 No. inherient departure relating to vertical alignment and stopping sight distance within the immediate approach to the junction (not affected by the proposed works) 1 No. decrease in stopping sight distance from 228m to 222m (Lane 1) and 168m to 164m (Lane 2)

5.3.1.4 Climate, Topography and Land Use

5.3.1.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.1.4.2 Topography and Land Use

The land to the south of the junction is residential housing. Land to the west, north and east is predominately agricultural/ pasture land.

5.3.1.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.1.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.11 – LILO 01 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
2412	2538

5.3.1.7 Land and Property Take

Whilst the upgrading of the existing B3 Banbridge Road, Loughbrickland T-junction to a LILO junction will require additional land to be acquired through the Vesting process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require acquisition of circa 0.546ha of agricultural and residential land for its construction.

5.3.1.8 Public Utilities

As the existing junction is lit, the lighting will be relocated or replaced as required, and be protected by safety barrier or made passively safe where required.

5.3.1.9 Structures

The proposed design will require the existing weighbridge load cell to be rotated 180° within its existing mounting and modification to some of its supporting electronic infrastructure but will not impact on the existing office building.

5.3.2 U4484 Banbridge Road (South)

5.3.2.1 Design– Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4484 Banbridge Road (south) junction (LILO 02) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 02 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads, the existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly and the side road will be enhanced locally within the extents of the junction.

As part of the designs development it is proposed to close the existing northern access point onto the U4484 Banbridge Road(south), located on the southbound carriageway of the A1 at approximately mainline scheme Ch. 1+680, on the grounds of safety and provide a turning facility on the side road south of this location.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.2.2 **Design Standards**

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4484 Banbridge Road(south) determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions;

5.3.2.3 **Detailed Engineering Description of the LILO Junction**

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD 42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD 9/93 for the design speed determined in section 5.3.1.2 above.

A summary of the departures from standard for the U4484 Old Banbridge Road (south) LILO junction are illustrated in Table 5.12 below:

Table 5.12 – LILO 02 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	20m	20m
TD 42/95	Lane Width (kerb-kerb)	10.9m	8.7m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, departures from standard from TD 9/93 will be required for the following:

Table 5.13 – LILO 02 Side Road Departures and Relaxations

Side Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Banbridge Road, South	60Bkph	4	1 No. adjustment in vertical alignment: existing gradient ranges from 4-7%; proposed vertical crest curve = 900m (to match existing levels) 1 No. horizontal curvature to replicate the existing sideroad geometry of 12.5m. 1 No. stopping sight distance of 30m to replicate the existing SSD. (TD42/95 7.6(a)) 1 No. combination departure of vertical and horizontal alignments
Mainline	120Akph	4	1 No. departure in diverge radius (20m) 1 No. departure in merge radius (20m)

			1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper. 1 No. inherient departure relating to stopping sight distance. It lies within the immediate approach to the junction (not affected by the proposed works)

5.3.2.4 Climate, Topography and Land Use

5.3.2.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.2.4.2 Topography and Land Use

The Old Banbridge Road(south) is at an elevation of approximately 1.5m higher than the A1 dual carriageway.

The land immediately next to the junction is primarily agricultural/ pasture land with some dwellings.

5.3.2.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.2.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.14 – LILO 02 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
1009	84

5.3.2.7 **Land and Property Take**

Whilst the upgrading of the existing U4484 Banbridge Road(south) T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.165ha of agricultural land for its construction.

5.3.2.8 **Public Utilities**

As existing overhead power cable poles are located adjacent to the junction they will be relocated as part of the works to facilitate the upgrade of the junction.

5.3.3 U4206 Springwell Loanin

5.3.3.1 **Design– Proposed Layout**

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4206 Springwell Loanin junction (LILO 03) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 03 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide an auxiliary diverge slip road and a give-way merge. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The U4206 Springwell Loanin will be widened over its length to the Old Newry Road to provide 2 lanes. The enhanced junction layout will require the existing drain crossing under the road between adjacent lands to be realigned.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.3.2 **Design Standards**

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4206 Springwell Loanin determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design; and
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions;

5.3.3.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of a diverge lane is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. A give-way is provided at the merge point with the A1 in accordance with TD42/95.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.2.2 above.

A summary of the departures from standard for the U4206 Springwell Loanin LILO junction are illustrated in Table 5.15 below:

Table 5.15 – LILO 03 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	Criteria Met	40m
TD 42/95	Lane Width (kerb-kerb)	5.7m	5.7m
TD 42/95	Lane Length	Criteria Met	-
TD 42/95	Taper	Criteria Met	-

In addition to the above, departures from standard from TD 9/93 will be required for the following:

Table 5.16 – LILO 03 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Springwell Loanin	60Bkph	2	1 No. vertical alignment where the gradient of 10.6% replicates the existing gradient. 1 No. adjustment in vertical sag curvature from 300m, with a 4% uphill gradient to 650m with a flat gradient.

Mainline	120Akph	2	1 No. inherient departure relating to vertical alignment, horizontal alignment and stopping sight distance within the immediate approach to the junction (not affected by the proposed works) 1 No. inherient departure of stopping sight distance, due to vertical geometry, within the immediate approach to the junction (not affected by the proposed works): 228m (Lane 1) and 164m (Lane 2)

5.3.3.4 Climate, Topography and Land Use

5.3.3.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.3.4.2 Topography and Land Use

The land in the vicinity of the junction is predominately agricultural/ pasture land with a nearby poultry farm.

5.3.3.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network. The existing open drain running north to south crossing under the U4206 Springwell Loanin then under the A1 will be realignment as part of the junction works.

5.3.3.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.17 – LILO 03 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
253	2203

5.3.3.7 Land and Property Take

Whilst the upgrading of the existing U4206 Springwell Loanin T-junction to a LILO junction and widening will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.399ha of agricultural land for its construction.

5.3.3.8 Public Utilities

As existing overhead power cables cross the A1 and run adjacent to the U4206 Springwell Loanin they will be relocated as part of the works to facilitate the upgrade of the junction.

5.3.4 A50 Old Manse Road

5.3.4.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The A50 Old Manse Road, junction (LILO 04) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 04 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads, the existing physical island will be replaced by a larger physical junction splitter island thereby directing diverging and merging traffic correctly and the side road will be enhanced locally within the extents of the junction. The A1 southbound lanes will require realignment by shifting northward, thus reducing the width of the central reserve between Ch. 5+150 and Ch. 6+050. Although there is no technical justification for this junction to be lit the existing lighting will be retained to ensure there is no disbenefit to users.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where required.

5.3.4.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the A50 Old Manse Road determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions;

5.3.4.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.4.2 above.

A summary of the departures from standard for the A50 Old Manse Road LILO junction are illustrated in Table 5.18 below:

Table 5.18 – LILO 04 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	Criteria Met	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	Criteria Met	Criteria Met
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, departures from standard from TD 9/93 will be required for the following:

Table 5.19 – LILO 04 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Old Manse Road	60Bkph	5	1 No. increase in horizontal curvature from 70m to 93.5m. 1 No. adjustment in vertical crest curvature from 650m to 1000m.

			1 No. departure in stopping sight distance around the diverge due to proximity of existing houses to the junction - 45m min. 1 No. departure in stopping sight distance around the merge due to proximity of existing houses to the junction - 40m min. 1 No. departure due to existing cross-section at the tie-in not matching requirements in TD27 Figure 4-3a
Mainline	120Akph	5	1 No. inherient departure due to substandard vertical geometry impacting on stopping sight distance. It lies within the immediate approach to the junction but is not affected by the proposed junction 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper 1 No. inherient departure due to substandard vertical geometry impacting on stopping sight distance. It lies within the immediate approach to the junction and whilst it is not affected by the proposed works junction it is influenced by the provision of a central reserve VRS 1 No. new departure of stopping sight distance, affected by the provision of a central reserve VRS. It lies within the immediate approach to the junction but is not affected by the proposed junction: 169m (Lane 1) and 169m (Lane 2) 1 No. inherient departure of stopping sight distance, due to substandard vertical geometry. It lies within the immediate approach to the junction but is not affected by the proposed junction: 289m (Lane 1) and 289m (Lane 2)

5.3.4.4 Climate, Topography and Land Use

5.3.4.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.4.4.2 Topography and Land Use

The land immediately next to the junction is primarily residential housing. North and east of this housing is predominately agricultural/ pasture land with some settlements

5.3.4.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.4.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.20 – LILO 04 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
1005	510

5.3.4.7 Land and Property Take

It is anticipated that the upgrading of the existing A50 Old Manse Road T-junction to a LILO junction can be undertaken within the lands currently owned by the Department for Infrastructure and as such no additional land is required to be acquired through the Vesting Order process.

5.3.4.8 Public Utilities

As the existing junction is lit the lighting will be relocated or replaced as required and protected by safety barrier or made passively safe where required.

5.3.5 U4192 Lisnaree Road

5.3.5.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4192 Lisnaree Road junction (LILO 05) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 05 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads, the existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly and the side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.5.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4192 Lisnaree Road determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.5.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.5.2 above.

A summary of the departures from standard for the U4192 Lisnaree Road LILO junction are illustrated in Table 5.21 below:

Table 5.21 – LILO 05 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	30m	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	5.8m	6.3m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/06	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, departures from standard from TD 9/93 will be required for the following:

Table 5.22 – LILO 05 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Lisnaree Road	60Bkph	5	1 No. vertical sag curvature to replicate the existing geometry of sag = 265m 1 No. reduction in stopping sight distance from 59m min. to 48m min. and further on 1 no. increase in SSD from 22m to 35m around the merge 3 No. combination of relaxation to vertical-horizontal alignments
Mainline	120Akph	6	1 No. reduction in stopping sight distance from 59m to 54m and further on from 62m min. to 59m min. around the diverge 1 No. reduction in stopping sight distance from 295m to 233.5m min. within the immediate approach to the junction 1 No. reduction in stopping sight distance from 138m min. to 128m min. provided within the immediate approach to the junction 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper

			1 No. new departure of stopping sight distance, affected by the provision of a central reserve VRS. It lies within the immediate approach to the junction but is not affected by the proposed junction: reduction from 295m to 249m min. 1 No. new departure of stopping sight distance, affected by the provision of a central reserve VRS. It lies within the immediate approach to the junction but is not affected by the proposed junction: reduction from 252m (Lanes 1 and 2) to 227m min (Lanes 1 and 2).

- Substandard centreline geometry is due to the existing topographical conditions.
- Lisnaree Rd has in excess of 7% gradient, affecting the diverge and merge vertical geometry - both have severely substandard hog or sag curves which replicates or improves on existing.

5.3.5.4 Climate, Topography and Land Use

5.3.5.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.5.4.2 Topography and Land Use

The land in the vicinity of the junction is predominately agricultural/ pasture land.

5.3.5.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.5.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.23 – LILO 05 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
173	1496

5.3.5.7 Land and Property Take

Whilst the upgrading of the existing U4192 Lisnaree Road T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.346ha of agricultural land for its construction.

5.3.5.8 Public Utilities

As existing overhead power cables cross the A1 adjacent to and run along the U4192 Lisnaree Road they will be relocated as part of the works to facilitate the upgrade of the junction.

5.3.6 U4074 Graceystown Road

5.3.6.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4074 Graceystown Road junction (LILO 06) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 06 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide an auxiliary diverge slip road and a give-way merge. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly and the side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.6.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4074 Graceystown Road determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.6.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of a diverge lane is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. A give-way is provided at the merge point with the A1 in accordance with TD42/95.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.6.2 above.

A summary of the departures from standard for the U4074 Graceystown Road LILO junction are illustrated in Table 5.24 below:

Table 5.24 – LILO 06 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	30m	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	5.8m	-
TD 42/95	Lane Length	Criteria Met	-
TD 42/95	Taper	Criteria Met	-

In addition to the above, departures from standard from TD 9/93 will be required for the following:

Table 5.25 – LILO 06 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Graceystown Road	60Bkph	3	1 No. vertical sag curvature of 725m with a gradient of 16.6% all of which replicate the existing vertical alignment. 1 No. reduction in stopping sight distance around the diverge from 45m min. to 36m min. 1 No. reduction in stopping sight distance around the merge from 44m min. to 29m min.
Mainline	120Akph	2	1 No. reduction in stopping sight distance within the immediate approach to the junction due to the introduction of a diverge lane: SSD reduced from 295m to 242m min. 1 No. reduction in stopping sight distance within the immediate approach to the junction: SSD reduced from 147m min. to 129m min.

5.3.6.4 **Climate, Topography and Land Use**

5.3.6.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.6.4.2 Topography and Land Use

The land in the vicinity of the junction is predominately agricultural/ pasture land with some dwellings.

5.3.6.5 **Hydrology, Hydrogeology and Drainage**

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.6.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.26 – LILO 06 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
396	117

5.3.6.7 Land and Property Take

Whilst the upgrading of the existing U4074 Graceystown Road T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.124ha of agricultural land for its construction.

5.3.6.8 Public Utilities

There are overhead cables in the vicinity of the junction.

5.3.7 U4192 Kilmacrew Road

5.3.7.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4192 Kilmacrew Road junction (LILO 07) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 07 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate

5.3.7.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for U4074 Kilmacrew Road determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.7.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.7.2 above.

A summary of the departures from standard for the U4192 Kilmacrew Road LILO junction are illustrated in Table 5.27 below:

Table 5.27 – LILO 07 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	30m	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	5.8m	7.2m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.28 – LILO 07 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Kilmacrew Road	60Bkph	8	1 No. adjustment in horizontal curvature from 160m to 80m. 1 No. vertical sag curvature of 1110m to replicate the existing vertical alignment. 1 No. reduction in stopping sight distance from 46m min. to 36m min. 1 No. reduction in stopping sight distance from 70m min. to 55m min. 1 No. reduction in stopping sight distance from 53m min. to 45m min but further along the SSD increases from 29m min. to 42m min. around the merge. 3 No. combinations of vertical-horizontal alignments
Mainline	120Akph	5	1 No. reduction in stopping sight distance within the immediate approach to the junction due to the introduction of a diverge lane: SSD reduced from 295m to 242m min. 1 No. reduction in stopping sight distance within the immediate approach to the junction: SSD reduced from 162m to 139m min. 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper 1 No. new departure of stopping sight distance, affected by the provision of a central reserve VRS. It lies within the immediate approach to the junction and whilst it is not affected by the proposed junction, it is compounded by relaxed horizontal geometry: Proposed SSD 252m (Lanes 1 and 2) 1 No. inherent departure of stopping sight distance, due to substandard vertical geometry in conjunction with relaxed horizontal alignment. It lies within the immediate approach to the junction but is not affected by the proposed junction: SSD 220m (Lanes 1 and 2)

5.3.7.4 Climate, Topography and Land Use

5.3.7.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.7.4.2 Topography and Land Use

Gibson Brother’s Quarry is adjacent to the south side of the junction. The land to the immediate north and east of the junction is predominately agricultural/ pasture land with some dwellings.

5.3.7.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.7.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.29 – LILO 07 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
1498	794

5.3.7.7 Land and Property Take

Whilst the upgrading of the existing U4192 Kilmacrew Road T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.167ha of agricultural land and circa 0.170ha of commercial land for its construction.

5.3.7.8 Public Utilities

As existing overhead power cables cross the A1 and run adjacent to the U4192 Kilmacrew Road they will be relocated as part of the works to facilitate the upgrade of the junction.

5.3.8 U4066 Halfway Road (South)

5.3.8.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4066 Halfway Road (south) junction (LILO 08) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 08 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.8.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4066 Halfway Road (south) determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.8.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.8.2 above.

A summary of the departures from standard for the U4066 Halfway Road (south) LILO junction are illustrated in Table 5.30 below:

Table 5.30 – LILO 08 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	Criteria Met	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	Criteria Met	Criteria Met
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, departures from standard from TD 9/93 will be required for the following:

Table 5.31 – LILO 08 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Halfway Road (South) - Minor Road 1	60Bkph	5	1 No. horizontal curvature of 20m to replicate the existing horizontal alignment. 1 No. vertical alignment where the gradient is 0.214% to replicate the existing vertical alignment. 1 No. stopping sight distance of 35m min. which replicates the existing minimum SSD achievable. 1 No. vertical curvature of 650m to replicate the existing vertical alignment. 1 No. combination of vertical-horizontal alignment
Halfway Road (South) - Minor Road 2	60Bkph	1	1 No. horizontal curvature of 15m to replicate the existing horizontal alignment.
Mainline	120Akph	1	1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper

5.3.8.4 Climate, Topography and Land Use

5.3.8.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.8.4.2 Topography and Land Use

The land adjacent to the junction is predominately agricultural/ pasture land with some dwellings.

5.3.8.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network. The existing open drain running north to south crosses under the U4066 Halfway Road (south) and later passes under the A1 will be realigned within the extents of the works.

5.3.8.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.32 – LILO 08 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
3488	1125

5.3.8.7 Land and Property Take

Whilst the upgrading of the existing U4066 Halfway Road (south) T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.321ha of agricultural land for its construction.

5.3.8.8 **Public Utilities**

As existing overhead power cables run in the verge at the eastern tie in with the existing side they will be relocated as part of the works to facilitate the upgrade of the junction.

5.3.9 U40109 Mount Ida Road

5.3.9.1 **Design – Proposed Layout**

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U40109 Mount Ida Road junction (LILO 09) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 09 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.9.2 **Design Standards**

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U40109 Mount Ida roads determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.9.3 **Detailed Engineering Description of the LILO Junction**

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.9.2 above.

A summary of the departures from standard for the U40109 Mount Ida Road LILO junction are illustrated in Table 5.33 below:

Table 5.33 – LILO 09 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	20	20
TD 42/95	Lane Width (kerb-kerb)	9.7m	8.8m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, departures from standard from TD 9/93 will be required for the following:

Table 5.34 – LILO 09 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Mount Ida Road - Minor Road 1	60Bkph	3	1 No. horizontal curvature of 15m to replicate the existing horizontal alignment. 1 No. vertical curvature of 650m to replicate the existing vertical alignment. 1 No. stopping sight distance of 35m min. which replicates the existing minimum SSD achievable. 1 No. combination of vertical-horizontal alignments

Mount Ida Road - Minor Road 2	60Bkph	2	1 No. horizontal curvature of 15m to replicate the existing horizontal alignment. 1 No. vertical curvature of 650m to replicate the existing vertical alignment. 1 No. combination of vertical-horizontal alignments
Mainline	120Akph	3	1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper 1 No. departure in diverge radius (20m) 1 No. departure in merge radius (20m)

5.3.9.4 Climate, Topography and Land Use

5.3.9.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.9.4.2 Topography and Land Use

The land adjacent to the junction is predominately agricultural/ pasture land with some dwellings.

5.3.9.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.9.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.35 – LILO 09 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
446	16

5.3.9.7 Land and Property Take

Whilst the upgrading of the existing U40109 Mount Ida Road T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.062ha of planted woodland for its construction.

5.3.10 U4045 Boals Lane

5.3.10.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4045 Boals Lane junction (LILO 10) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 10 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction and a new connection from the side road to the private access leading to the agricultural underpass will be provided. A new private access will be provided to the property adjacent to the LILO 10 off of the access lane allowing closure of the properties existing access which is too close to the start of the new diverge slip.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.10.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4045 Boals Lane determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.10.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.10.2 above.

A summary of the departures from standard for the U4045 Boals Lane LILO junction are illustrated in Table 5.36 below:

Table 5.36 – LILO 10 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	Criteria Met	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	5.6m	6.3m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.37 – LILO 10 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Boals Lane	60Bkph	4	1 No. horizontal curvature of 15m to replicate the existing horizontal alignment. 1 No. vertical alignment where the longitudinal gradient is 0.23% to replicate the existing vertical alignment at the tie-in point. 1 No. increase in stopping sight distance from 27m min. to 40m min but further along the SSD reduces from 39m min. to 37m min. around the diverge. 1 No. reduction in stopping sight distance from 47m min. to 37m min. around the merge.
Mainline	120Akph	5	1 No. reduction in stopping sight distance within the immediate approach to the junction: SSD reduced from 145m to 126m min. 1 No. departure in diverge radius (30m) 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper 1 No. inherient departure for stopping sight distance within the immediate approach to the junction but not affected by the proposed junction: SSD 223m min. (Lane 1 and 2) 1 No. inherient departure for combination of horizontal alignment-stopping sight distance within the immediate approach to the junction but not affected by the proposed junction.

5.3.10.4 Climate, Topography and Land Use

5.3.10.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.10.4.2 Topography and Land Use

The land adjacent to the junction is predominately agricultural/pasture land with some dwellings

5.3.10.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.10.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.38 – LILO 10 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
1500	864

5.3.10.7 Land and Property Take

Whilst the upgrading of the existing U4045 Boals Lane T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.3479ha of agricultural land for its construction.

5.3.10.8 Public Utilities

Whilst there are existing overhead power cables in the vicinity of the U4045 Boals Lane junction the extents of the works required should not require their relocation.

5.3.10.9 Structures

Whilst there is an existing underpass adjacent to the U4045 Boals Lane junctions the works required will be limited to a tie in with the existing private access.

5.3.11 U4061 Mackeys Lane

5.3.11.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4061 Mackeys Lane junction (LILO 11) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 11 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction and a new connection from the side road to the private access leading to the agricultural underpass will be provided.

Existing accesses to adjacent businesses, dwellings and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.11.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4061 Mackeys Lane determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.11.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.11.2 above.

A summary of the departures from standard for the U4061 Mackeys Lane LILO junction are illustrated in Table 5.39 below:

Table 5.39 – LILO 11 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	Criteria Met	20m
TD 42/95	Lane Width (kerb-kerb)	5.7m	7.2m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.40 – LILO 11 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Mackeys Lane	60Bkph	3	1 No. increase in stopping sight distance from 29m min. to 53m min around the diverge. 1 No. reduction in stopping sight distance from 32m min. to 29m min. around the merge. 1 No. reduction in horizontal curvature from 215m to 183.5m in combination with an adjustment in vertical curvature, going from a crest curve of 350m and a sag curve of 660m to a crest curve of 650m.
Mainline	120Akph	7	1 No. reduction in stopping sight distance within the immediate approach to the junction: SSD reduced from 146m to 126m min.

			1 No. inherient departure for combination of vertical alignment-stopping sight distance within the immediate approach to the junction and it is nominally affected by the proposed junction. 1 No. departure in merge radius (20m) 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper 1 No. departure required due to provision of diverge taper on the inside of a bend. 1 No. inherient departure for combination of horizontal alignment-stopping sight distance within the immediate approach to the junction but is not affected by the proposed junction. 1 No. inherient departure for combination of vertical alignment-stopping sight distance within the immediate approach to the junction but is not affected by the proposed junction.

5.3.11.4 Climate, Topography and Land Use

5.3.11.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.11.4.2 Topography and Land Use

The land adjacent to the junction is predominately agricultural/ pasture land with some dwellings.

5.3.11.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.11.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.41 – LILO 11 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
3116	180

5.3.11.7 Land and Property Take

Whilst the upgrading of the existing U4061 Mackeys Lane T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.229ha of agricultural land for its construction.

5.3.11.8 Public Utilities

Whilst there are exiting overhead power cables in the vicinity of the U4061 Mackeys Lane junction the extents of the works required should not require their relocation.

5.3.11.9 Structures

As there is an existing agricultural underpass adjacent to the U4061 Mackeys Lane junction it is anticipated that minor works to extend the underpass or increase the height of the parapet wall on the western side will be required to facilitate the adjustments to the verge required for the auxiliary merge slip.

5.3.12 U4027 Lower Quilly Road (West)

5.3.12.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4027 Lower Quilly Road (west) junction (LILO 12) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 12 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide an auxiliary diverge slip road and a give-way merge. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, dwellings and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.12.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4027 Lower Quilly Road (west) determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and

5.3.12.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of a diverge lane is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. A give-way is provided at the merge point with the A1 in accordance with TD42/95.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.12.2 above.

A summary of the departures from standard for the U4027 Lower Quilly Road (west) LILO junction are illustrated in Table 5.42 below:

Table 5.42 – LILO 12 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	20m	20m
TD 42/95	Lane Width (kerb-kerb)	Criteria Met	7.2m
TD 42/95	Lane Length	Criteria Met	-
TD 42/95	Taper	Criteria Met	-

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.43 – LILO 12 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Lower Quilly Road (West)	60Bkph	4	1 No. reduction in horizontal curvature of from 130m to 80m. 1 No. increase in stopping sight distance from 24m min. to 29m min. around the diverge. 1 No. increase in stopping sight distance from 42m min. to 43m min. around the merge. 1 No. adjustment in vertical sag curvature from 1000m to 900m.
Mainline	120Akph	4	1 No. inherient departure for combination of vertical alignment-stopping sight distance within the immediate approach to the junction but is not affected by the proposed junction. 1 No. departure in diverge radius (20m) 1 No. departure in merge radius (20m) 1 No. inherient departure due to a substandard vertical alignment. It lies within the immediate approach to the junction but is not affected by the proposed junction

5.3.12.4 Climate, Topography and Land Use

5.3.12.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.12.4.2 Topography and Land Use

The land adjacent to the junction is residential and agricultural/ pasture land with some dwellings.

5.3.12.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.12.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.44 – LILO 12 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
20	1631

5.3.12.7 Land and Property Take

Whilst the upgrading of the existing U4027 Lower Quilly Road (west) T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.142ha of agricultural land for its construction.

5.3.12.8 Public Utilities

As existing overhead power cables cross the A1 adjacent to and run along the U4027 Lower Quilly Road (west) they will be relocated as part of the works to facilitate the upgrade of the junction.

5.3.13 U4450 Maypole Hill

5.3.13.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4450 Maypole Hill junction (LILO 13) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 13 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads, the existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly and the side road will be enhanced locally within the extents of the junction. The A1 southbound lanes will require realignment by shifting northward, thus reducing the width of the central reserve between Ch. 15+750 and Ch. 16+570.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.13.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4450 Maypole Hill determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.13.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.13.2 above.

A summary of the departures from standard for the U4450 Maypole Hill LILO junction are illustrated in Table 5.45 below:

Table 5.45 – LILO 13 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	30m	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	6.4m	6.4m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.46 – LILO 13 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Maypole Hill	60Bkph	4	1 No. reduction in stopping sight distance from 78m min. to 58m min. around the diverge. 1 No. increase in stopping sight distance from 22m min. to 36m min. around the merge. 1 No. horizontal curvature of 130m in combination with a vertical gradient of 10% to replicate the existing horizontal and vertical conditions. 1 No. horizontal curvature of 60m in combination with a vertical gradient of 11% to replicate the existing horizontal and vertical conditions.
Mainline	120Akph		1 No. new departure for combination of vertical alignment-stopping sight distance within the immediate approach to the

			junction but is not affected by the proposed junction 1 No. decrease in stopping sight distance from 228m to 222m (Lane 1) and 168m to 164m (Lane 2) 1 No. departure in diverge radius (20m) 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper

5.3.13.4 Climate, Topography and Land Use

5.3.13.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.13.4.2 Topography and Land Use

The land adjacent to the junction is predominately residential.

5.3.13.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.13.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.47 – LILO 13 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
705	2053

5.3.13.7 Land and Property Take

Whilst the upgrading of the existing U4450 Maypole Hill T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.346ha of planted embankment land for its construction.

5.3.13.8 Public Utilities

Whilst the existing junction is not lit there is lighting on the approach to the junction and single column lighting and adjacent footpath. Where the design impacts on the existing lighting it will be relocated or replaced as required.

5.3.14 U4017 Connellystown Road

5.3.14.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4017 Connellystown Road junction (LILO 14) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 14 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly and the side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, dwellings and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.14.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4017 Connellystown Road determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.14.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.14.2 above.

A summary of the departures from standard for the U4017 Connellystown Road LILO junction are illustrated in Table 5.48 below:

Table 5.48 – LILO 14 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	Criteria Met	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	5.8m	6.4m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.49 – LILO 14 Side Road Departures and Relaxations

Side Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Connellystown Road	60Bkph	6	1 No. horizontal curvature of 143m to replicate the existing horizontal alignment. 1 No. vertical sag curvature of 500m to replicate the existing horizontal alignment.

			1 No. vertical sag curvature of 1000m to replicate the existing horizontal alignment. 1 No. increase in stopping sight distance from 31m min. to 40m min around the diverge. 1 No. increase in stopping sight distance from 25m min. to 44m min. around the merge. 1 No. combination of vertical-horizontal alignment
Mainline	120Akph		1 No. increase in stopping sight distance within the immediate approach to the junction: SSD reduced from 133m to 150m min. 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper 1 No. new departure of stopping sight distance, affected by the provision of a central reserve VRS. It lies within the immediate approach to the junction but is not affected by the proposed junction: SSD 236m (Lane 1) and 182m (Lane 2)

5.3.14.4 Climate, Topography and Land Use

5.3.14.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.14.4.2 Topography and Land Use

The land adjacent to the junction is predominately agricultural/ pasture land with some dwellings.

5.3.14.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network. The existing open drain running north to south crossing under the U4017 Connellystown Road parallel with the A1 will be realigned as part of the works.

5.3.14.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.50 – LILO 14 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
643	3303

5.3.14.7 Land and Property Take

Whilst the upgrading of the existing U4017 Connellystown Road T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.341ha of agricultural land for its construction.

5.3.15 U4012 Grove Road

5.3.15.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U4012 Grove Road junction (LILO 15) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 15 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.15.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4012 Grove Road determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.15.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.15.2 above.

A summary of the departures from standard for the U4012 Grove Road LILO junction are illustrated in Table 5.51 below:

Table 5.51 – LILO 15 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	Criteria Met	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	5.8m	6.4m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.52 – LILO 15 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Grove Road	60Bkph	6	1 No. adjustment in vertical crest curvature from 500m to 650m. 1 No. adjustment in vertical sag curvature from 400m to 650m. 1 No. adjustment to vertical alignment gradient from 9% to 7.8% 1 No. increase in horizontal curvature from 50m to 90m. 1 No. increase in stopping sight distance from 45m min. to 52m min around the diverge. 1 No. reduction in stopping sight distance from 70.5m min. to 34m min around the merge.
Mainline	120Akph	3	1 No. new departure of stopping sight distance, affected by the provision of a central reserve VRS. It lies within the immediate approach to the junction but is not affected by the proposed junction. SSD 180m (Lanes 1) and 128m (Lane 2) 1 No. increase to stopping sight distance from diverge around the junction. 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper

5.3.15.4 Climate, Topography and Land Use

5.3.15.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.15.4.2 Topography and Land Use

The land surrounding the junction is predominately agricultural/ pasture land with some dwellings. Adjacent to the junction is a builder's merchant yard.

5.3.15.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.15.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.53 – LILO 15 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
1444	1500

5.3.15.7 Land and Property Take

Whilst the upgrading of the existing U4012 Grove Road T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.194ha of agricultural land for its construction.

5.3.15.8 Public Utilities

As existing overhead power cables cross the A1 and run adjacent to the U4012 Grove Road they will be relocated as part of the works to facilitate the upgrade of the junction.

5.3.16 U4023 Hillsborough Road (North)

5.3.16.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. TheU4023 Hillsborough Road (north) junction (LILO 16) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 16 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide an auxiliary diverge slip road and a give-way merge. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.16.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U4023 Hillsborough Road (north) determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.16.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of a diverge lane is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. A give-way is provided at the merge point with the A1 in accordance with TD42/95.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.16.2 above.

A summary of the departures from standard for the U4023 Hillsborough Road (north) LILO junction are illustrated in Table 5.54 below:

Table 5.54 – LILO 16 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	20m	20m
TD 42/95	Lane Width (kerb-kerb)	Criteria Met	7.3m
TD 42/95	Lane Length	Criteria Met	-
TD 42/95	Taper	Criteria Met	-

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.55 – LILO 16 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Hillsborough Road (North)	60Bkph	7	1 No. adjustment in horizontal curvature from straight to 25m. 1 No. adjustment in horizontal curvature from straight to 50m. 1 No. increase in horizontal curvature from 12m to 15m. 1 No. vertical crest curvature of 500m to replicate existing vertical alignment. 1 No. increase in stopping sight distance from 22m min. to 29m min around the diverge.

			1 No. increase in stopping sight distance from 44m min. to 52m min around the diverge. 1 No. combination due to vertical-horizontal alignment
Mainline	120Akph	5	1 No. decrease in stopping sight distance from 126m min. to 121m min. 1 No. departure in diverge radius (20m) 1 No. departure in merge radius (20m) 2 No. inherient departure for combination of horizontal alignment-stopping sight distance within the immediate approach to the junction but is not affected by the proposed junction

5.3.16.4 Climate, Topography and Land Use

5.3.16.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.16.4.2 Topography and Land Use

The land surrounding the junction is both residential and agricultural/ pasture land with some dwellings.

5.3.16.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.16.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.56 – LILO 16 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
693	139

5.3.16.7 Land and Property Take

Whilst the upgrading of the existing U4023 Hillsborough Road (north) T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.012ha of residential garden and circa 0.140ha of agricultural land for its construction.

5.3.16.8 Public Utilities

As existing overhead power cables cross the A1 adjacent to and run along the U4023 Hillsborough Road (north) they will be relocated as part of the works to facilitate the upgrade of the junction.

5.3.17 C0360 Milebush Road (North)

5.3.17.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The C0360 Milebush Road (north) junction (LILO 17) existing central reserve crossing and the adjacent central reserve crossing for Wilson Yard will be closed by the physical removal of the turning facilities, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 17 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide an auxiliary diverge slip road and a give-way merge. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.17.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the C0360 Milebush Road (north) determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and

5.3.17.3 **Detailed Engineering Description of the LILO Junction**

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of a diverge lane is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. A give-way is provided at the merge point with the A1 in accordance with TD42/95.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.17.2 above.

A summary of the departures from standard for the C0360 Milebush Road (north) LILO junction are illustrated in Table 5.57 below:

Table 5.57 – LILO 17 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	30m	20m
TD 42/95	Lane Width (kerb-kerb)	6.4m	8.3m
TD 42/95	Lane Length	Criteria Met	-
TD 22/06	Taper	Criteria Met	-

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.58 – LILO 17 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Milebush Road (North)	60Bkph	8	1 No. reduction in horizontal curvature from 180m to 75m combined with an adjustment in vertical sag curvature from 500m to 900m and an adjustment in vertical crest curvature from 500m to 1000m. 1 No. adjustment in vertical sag curvature from 500m to 1000m. 1 No. increase in stopping sight distance from 30m min. to 41m min around the diverge. 1 No. stopping sight distance of 74m min. which replicates the existing minimum SSD achievable. 1 No. reduction in "y" value from 90m to 70m. 1 No. reduction in "y" value from 90m to 25m and from 90m to 40m. 1 No. reduction in "y" value from 90m to 55m. 1 No. reduction in "y" value from 295m to 235m.
Mainline	120Akph	1	1 No. inherient departure for combination of horizontal alignment-stopping sight distance within the immediate approach to the junction but is not affected by the proposed junction

- Generally the vertical geometry satisfies minimum standards. Where this is not the case is a result of existing constraints. Notably, the alignment runs between two parcels of land that are owned by Wilson's yard. Therefore the design approach is of a 'best fit' scenario in which this alignment can satisfy the needs of the private land owner.

5.3.17.4 Climate, Topography and Land Use

5.3.17.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.17.4.2 Topography and Land Use

The land surrounding the junction is both residential and agricultural/ pasture land with some dwellings.

5.3.17.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.17.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.59 – LILO 17 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
433	2084

5.3.17.7 Land and Property Take

Whilst the upgrading of the existing C0360 Milebush Road (north) T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require the demolition of an existing property taking circa 0.036ha of residential land, 0.236ha of land with planning permission and 0.003ha of existing road verge for its construction.

The construction of the LILO junction at Milebush Road North will require demolition of 1 No. residential property and 3 No. out-building to the south of the junction. Asbestos surveys (in accordance with the Control of Asbestos Regulations (Northern Ireland) 2012) may need to be carried out in advance of any demolition works.

5.3.17.8 Public Utilities

As existing overhead power cables cross and run along the northbound verge of the A1 adjacent to C0360 Milebush Road (north) they will be relocated as part of the works to facilitate the upgrade of the junction. There is also a single lamp post at the corner of the existing C0360 Milebush Road junction which will be removed as part of the works so that it does not conflict with the adjacent lighting of the new Listullycurran compact grade separated junction.

5.3.17.9 Structures

There are dwellings in the vicinity of the junction.

5.3.18 U0403 Taughblane Road

5.3.18.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U0403 Taughblane Road junction (LILO 19) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 19 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.18.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U0403 Taughblane Road determined as 70Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.18.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.18.2 above.

A summary of the departures from standard for the U0403 Taughblane Road LILO junction are illustrated in Table 5.60 below:

Table 5.60 – LILO 19 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	Criteria Met	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	5.7m	6.3m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.61 – LILO 19 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Taughblane Road	70Bkph	3	1 No. stopping sight distance of 38m min. which replicates the existing minimum SSD achievable. 1 No. increase in stopping sight distance from 43m min. to 62m min around the diverge. 1 No. reduction in horizontal curvature from 360m to 127m combined with vertical sag curvature of 900m - this sag curve replicates the existing vertical alignment.
Mainline	120Akph	2	1 no. departure in stopping sight distance from diverge around the junction. SSD 38m min. matches existing conditions 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper

5.3.18.4 Climate, Topography and Land Use

5.3.18.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.18.4.2 Topography and Land Use

The land surrounding the junction is agricultural/ pasture land with some dwellings.

5.3.18.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.18.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.62 – LILO 19 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
4339	1979

5.3.18.7 Land and Property Take

Whilst the upgrading of the existing U0403 Taughblane Road T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.366ha of agricultural land for its construction.

5.3.18.8 Public Utilities

Whilst there are existing overhead power cables in the vicinity of the U0403 Taughblane Road junction the extents of the works required should not require their relocation.

5.3.19 U0404 Dromara Road

5.3.19.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U0404 Dromara Road junction (LILO 20) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 20 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.19.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U0404 Dromara Road determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.19.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.19.2 above.

A summary of the departures from standard for the U0404 Dromara Road LILO junction are illustrated in Table 5.63 below:

Table 5.63 – LILO 20 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	30m	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	6.3m	6.3m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.64 – LILO 20 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Dromara Road	60Bkph	3	1 No. vertical sag curvature of 150m which replicates the existing vertical alignment. 1 No. increase in stopping sight distance from 51m min. to 52m min around the diverge. 1 No. increase in stopping sight distance from 45m min. to 51m min around the merge.
Mainline	120Akph	5	1 No. inherient departure for combination of vertical alignment-stopping sight distance within the immediate approach to the junction but is not affected by the proposed junction 1 No. departure in diverge radius (30m) 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper 1 No. new departure of stopping sight distance, affected by the provision of a central reserve VRS. It lies within the immediate approach to the junction but is not affected by the proposed junction: Proposed SSD 287m (Lanes 1 and 2) 1 No. inherient departure for combination of vertical-horizontal alignment within the immediate approach to the junction but is not affected by the proposed junction

5.3.19.4 Climate, Topography and Land Use

5.3.19.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.19.4.2 Topography and Land Use

5.3.19.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.19.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.65 – LILO 20 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
374	2708

5.3.19.7 Land and Property Take

Whilst the upgrading of the existing U0404 Dromara Road T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.267ha of agricultural land for its construction.

5.3.20 U0404 Glen Road

5.3.20.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The U0404 Glen Road junction (LILO 21) existing central reserve crossing will be closed by the physical removal of the turning facility, the installation of kerbing with soil and seeding to match the adjacent central reserve make up and the installation of a continuous central reserve barrier throughout.

To allow LILO 21 to operate efficiently, once the central reserve is closed, the existing junction will be upgraded to provide auxiliary diverge and merge slip roads. The existing T-junction will be replaced by a formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally within the extents of the junction and the existing connection to the private underpass will be retained.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.20.2 **Design Standards**

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the U0404 Glen Road determined as 60Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and
- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.20.3 **Detailed Engineering Description of the LILO Junction**

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI’s Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.20.2 above.

A summary of the departures from standard for the U0404 Glen Road LILO junction are illustrated in Table 5.66 below:

Table 5.66 – LILO 21 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	20m	20m
TD 42/95	Lane Width (kerb-kerb)	Criteria Met	7.3m
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/95	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following:

Table 5.67 – LILO 21 Side Road Departures and Relaxations

Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Glen Road	60Bkph	4	1 No. vertical sag curvature of 300m which replicates the existing vertical alignment, combined with an increase in stopping sight distance from 27m to 42m. 1 No. vertical crest curvature of 650m which replicates the existing vertical alignment. 1 No. stopping sight distance of 73m min. which replicates the existing minimum SSD achievable. 1 No. increase in stopping sight distance from 43m min. to 48m min around the diverge.
Mainline	120Akph		1 No. departure in diverge radius (15m) 1 No. departure in diverge radius (20m) 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper 1 No. inherient departure of stopping sight distance, due to substandard vertical geometry. It lies within the immediate approach to the junction but is not affected by the proposed junction: 160m (Lane 1) and 157m (Lane 2)

5.3.20.4 Climate, Topography and Land Use

5.3.20.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.20.4.2 Topography and Land Use

The land surrounding the junction is agricultural/ pasture land with some dwellings.

5.3.20.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.20.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.68 – LILO 21 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
1297	195

5.3.20.7 Land and Property Take

Whilst the upgrading of the existing U0404 Glen Road T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent businesses, properties and land. The proposed design will require circa 0.2679ha of agricultural land for its construction.

5.3.20.8 Public Utilities

As existing overhead power cables cross the A1 adjacent to and run along the U0404 Glen Road they will be relocated as part of the works to facilitate the upgrade of the junction.

5.3.20.9 Structures

As there is an existing agricultural underpass adjacent to the U0404 Glen Road junction it is anticipated that minor works to extend the underpass or increase the height of the parapet wall on the western side will be required to facilitate the adjustments to the verge required for the auxiliary diverge slip.

5.3.21 C0363 Moira Road

5.3.21.1 Design – Proposed Layout

The primary aim of the scheme is to close all gaps within the central reserve due to the vehicle conflict points they facilitate. The C0363 Moira Road junction (LILO 22) central reserve crossing was closed physically removing the turning facility by installing kerbing with soil and seeding matching the adjacent central reserve make up and installing a continuous central reserve barrier.

To allow LILO 22 to operate efficiently, the existing junction will be upgraded to provide compliant auxiliary diverge and merge slip roads. The existing T-junctions physical splitter island will be replaced by a larger formalised physical junction splitter island thereby directing diverging and merging traffic correctly. The side road will be enhanced locally by realigning it northwards within the extents of the junction to mitigate the potential impact on the Downshire rifle club.

Existing accesses to adjacent businesses, properties and farm lands have been considered, discussed with the landowner and are shown on the proposed junction layout drawings contained within Appendix A and Appendix B where appropriate.

5.3.21.2 Design Standards

DEM 118/16 Design Speed for Roads identifies how Design Speeds are derived. In accordance with DEM 118/16 policy requirements the A1 carriageway is designed to meet the standards appropriate for a 120A kph design speed. As the side roads are not sufficiently long to calculate the design speed in accordance with TD 9/93 Highway Link Design DEM 118/16 offers an alternative approach based upon measured vehicle speeds. Vehicle speed surveys were undertaken by a specialist survey company in April 2018 with the Design Speed for the C0363 Moira Road determined as 70Bkph.

The intention of the design is to improve upon the existing layout where possible and the minimum standards have not been provided. Where this is not possible, a balance between the standards, environmental impacts, cost and traffic flow has been considered to ensure the best design possible is provided.

The development of the proposed layout has been undertaken in accordance with the following DMRB standards within Volume 6:

- Section 1 TD9/93 Highway Link Design;
- Section 2 Part 6 TD42/95 Geometric Design of Major/ Minor Priority Junctions; and

- Section 2 Part 1 TD22/06 Layout of Grade Separated Junctions.

5.3.21.3 Detailed Engineering Description of the LILO Junction

Table 3.1 of this report outlines the level of intervention proposed at each junction identifying where diverge and merge lanes are proposed.

The provision of diverge and merge lanes is based upon the requirements of TD42/95 with a commitment to provide auxiliary lanes in lieu of direct tapers. Furthermore, discussions with the DfI's Standards Branch also agreed that an enhanced merge taper would be provided, where required, based upon the requirements of TD22/06.

The design of the side road tie in is based upon the design criteria stated within Table 3 of TD9/93 for the design speed determined in section 5.3.21.2 above.

A summary of the departures from standard for the C0363 Moira Road LILO junction are illustrated in Table 5.69 below:

Table 5.69 – LILO 22 Departure Summary

Design Standard	Element Description	Diverge Lane	Merge Lane
TD 42/95	Corner Radius	20m	Criteria Met
TD 42/95	Lane Width (kerb-kerb)	8.3m	Criteria Met
TD 42/95	Lane Length	Criteria Met	Criteria Met
TD 42/94	Taper	Criteria Met	-
TD 22/06	Taper	-	Criteria Met

In addition to the above, a departure from standard from TD 9/93 will be required for the following on the C0363 Moira road:

Table 5.70 – LILO 22 Side Road Departures and Relaxations

Side Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Moira Road	70Bkph	3	1 No. increase in stopping sight distance from diverge around the junction. SSD from 27m min. to 41m min. 1 No. stopping sight distance of 62m min. combined with horizontal curvature of 180m radius

			1 No. stopping sight distance of 41m min. combined with horizontal curvature of 180m radius
Mainline	120Akph	4	2 No. combinations of vertical alignment-stopping sight distance 1 No. departure in diverge radius (30m) 1 No. departure to merge auxiliary lane to include 40m nose, 130m auxiliary lane and 55m taper

5.3.21.4 Climate, Topography and Land Use

5.3.21.4.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.3.21.4.2 Topography and Land Use

The land surrounding the junction is agricultural/ pasture land with some dwellings.

5.3.21.5 Hydrology, Hydrogeology and Drainage

As the upgrading of the existing T-junction to a LILO junction introduces a small additional area of blacktop the impact on the surface water runoff is deemed negligible and as such it is proposed, where possible, the existing drainage system will be utilised. The existing road drainage is primarily kerbed with gullies leading to a carrier drain system therefore where new drainage is required it will replicate the existing and connect into the existing drainage network.

5.3.21.6 Earthworks

Whilst the existing mainline and side road cut and fill slopes are typically 1:2 or locally steeper, to accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

Table 5.71 - LILO 22 Bulk Earthworks Summary

Bulk Cut Volume (m^3)	Bulk Fill Volume (m^3)
325	1134

5.3.21.7 **Land and Property Take**

Whilst the upgrading of the existing C0363 Moira Road T-junction to a LILO junction will require additional land to be acquired through the Vesting Order process the design seeks to minimise the impact on adjacent properties and land. The proposed design will require circa 0.270ha of agricultural land for its construction.

5.3.21.8 **Public Utilities**

As the existing junction is lit the lighting will be relocated or replaced as required and protected by safety barrier or made passively safe where required.

5.4 LISTULLYCURRAN ROAD

5.4.1 Introduction

Listullycurran Road Junction (Junction 1) is located approximately 5.2km north of the town of Dromore. The junction was selected as a suitable location for the construction of a CGSJ during the Stage 1 Scheme Assessment.

The Listullycurran Road Junction was identified as having a significant volume of right turn movements, compared to adjacent side roads. Therefore, based on the guidance based in both TD9 and RSPPG_E038, the Stage 1 Scheme Assessment identified that some form of grade separation at this junction should be provided.

Three CGSJ junction options were assessed during the Stage 2 Scheme Assessment. The Blue Option was favoured under the economic objective as it is the lowest cost option and was more favourable than the Amber Option under the accessibility and safety objectives, as well as maintaining route consistency. The Brown Option is very similar to the Blue option in terms of scheme objectives, however occupied a larger footprint, resulting in the purchase of additional lands.

This section of the report considers the engineering aspects of the proposed CGSJ at Listullycurran Road as described in Chapter 3.

5.4.2 Design Standards

The design documents and standards particularly relevant to the Listullycurran Road Junction are outlined in Section 5.2.1 of this SAR.

5.4.2.1 Mainline

The section of dual carriageway on which the proposed Listullycurran Junction is to be located is designed to meet the standards appropriate to a 120Akph design speed and is classified as a Category 5 in accordance with 'Highway Link Design' (DMRB Volume 6, Section 1, Part 1, TD 9/93) Table 4 – Recommended Rural Road Layouts. It comprises two 7.3m wide carriageways with additional 1.0m hardstrips on either side and the central reserve is to be a minimum of 2.5m (widened for visibility where necessary) in accordance with 'Cross Sections and Headroom' (DMRB Volume 6, Section 1, Part 2 TD 27/05). The existing hardshoulder will taper to meet the width of the proposed hardstrips over the length of the diverge and merge tapers. Pavement edge details will comprise kerbs and gullies or concrete channels to provide positive drainage and a safety barrier will be provided in the central reserve over the full length of the junction extents and will connect into the safety barrier proposed for the Whole Scheme as discussed in Section 5.2.

The extents of the section of mainline associated with the Listullycurran Road junction starts at a point approximate 385m in a north easterly direction from the existing Listullycurran Road junction with the A1 dual carriageway to a point approximately 525m in a south easterly direction from the same junction.

5.4.2.2 Compact Grade Separated Junction

A CGSJ has been provided, just south of where the dual carriageway intersects with Listullycurran Road. The Junction allows traffic from Listullycurran Road, Backnamullagh Road and the public laneway (connecting to the former Milebush Road) on the east side of the southbound carriageway to join the dual carriageway. This facilitates the closure of the existing junction with the Backnamullagh Road and the access onto the former Milebush Road.

The junction has been designed to comply with the requirements of 'Layout of Compact Grade Separated Junctions' (DMRB Volume 6, Section 2, Part 5, TD 40/94). The junction has been designed for a design speed of 50kph as per TD40. The minimum internal radii of the compact connector road is 40m.

Compact connector roads are nominally 7.9m wide but are curve widened to accommodate large vehicles. The proposed connector road at the Listullycurran Junction is nominally 10.8m to accommodate not only large vehicles but also right turn lanes for access to Listullycurran Road, Backnamullagh Road and the public laneway (leading to the former Milebush Road) on the east side of the Southbound carriageway. Merge and diverge lanes and tapers provide the link to the mainline.

The merge and diverge lanes and tapers have been designed to comply with the requirements of 'Geometric Design of Major/Minor Priority Junctions' DMRB Volume 6, Section 2, Part 6, TD 42/95. The diverge has been designed as an auxiliary lane with a deceleration length of 110m with a direct taper length of 30m as per TD42. The merge has been designed as an auxiliary lane with a merging length of 130m, in addition to a merge nose of length of 40m and a taper length of 55m. The minimum width of the lane excluding hardstrips varies from 5.7m (at the nose) and 3.7m. The merge nose and auxiliary lane length is compliant with TD42, albeit TD42 specifies a merge taper as opposed to auxiliary lane and therefore a departure from standard is required. The 55m taper is compliant with the requirements of 'Layout of Grade Separated Junctions' (DMRB Volume 6, Section 2, Part 1, TD 22/06). A Design Speed of 120kph has been applied to the slip lanes.

5.4.2.3 Side Roads

As the side roads approach the new junction they are generally realigned to achieve the required connection to the compact connector road in terms of the horizontal approach to the connector road to achieve adequate junction spacing and also vertical alignment to tie-in with the connector road levels which have been set to achieve clearance over the existing dual carriageway.

Listullycurran Road is generally regraded to the south of the existing Listullycurran Road, while both the Backnamullagh Road and the Public Laneway (Leading to the former Milebush Road) have been realigned both horizontally and vertically on new alignments.

Geometric standards of the existing roads vary significantly; however, their replacements will be designed to comply with Category S2 of 'Highway Link Design' (DMRB Volume 6, Section 1, Part 1, TD 9/93). All side roads are subject to the National Speed Limit. Any improvements or realignments to these roads should be designed to a 100kph Design Speed; however, this may be above the speed that would be appropriate for the existing roads, some of which are much narrower than would be required by modern standards with poorer visibility. As the side roads are only affected locally, it was not considered possible or pragmatic to calculate the Design Speed in accordance with the TD 9/93 method as this would involve assessing a disproportionately longer length of carriageway than was affected. Therefore in accordance with the DEM 118/16, the Design Speeds were based on measured vehicle speeds on approach to the proposed junction to determine the 85th percentile traffic speed. The speed surveys were undertaken in accordance with the requirements of 'Vehicle Speed Measurement on All Purpose Roads' DMRB Volume 5, Section 1 TA 22/81. The measured Design Speeds and carriageway cross sections are listed in Table 5.72 below:

Table 5.72 – Junction 1 Design Speed and Carriageway Cross-sections

Side Road	Existing Width		Proposed	Minimum Proposed Width	
	Carriageway	Verge	Design Speed (kph)	Carriageway	Verge
Listullycurran Road	4.40 – 4.95	0.15 – 2.79	60B	4.8m	2.0m LHS 1.0m RHS
Backnamullagh Link Road	4.79 – 5.10	1.12-2.47	70B	6.0m	2.5m LHS 2.0m RHS
Public Laneway (Leading from Bus stop)	n/a	n/a	60B	6.0m	2.5m LHS 1.4m RHS

5.4.2.4 Access Lanes

There are currently 11 no. private accesses, including field accesses, which access directly onto the mainline within the vicinity of the proposed junction.

On safety grounds, it is proposed that where possible, any existing direct access to the A1 within the vicinity of the junction, shall be closed and alternative access provided.

There are approximately 697m of new access lanes and 287m of upgraded access lanes provided with a minimum width of 4m and verge widths of 1.0m. This provision is increased where access to commercial premises is required and as such turning movements are designed to accommodate design vehicles that vary with the anticipated usage of the laneway.

5.4.2.5 Road Drainage

Refer to Section 5.2.1.7 of this SAR for details of road drainage standards.

5.4.3 Departures from Standards

One Departure from Standard has been identified on the mainline for reduced SSD on both the southbound and northbound carriageway on approach to the horizontal curve at the overbridge location, though the reduction is contained within the existing departure band as identified in the inherent departure report. Two Departures have been identified on the mainline for the provision of a 130m of auxiliary merge lane with 55m merge taper on the southbound and northbound carriageways in lieu of 130m merge taper. One Departure has been identified for the provision of a diverging taper, on the inside horizontal curve of the southbound carriageway.

The reduction in mainline SSD is required due to the location of the safety barrier in the central reserve and existing road geometry while the departures for auxiliary lane, additional merge taper and provision of the diverge taper are required to maintain route consistency along the A1.

The existing A1 mainline within the confines of Listullycurran Road and Backnamullagh Road has a number of inherent departures from standard when compared to the desirable minimum standards as set out in ‘Highway Link Design’ (DMRB Volume 6, Section 1, Part 1, TD 9/93). These are for sub-standard provision of superelevation on both the northbound and southbound carriageways in combination with a relaxation from standard for the horizontal curve which is two steps below desirable minimum at 625m, a relaxation from standard for the vertical profile which is one step below desirable minimum at k=120 and a two-step relaxation in SSD from 295m to 160m. The superelevation provided on the northbound carriageway ranges from 1.5 to 3.0% when 7% is required and superelevation on the southbound carriageway is -1.5 to -3% when -7% is required. The location of the proposed departures and relaxations on the mainline are shown on the drawings within Appendix C.

The compact connector road on the CGSJ was assessed for 30kph in accordance with ‘Layout of Compact Grade Separated Junctions’ (DMRB Volume 6, Section 2, Part 5, TD 40/94). One Departure has been identified on the compact connector road for carriageway width. Two Relaxations have been identified on the compact connector road for reduced SSD. The SSD has been reduced to 50m to minimise the verge widths which would have increased the requirement for fill material as well as minimise the available land within the junction for proposed sustainable urban drainage system (SuDS) Ponds. The design for horizontal and vertical curvature both meet the desirable minimum standards as set out in ‘Layout of Compact Grade Separated Junctions’ (DMRB Volume 6, Section 2, Part 5, TD 40/94). The location of the proposed departures and relaxations on the compact connector road are shown on the drawings within Appendix E.

In accordance with DEM 118/16 the preset design speed value for unrestricted carriageways i.e. those on which the national speed limit applies, shall be 100Akph however it is proposed that the Design Speed shall deviate from the preset value given the sub-standard nature of the existing roads. It was not considered possible or pragmatic to calculate the Design Speed in accordance with the TD 9/93 method as this would involve assessing a disproportionately longer length of carriageway than was affected and therefore measured vehicle speeds in accordance with TA 22/81 were assessed. Refer to Table 5.72 above for measured Design Speeds.

A number of Departures and Relaxations were identified on the side roads, these are summarised in Table 5.73 below and on the drawings in Appendix C. Table 5.73 also shows the design speed that the departures and relaxations were assessed to.

Table 5.73 **– Junction 1 Side Road Departures and Relaxations**

Side Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Listullycurran Road	60Bkph	Departures 5	1 No. non provision of widening on curves of low radius 1 No. reduction in cross section. 2 No. reduction in visibility from 'y' distance 90m to 70m for a private access. 1 No. reduction in visibility from 'y' distance 90m to 38.5m.
		Relaxations 5	1 No. reduction in horizontal curvature from 510m to 127m. 3 No. Reduction in Junction Visibility from 'x' distance of 9m to 2.4m. 1 No. Reduction in Junction Visibility from 'x' distance of 9m to 4.5m.
Backnamullagh Road	70Bkph	Departures 6	1 No. reduction in horizontal curvature from 720m to 255m. 1 No. reduction in horizontal curvature from 720m to 360m. 2 No. reductions in vertical curvature to K value of 10. 1 No. reduction in visibility from 'y' distance of 120m to 90m. 1 No reduction in vertical visibility from 120m to a minimum of 71.1m for a target height of 0.26m.
		Relaxations 3	1 No. Reduction in Junction Visibility from 'x' distance of 9m to 4.5m. 1 No. reduction in horizontal curvature from 360m to 255m. 1 No. Reduction in Junction Visibility from 'x' distance of 9m to 4.5m, for private access
	60Bkph	5	1 No. reduction in cross section.

Public Laneway (Leading to the former Milebush Road)			1 No. reduction in horizontal curvature from 510m to 116m. 1 No. non provision of widening on curves of low radius 1 No. reduction in vertical curvature to K value of 10. 1 No. reduced SSD from 90m to 50m.
		1	1 No. Reduction in Junction Visibility from 'x' distance of 9m to 4.5m.

5.4.4 Geotechnical Features

5.4.4.1 Bedrock

Refer to Section 2.5.1.1 of this SAR for an overview of the bedrock geology at Listullycurran Road / Backnamullagh Road Junction.

The predominant bedrock in this area is highly weathered Shale with rock quality designation in the range of 0-45%. The bedrock was encountered at elevations between 131.67m OD and 135.97m OD. Rock outcrops were identified on site and rock was encountered at shallow depth on the north side of the A1 mainline at a depth of 1.80m bgl to 2.0mbgl. The Rock Quality Designation (RQD) values determined in the core samples are indicative of very poor to poor rock quality.

The proposed junction layout will encounter rock between Ch. 310 – 390 where a significant area of cut is required.

5.4.4.2 Subsoil

In the vicinity of the junction at Listullycurran, the typical soil profile encountered is as follows:

- Topsoil: 0.0 to 0.3m bgl depth;
- Soft brown Silty sandy gravelly clay 0.3m bgl to 1.5m bgl.
- Firm sandy gravelly clay 1.5m bgl to 3.0m bgl
- The silty sandy gravelly clays are frequently interspersed with cobble and boulder content.
- Groundwater was observed in 8 trial pits at varying depths of 0.7m bgl – 2.5m bgl depth.

Some rock outcrops were identified at the northern section of this junction. The rock was generally classified as highly weathered shale. Some sections of poor soil were identified in the east section of the junction at PTP07. These soft spots mainly comprised soft silty sandy clay. These were generally identified as localised soft spots with maximum depths of up to 2.1m bgl.

Please also refer also to Section 2.5.3.1 of this SAR.

5.4.4.2.1 Soil Testing

The PSD testing carried out at Listullycurran indicates that the most common soil types are described as gravelly sandy silty clays and gravelly sands. For the gravelly sands, fines contents ranged from 3% to 19%.

Samples tested can be predominately classified as low or medium plastic inorganic clays in the range of between 13 and 26 for plasticity. One sample taken from BH01 indicated high plasticity silt. Three other samples taken indicated silty clays of low plasticity, these samples were taken from PTP07.

The plastic limit ranges from 11% to 28%, with an average plastic limit of 18%. The liquid limit ranged from 24% to 58% with an average liquid limit of 40%. The average depth tested for liquid limit and plastic limit was 1.4m. Plasticity Index's ranged from 11 to 28 with an average of 18.

NMC of samples tested indicates samples ranging from 11% to 35%. Average NMC is 20%.

In total 13 No. CBR tests were performed. The majority of CBR values are in the range of 0 – 4 % these values are relatively low and it is recommended that additional CBR testing be carried out during detailed design and construction to determine the exact extent of suitable and unsuitable material and the degree of processing required.

The MCV of samples tested indicates that all samples returned a result of less than 8. This indicates that most of the soils tested are unsuitable for immediate reuse without some degree of improvement/stabilisation (e.g drying, lime stabilisation, etc).

5.4.4.2.2 Chemical Testing

Chemical testing for chloride was carried out on 4 samples. The values of chloride content ranged from 1.4 to 4.3 mg/l.

Chemical testing for sulphate was carried out on 4 samples. The values of sulphate content ranged from 10 to 29 mg/l.

pH testing was carried out on 4 samples. pH values ranged from 7.0 – 7.1. Organic matter content was in the range from <0.1 – 0.8%.

The results of the laboratory chemical testing for aggressive chemical environment for concrete classification have been assessed in accordance with BRE Special Digest 1. Laboratory sulphate analysis undertaken on soil samples indicate that buried concrete can be designed in accordance with the design sulphate class DS-1 of ACEC class of AC-1 of BRE Special Digest 1 (2005).

5.4.4.2.3 In-Situ Testing

Standard Penetration Tests were conducted at regular intervals at the Listullycurran Junction. This gives an indication of soil consistency, it is clear from the results obtained that the soil in this area has good bearing capacity. The SPT values recorded for all test holes conducted in this area were greater than 20 except in two tests conducted at 1.0m bgl. The SPT values for the Listullycurran junction indicate that at 5.0m bgl or greater the SPT of the soil is 50.

5.4.5 Geology

Refer to Section 2.5 of this SAR for details of geology within the study area.

5.4.6 Geomorphology

The existing junction between the A1 and Listullycurran is located approximately 2.8 miles north of Dromore town. The site is rural and consists largely of farmland with some residential properties within the vicinity. The proposed grade separation at this location will consist of new northbound and southbound on/off slips, overbridge across the existing carriageway with central pier support and reinforced earth abutments as well as associated approach embankments. The fill on the western slip road between Ch. 30 – 220 has a maximum height of approximately 6.75m. The fill on the eastern slip road from Ch. 260 – 300 has a maximum height of approximately 6.5m and turns to an 80m long cut with a depth of approximately 4.3m bgl. The earthworks outline of this cut is exaggerated as it is chasing the slope of the hill. Finally, the fill located to the east of the mainline between Ch. 400 – 470 has a maximum height of 4.5m. Placed fill, (locally sourced) is anticipated to largely form the carriageway formation.

5.4.7 Climate, Topography and Land Use

5.4.7.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.4.7.2 Topography and Land Use

The existing A1 and surrounding area at the Listullycurran Road Junction is predominantly pasture with some scattered farms and houses to the north and east with improved and semi-improved grassland, which are separated by hedgerows. The buildings within the study area include residential properties, farm buildings and a B&B.

To the south of the Junction the A1 lies at an elevation of 123m AOD and rises over a distance of 940m to an elevation of 136.9m AOD at the north end of the Junction, adjacent to the existing Backnamullagh Road Junction.

To the east of the junction the surrounding field lies at an elevation of 133.91m AOD and rises over a distance of 132m to an elevation of 151.96m AOD. The residential properties to the north east of the junction lie at elevations of 140.02m, 139.96m and 140.05m AOD respectively.

To the west of the junction the surrounding field lies at an elevation of 136.9m AOD and falls over a distance of 95m to an elevation of 132.4m AOD. Listullycurran Road falls from an elevation of 143.26m AOD over a distance of 153m to its intersection with the A1 at an elevation of 136.95m AOD. The commercial property to the north west of the junction lies at an elevation of 142.95m AOD.

5.4.8 Hydrology, Hydrogeology and Drainage

5.4.8.1 Drainage

The land immediately surrounding the mainline within the junction extents is predominantly permanent pasture with some scattered housing to the east and west with improved and semi-improved grassland. The buildings within the area include residential properties, a commercial premises, and farms. The compact connector road, merge and diverge widening and realignment of side roads will involve providing a significant area of new road construction mainly through the greenfield sites however some of the private and a commercial property are affected.

The mainline crosses a minor watercourse to the north of the Listullycurran Road which then flows parallel to the A1 southbound, within the junction extents. The existing culvert at this location consists of a 0.3m x 0.6m box culvert which will be extended to allow the watercourses to pass beneath the widened road. In addition, there are additional minor field drains which drain into this watercourse through the length of the scheme that will require the existing culvert arrangement to be extended. These watercourses offer opportunities for drainage from the road scheme

5.4.8.2 Pre-earthworks Drainage

Refer to Section 5.2.7.3 of this SAR.

5.4.8.3 Outline Road Drainage Design

Refer to Section 5.2.7.4 of this SAR.

5.4.8.4 Attenuation and Treatment

It is proposed that SuDS retention ponds will be utilised downstream of all proposed carriageway road drainage from the junction and side roads and upstream of the proposed drainage outfalls to reduce the impact of the proposed junction drainage waters on the receiving watercourse. Pre-earthworks drainage is required to intercept runoff from land which falls towards the junction and this drainage may also necessitate the provision of outfalls discharging directly to watercourses however where possible these will gravitate to the retention ponds.

The nature and shape of the proposed junction have influenced the SuDS proposals as they provide an area of land within the compact connector road on each side of the A1 mainline which lends itself to the inclusion of SuDS retention pond. As DfI would prefer to minimise the land take and the impact of the scheme on the local landowners, retention ponds in these locations have been chosen as the preferred form of sustainable drainage system for the scheme.

5.4.8.5 Greenfield Runoff

Refer to Section 5.2.7.6 of this SAR.

5.4.8.6 **Retention Ponds**

The locations of proposed ponds are shown on drawing 168014-RPSB-HDG-J1-DR-D-500-00003 which is included in Appendix G.

5.4.8.7 **Culvert Design**

There are no designated watercourses in the immediate vicinity of the proposed junction. An undesignated watercourse flows eastwards and crosses the A1 in close proximity to the Listullycurran Road. This watercourse then turns and runs adjacent to the southbound carriageway of the A1. This watercourse is culverted under the existing A1. It is proposed to provide 1 No. new culvert of 900mm diameter which will carry the watercourse under the compact connector road. The existing culvert under the A1 will need to be extended to allow the watercourses to pass beneath the new roads / road widening.

There are therefore one new culvert and one culvert extension structure required at the proposed junction. The internal dimension of the new culvert is 900mm diameter while the existing culvert is 900mm diameter. Dimensions are subject to agreement with DfI Rivers and future maintenance requirements.

Please also refer to Section 5.2.7.8 of this SAR.

5.4.9 Earthworks

5.4.9.1 **Modelling of the Listullycurran Road Junction**

To accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software. The cut and fill slopes were created at a 1:3 slope.

5.4.9.2 **Analysis and Assumptions**

The volumetric analysis has been carried out for the entire junction including side roads, subdivided where necessary. The following has been assumed:

- Existing carriageways have been assumed to have a construction depth of 210 millimetres.
- Average topsoil depth of 0.35m for the entire junction; and
- For the present, traffic islands have been assumed to be treated as areas of footway.

The acceptability of the excavated soft material, which does not include topsoil, has been calculated using detailed values. Using these values and carrying out further volumetric analysis within the junction area, an acceptability percentage was calculated for each type of material encountered. A summary of the Earthworks Volumes can be seen in Table 5.74 below:

Table 5.74 – Junction 1 Bulk Earthworks Summary

Works	Volume (m^3)
Excavate, Deposit and Compact Rock	5,128
Excavate, Deposit and Compact – Acceptable Material	18,779
Excavate and Deposit – Topsoil	10,450
Excavate, Deposit and Compact – Landscaping Fill	1,000
Excavate and Dispose – Unacceptable Soft Material	51,001
Excavate and Dispose – Excess Topsoil	11,040
Import, Deposit and Compact Acceptable Fill	29,882
Compact Rock as Capping Material	4,103
Process unacceptable material, deposit and compact	5,634

5.4.9.3 Material Acceptability

This cut is approximately 80m long and extends to 4.3m bgl at its maximum. Overburden is approximately 7.2m bgl.

Laboratory results were based on PBH03. NMC was found to be 18% and 17% which gave MCVs of 4.0 (2.0m bgl) and 2.1 (5.0m bgl) respectively.

CBR values of 1.1% to 1.8% were obtained from material with NMC 17% - 22% at a depth of 0.5m bgl and 3.0m bgl. In general the material in this cut is unlikely to be suitable for reuse without processing due to the low CBR values obtained in this area and the low MCV values.

After the topsoil is removed, the remainder of the overburden material within this cut is expected to be reusable as a Class 2 fill. Based on the results of the lab tests described above it is expected the material will require processing.

It is estimated that approximately 15% to 20% of the material in this cut will be suitable for re-use as general fill without significant processing.

5.4.9.4 Excavatability

Referring to the Ground Investigation Report (168014-RPSD-HGT-XX-RP-D-00001) bedrock is below formation level and has been identified in PBH01 at 1.8m bgl.

From the ground investigations and lab testing, the rock is indicated to be predominantly weak and moderately weathered with RQD values generally less than 45%.

For the most part, it is expected that the bedrock encountered will be possible to excavate with conventional plant with ripping being required at most.

Excavation in overburden is not envisaged to be problematic for conventional earthworks plant. However, it may be necessary to employ more robust plant for removal of large boulders.

5.4.10 Land and Property Take

The following section outlines the land and property take associated with the provision of a CGSJ at Listullycurran Road / Backnamullagh Road. The vesting boundary land take for the scheme broken down into land categories is provided in Table 5.75 below. (The Land take (ha) column does not equal the total vested area of the vesting boundary due to areas of land having multiple designations).

Table 5.75 – Listullycurran CGSJ Associated Land Take

Entity	Land take (ha)
Residential	0.69
Agricultural	5.40
Commercial	0.12
Publicly Owned/ Existing Road Bed	2.37
Total (Vesting Boundary)	**8.58**

5.4.11 Public Utilities

Initially all utility providers were contacted to confirm ownership of apparatus within the study area. This allowed the scheme to be developed minimising the potential impact to utility apparatus. At Stage 2 (Preferred Route Selection), details of the apparatus within the study area was requested, in accordance with a NIRAUC C2 request. The undertakers listed below provided details of their infrastructure in the study area:

- British Telecom plc (BT);
- Northern Ireland Electricity (NIE); and
- Northern Ireland Water Ltd (NIW);

Further utility companies including Firmus, Cable and Wireless, Virgin Media, Eircom and Phoenix Gas were also contacted however their records did not reveal the existence of apparatus within the study area for the junction.

Upon appointment of RSC to undertake the Stage 3 Assessment, a NIRAUC C3 request was submitted to each affected utility provider, seeking preliminary details of the effects on their apparatus together with budget estimates for the works and an indication of any special requirements. Drawings indicating the location of existing services have been prepared and are summarised on drawing numbers 168014-RPSB-VUT-ML-DR-HE-100-00001 to 00014 within Appendix E. The details of the information received from each statutory undertaker are given below.

5.4.11.1 British Telecom

Telecommunications apparatus belonging to BT is affected by the proposed CGSJ at Listullycurran Road / Backnamullagh Road and associated works.

BT has a network of both overhead and underground services throughout the area of the works which serve the surrounding properties and farms. At the junction of the Listullycurran Road with the A1, the overhead line along Listullycurran Road turns northwards to supply dwelling no. 157 Hillsborough Road. Underground BT ducts run along both sides of the A1 and also along the northern verge of Listullycurran Road. Both Fibre Optics and copper cables are contained within the A1 duct tracks. The exact location of BT ducts along the A1 varies between the verge, hard shoulder and carriageway.

BT has proposed that the existing BT apparatus shall be lowered, protected or redirected. Existing apparatus includes BT ducts containing fibre optics and copper cables. This will involve the laying of new duct routes within the confines of the junction and converting the existing aerial cable routes to No. 157 and the section on the Backnamullagh Road to an underground ducted feed. The relocation of existing services, such as those on the Backnamullagh Road and Listullycurran Road will ensure that suitable access is maintained for repairs and maintenance.

The response to the C3 request for outline diversionary works costs indicated a cost of £57,197.25 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J1-DR-HE-100-00002 to 00004 which have been prepared for information purposes only and are contained within Appendix E.

5.4.11.2 Northern Ireland Electricity

Electrical apparatus belonging to NIE is affected by the proposed CGSJ at Listullycurran Road / Backnamullagh Road and associated works.

NIE has a network of both overhead and underground services throughout the area of the works which range from MV to 11kV. This consists of two 11kV overhead services, one running parallel to the Listullycurran Road and the other running in north-south direction to the west of the junction. The eastern 11kV service splits into a smaller MV supply within the grounds of property No. 157 Hillsborough Road, which then crosses the A1 on an overhead to property No.'s 150, 152 and 154. There is also an overhead MV supply running along the verge of Listullycurran Road which feeds the properties located along the road, and an overhead MV supply which runs along the verge of Backnamullagh Road.

- MV - NIE have proposed that the existing overhead MV supply on Listullycurran Road and the Backnamullagh Road and associated plant is placed underground in new duct routes within the verges of each of the roads.

The response to the C3 request for outline diversionary works costs indicated a cost of £6,500 (Incl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J1-DR-HE-100-00002 to 00004 which have been prepared for information purposes only and are contained within Appendix E.

5.4.11.3 Northern Ireland Water

Water main apparatus belonging to NIW is affected by the proposed CGSJ at Listullycurran Road / Backnamullagh Road and associated works.

The existing 4 inch water main runs along the verge of the southbound carriageway of the A1, before crossing the carriageway at right angles, at which point it splits and continues within the southern verge of the Listullycurran Road and southwards within the verge of the Northbound carriageway of the A1. The dwellings on the southern side of Backnamullagh Road are supplied by a water main that branches off from the main located in the eastern verge of the A1 southbound carriageway.

NIW have proposed that the existing water main network will be modified to follow the new verge of the realigned Listullycurran Road and connector road where it can connect into the existing water main located in the verge of the northbound carriageway.

The response to the C3 request for outline diversionary works costs indicated a cost of £33,734.84 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J1-DR-HE-100-00002 to 00004 which have been prepared for information purposes only and are contained within Appendix E.

5.4.12 Structures

The proposed Listullycurran Road Junction would require the construction of a number of structures, summarised below:

- One no. two-span integral overbridge structure on the compact connector road crossing the A1 Dual Carriageway;
- One retaining wall structure;
- One new drainage culvert structure; and
- One drainage culvert extension structure, incorporating headwall elements.

5.4.12.1 Overbridge

The following summary should be read in conjunction with Drawing 168014-RPSD-SBR-J1-DR-S-1700-00001 which is included within Appendix F.

The proposed compact connector road overbridge would be a two span structure, with two main spans of circa 20.26m and 19.61m and would carry the compact connector road over the existing A1 mainline. The square structure will be approximately 58m long and about 16.8m wide. The bridge deck would be formed from precast pre-stressed concrete beams with an in-situ reinforced concrete deck slab that would be integral with the intermediate pier and abutments. Aesthetically, it is proposed that a structure with a closed aspect would be provided and reinforced earth walls would be constructed at the east and west abutments in order to reduce the overall span.

The pier and abutments substructures would be constructed from reinforced concrete with spread footed or piled foundations, subject to ground conditions. A more detailed Geotechnical Investigation is planned to aid and inform this decision as part of the Construction Tender stage of the project.

Final selection of the structural form would depend on the Contractor's construction preferences and would be developed and finalised during the Pre-Construction Tender stage of the project.

Minimum headroom of 5.3m shall be provided below the beam soffit over the mainline carriageway.

5.4.12.2 Retaining Walls

The following summary should be read in conjunction with Drawing 168014-RPSD-SBR-J1-DR-S-1700-00002 which is included within Appendix F.

A retaining wall of reinforced concrete construction is proposed within the area of Junction 1. This retaining wall is located at the back of the existing houses to the north east of the junction to facilitate construction of the shared access lane at the interface of the private property. It will retain up to 2m of ground and have an L-shape cross-section with the base extending away from the retained ground under the access road to avoid excessive impact on the existing property with a shear key provided at the free edge of the base. The wall is approximately 20m long.

The wall is envisaged to be constructed in 5-6m long sections. Expansion joints will not be required due to relatively short wall sections. A granular permeable material with high value of internal shear angle (6N material) is proposed as a backfill with wall drainage to be installed at the back of the wall.

5.4.12.3 Culverts

The mainline currently crosses a minor watercourse. There is 1 No. 0.3m x 0.6m existing box culvert within the junction extents at this crossing. It is also proposed to extend this culvert to allow the watercourse to pass beneath the new roads / road widening.

The proposed compact connector road will also cross this watercourse and therefore one new culvert is required. The internal dimension of this culvert is proposed at 900mm subject to agreement with DfI Rivers and future maintenance requirements. The culvert is 74.3m in length.

The exit to the culvert extension as well as the entry and exit to the new culvert will require a headwall, flanked on each side by wingwalls, to retain the adjacent embankment. Pedestrian protection would be provided, as required. An apron section may be required between the wingwalls, for scour protection and hydraulic channel requirements. This would be confirmed at Detailed Design stage.

The structure's internal dimensions have been determined to suit the requirements of DFI Rivers subject to agreement and to allow manual inspection of the internal faces in the future. The construction methodology will have to consider the importance of minimising disturbance to the water quality and habitat during both the temporary works phase, when any temporary diversion works to allow construction to take place would be carried out, and during the permanent works phase, where a 'naturalistic' granular material bedding layer may be required above any base slab of the new construction.

It is anticipated that the culverts will be formed from pipe section precast reinforced concrete elements, dependant on required internal dimensions and Contractor's construction preference. It is anticipated that headwalls and wingwalls would be formed from discrete precast reinforced concrete elements or cast in-situ. A typical general arrangement drawing for a culvert is included in Appendix F.

5.4.12.4 Geotechnical Requirements at Structures

The A1 mainline is at grade at this location and the overbridge abutments are recommended to be constructed as raised bankseats on shallow foundations, sitting perched within the approach embankments. The sections of the embankments underneath the bankseat foundations shall be constructed from Class 6N upfill from existing ground as a minimum. This upfill may also be required to extend below existing ground to a suitable bearing stratum, as described below.

The ground conditions in this area generally comprise clayey gravel of depth 0.3 – 3.8m bgl, overlaying highly weathered Shale as shown in Table 5.76. Groundwater was not encountered in the boreholes conducted in this area. Sulphate levels in the groundwater are up to 29 mg/l with pH of 7.1. This location is classified as ACEC Class DS-1 (Buried Concrete Classification BRE Special Digest No.1).

Table 5.76 – Listullycurran Overbridge Ground Conditions

Exploratory Position	Depth (m)	Soil/Rock Description	Depth (m) bgl	SPT (N)	C_u (kPa)
PBH01	0.0 - 1.8	Brown sandy clayey subangular to subrounded fine to coarse GRAVEL.	1 2	40 50	87 240
	1.8 – 6.8	Highly weathered fractured SHALE			
PBH02	0 to 1.7	Firm brown sandy gravelly silty CLAY.	1	12	58
	1.7 – 2.4	Stiff brown very sandy gravelly CLAY.	2	30	108
	2.4 – 3.8	Very dense brown sandy clayey subangular to subrounded fine to coarse GRAVEL	3	65	320
	3.8 – 10.0	Highly weathered fractured SHALE			

The embankment underneath the east abutment is located in an area of clay overburden with relatively high SPT values in the upper layers. In order to obtain a good bearing stratum it is recommended that the upper 1.0m of soil is excavated and the Class 6N upfill extended down to this level.

The embankment underneath the west abutment is located in an area of sandy gravelly CLAY with SPT's of 30 at 2m bgl and approximate shear strength of 320kPa at 2.4m bgl. In order to achieve a good bearing stratum the upper 1.0m of overburden should be excavated with the Class 6N extending down to this level.

Note that as raised bankseats are recommended as the preferred solution for the abutments, the combination of settlements within the Class 6N upfill, the adjacent embankment materials, and the underlying ground, need to be considered at detailed design. Suitable hold points during the construction of the bridge will be required to ensure settlements are substantially complete prior to landing of bridge beams etc.

No testing was conducted in the location of the central pier, however with respect to the ground conditions in the area, it is envisaged that the overburden will consist of firm sandy gravelly silty CLAY. It is assumed that rock is located at a depth of approximately 3.8m bgl, based on adjacent boreholes. The central pier will be constructed at grade and will require excavation of approximately 2.0m bgl to a suitable bearing stratum from which to build up the Class 6N upfill. Further investigations at the central pier location are recommended at detailed design stage to more accurately assess the ground conditions and suitability for a shallow pad foundation.

5.4.13 Health and Safety

General health and safety issues for the scheme have been noted under the Whole Scheme section, Section 5.2.13 of this SAR; however there are some site specific risks relevant to Junction 1, Listullycurran Road which are discussed below.

As part of the construction of the junction, the existing direct access to houses 150, 152 and 154 will require the contractor to maintain this local access for both vehicles and pedestrian movements during the construction of the works. Whilst the usage will be low, the sporadic nature of access to residential properties may have an increase on the likelihood and severity of vehicular accidents due to the proximity of site traffic, site staff, public traffic and non-motorised users on the adjacent roads at this location.

In addition, due to the close proximity of grazing land, the contractor will need to ensure that boundary fencing is stock proof and well maintained to prevent cattle from accessing the A1.

5.5 MILEBUSH LINK ROAD

5.5.1 Introduction

The Milebush Road is located at the existing Hillsborough Road compact grade separated junction.

The southern access to the A1 northbound carriageway was identified for closure based on its proximity to the existing Hillsborough compact grade separated junction, Dromore. By connecting the

Milebush Road to the Hillsborough CGSJ users will have safe access to both Northbound and Southbound carriageways of the A1.

This section of the report considers the engineering aspects of the proposed link road at Milebush as described in Chapter 3.

5.5.2 Design Standards

The design documents and standards particularly relevant to the Milebush Link Road Junction are outlined in Section 5.2.1 of this SAR.

5.5.2.1 Milebush Link Road

The proposed link road at Milebush referred to as Milebush Link Road is to be located between the Hillsborough compact grade separated junction which has been designed to meet the standards appropriate to a CGSJ "Layout of Compact Grade Separated Junctions" (DMRB Volume 6 Section 2 Part 5 TD 40/94) of design speed 30kph and the Milebush Road designed in accordance with "Highway Link Design" (DMRB Volume 6, Section 1, Part 1, TD9/93). It is noted that since Milebush Road is subject to the National Speed Limit, any improvements or realignments to this road should typically be designed to a 100kph Design Speed. However, given the substandard nature of the existing road, a design speed of 100kph may not be appropriate for the existing Milebush Road. As the Milebush Road is only affected locally, it was not considered appropriate to calculate the design speed in accordance with TD 9/93 method as this would involve assessing disproportionately longer lengths of carriageway than was affected. Therefore in accordance with the DEM 118/16, the Design speed was based on measured vehicle speeds on approach to the proposed Junction to determine the 85th percentile traffic speed. The speed surveys were undertaken in accordance with the requirements of "Vehicle Speed Measurement on All Purposed Roads" DMRB Volume 5, Section 1 TA 22/81. The measured Design speed for Milebush Road is listed in the table below.

Table 5.77 – Junction 2 Design Speed and Carriageway Cross-sections

Side Road	Existing Width		Proposed	Minimum Proposed Width	
	Carriageway	Verge	Design Speed (kph)	Carriageway	Verge
Milebush Road	3.8m-4.07m	1.94m-2.57m	60B	7.3m	1.0m LHS 2.5m RHS

Given the Milebush Road has a Design Speed of 60kph and the Hillsborough Road CGSJ connector road was designed to a Design Speed of 30kph, it would not be appropriate to apply a Design Speed of 100kph to the new Milebush Link Road over such a short distance. Therefore, the proposed Link Road will be designed in accordance with "Highway Link Design" (DMRB Volume 6, Section 1, Part 1, TD9/93) with a proposed design speed of 60BKph.

5.5.2.2 Access Lanes

In the vicinity of the proposed link road there are a number of field accesses. These field accesses will be maintained through access tracks onto the proposed Milebush Link Road and proposed works to Milebush Road. In total 85m of access tracks will be in place.

One field access is located to the southern end of Milebush Road while three others are located along the proposed Milebush Link Road.

5.5.2.3 Road Drainage

Refer to Section 5.2.1.7 of this SAR for details of road drainage standards.

5.5.3 Departures from Standards

Two Departures from standard have been identified on the Hillsborough compact grade separated junction at the ghost island location, width and taper. One Departure from standard was identified on Milebush Road where a gradient of 10% is proposed. It is noted that this is an improvement from existing conditions as the existing Milebush Road geometry has a gradient of 12%. Though a reduction in gradient has been provided a departure will still be required due to the proposed gradient exceeding 8%.

Departures from Standard will also be required on Milebush Road as a result of the horizontal and vertical realignment. Departures will be required in relation to the non-provision of superelevation, proposed verge width and the non-provision of hardstrips.

The existing A1 mainline meets the desirable minimum standards as set out in “Highway Link Design” (DMRB Volume 6, Section 1, Part 1, TD9/93) for the vertical profile however there are a number of inherent departures from standard for sub-standard provision of superelevation on both the northbound and southbound carriageways in combination with a relaxation from standard for the horizontal curve which is one step below desirable minimum at 605m and one step relaxation in SSD from 295m to 215m. The superelevation provided on the northbound carriageway is 5% when 7% is required. The location of the proposed departures and relaxations on the mainline are shown on the drawing within Appendix C.

5.5.4 Geotechnical Features

5.5.4.1 Bedrock

No bedrock was encountered in the test holes conducted at the proposed J2 Milebush Link Road Junction.

5.5.4.2 Subsoil

The typical soil conditions located at the Milebush Junction are as follows;

- Topsoil: 0.0 to 0.4m bgl depth
- Light brown gravelly sand 0.4m bgl to 1.5m bgl to the south of the proposed junction and soft sandy gravelly clay to the north of the proposed link road.
- Brown sandy clayey gravel 1.5m bgl to 2.5m bgl
- Grey soft to firm sandy gravelly clay 3.3m bgl to 4.5m bgl depth.
- Groundwater was encountered in one trial pit at a depth of 2.3m bgl

No soft spots or areas of rock outcrop were identified in the area.

Refer also to Section 2.5.3.2.

5.5.4.2.1 Soil Testing

The PSD testing carried out at Milebush indicates that the most common soil types are described as well graded gravelly sandy silty clays and gravelly sands. For the gravelly sands, fines contents ranged from 4% to 18%.

Samples tested can be predominately classified as medium plastic inorganic clays in the range of between 18 and 22 for plasticity. One sample taken from PTP04 indicated high plasticity clay.

The plastic limit ranges from 17% to 27%, with an average plastic limit of 21.5%. The liquid limit ranged from 35% to 64% with an average liquid limit of 45%. The average depth tested for liquid limit and plastic limit was 1.83m. Plasticity Index's ranged from 18 to 37 with an average of 24.

NMC of samples tested indicates samples with moisture contents lower than 25%. The samples have NMCs ranging from 14% to 25%. Average NMC is 17.5%.

In total 4 No. CBR tests were performed. 2 out of 4 samples returned a CBR of less than 2%. The CBR value in PTP02 and PTP03 are much larger than the values obtained at PTP01 and PTP04. It may be necessary during construction that additional CBR testing be carried in the vicinity of PTP01 and PTP04 to determine the suitable and unsuitable material and the degree of processing required.

The MCV of samples tested indicates that all samples returned a result of less than 8. This indicates that most of the soils tested are unsuitable for immediate reuse without some degree of improvement/stabilisation (e.g drying, lime stabilisation, etc).

5.5.4.2.2 Chemical Testing

pH testing was carried out on 1 sample. The pH value obtained was 8.3.

5.5.4.2.3 In-Situ Testing

No SPT tests were conducted at the Milebush Junction.

5.5.5 Geology

Refer to Section 2.5 of this SAR for details of geology within the study area.

5.5.6 Geomorphology

The Milebush Junction is located 0.9 miles from the centre of Dromore town. The works will consist of a new link road that will connect the southern end of the Milebush Road to the existing Hillsborough Road Junction, south of the A1 mainline. In order to connect the link road to the Milebush Road a substantial area of fill will be required to construct an embankment. The maximum height of fill required to construct the link road is 6.3m. The Milebush Road site is rural, consisting of mature farmland with adjacent residential properties.

5.5.7 Climate, Topography and Land Use

5.5.7.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.5.7.2 Topography and Land Use

The existing A1 and surrounding area at the Milebush Link Road is predominately pasture with some scattered settlements to the north and south with arable fields which are separated by poorly maintained hedgerows. The buildings located within the study area include residential properties and farms.

To the West of the junction the A1 lies at an elevation of 94.59M AOD.

To the North of the link road the field lies at an elevation of 105.5m AOD falling over a distance 151m to an elevation of 91.33m AOD. The property to the North East lies at an elevation of 108.21m AOD. Milebush Road falls from an elevation of 105.60m AOD over a distance of 213.8m to an elevation of 89.7m AOD.

To the south of the link road the fields lie at an elevation of 88.33m AOD falling over a distance of 114m to an elevation of 85.16m AOD. The property to the west lies at an elevation of 87.71m AOD.

5.5.8 Hydrology, Hydrogeology and Drainage

5.5.8.1 Drainage

The land immediately surrounding the link road extents is predominantly permanent pasture with some scattered housing to the north and west with improved and semi-improved grassland and arable fields. The link road will involve providing a significant area of new road construction mainly through the greenfield sites.

The link road also crosses a minor watercourse. It is proposed to provide a 1500mm high x 2100 wide box culvert at this location. This watercourse offers an opportunity for drainage from the road scheme.

5.5.8.2 Pre-earthworks Drainage

Refer to Section 5.2.7.3 of this SAR.

5.5.8.3 Outline Road Drainage Design

Refer to Section 5.2.7.4 of this SAR.

5.5.8.4 Attenuation and Treatment

It is noted that in order to avoid excessive impact on land and property take for the link road, a retention pond will not be provided at this location. Attenuation and treatment will be provided by online storage within pipes and manholes with treatment being provided by infiltration ditches where required.

5.5.8.5 Greenfield Runoff

Refer to Section 5.2.7.6 of this SAR.

5.5.8.6 Culvert Design

There are no designated watercourses in the immediate vicinity of the proposed junction. An undesignated watercourse flows westwards crossing the proposed Link Road at approximately Chainage 90.

It is therefore proposed to provide a new culvert structure. The internal dimensions of the culvert extensions are proposed at 1500mm high x 2100mm wide subject to agreement with DfI Rivers and future maintenance requirements.

Please also refer to Section 5.2.7.8 of this SAR.

5.5.9 Earthworks

5.5.9.1 Modelling of Milebush Link Road

To accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

5.5.9.2 Analysis and Assumptions

The volumetric analysis has been carried out for the entire Link including access tracks, subdivided where necessary. The following assumptions have been made:

- Existing carriageways have been assumed to have a construction depth of 250 millimetres;
- Average topsoil depth of 0.3m for the entire junction; and
- For the present, traffic islands have been assumed to be treated as areas of footway.

The acceptability of the excavated soft material, which does not include topsoil, has been calculated using detailed values. Taking these values and carrying out further volumetric analysis within the junction area, an acceptability percentage was calculated for each type of material encountered. A summary of the earthworks volumes can be seen in Table 5.78 below:

Table 5.78 – Bulk Earthworks Summary

Works	Volume (m^3)
Excavate, Deposit and Compact Rock	0
Excavate, Deposit and Compact – Acceptable Material	952
Excavate and Deposit - Topsoil	2,048
Excavate, Deposit and Compact - Landscaping Fill	166
Excavate and Dispose – Unacceptable soft material	7,345
Excavate and Dispose Excess - Topsoil	1,801
Import, Deposit and Compact Acceptable material	35,013
Compact rock as capping	0
Process unacceptable material, deposit and compact	0
Excavate and Dispose – Acceptable material	0

5.5.9.3 Material Acceptability

No major cuts were identified at Milebush Link Road junction, therefore there is little material re-use potential.

5.5.9.4 Excavatability

Excavation for removal of soft ground is all that is expected at the Milebush Link Road junction. It is not expected to encounter any rock.

5.5.10 Land and Property Take

The following section outlines the land and property take associated with provision of the Link Road connecting the Milebush Road to the Hillsborough CGSJ. The vesting boundary land take for the scheme broken down into land categories is provided in Table 5.79 below. There will also be the need to demolish a derelict stables block to allow for the construction of the proposed works.

Table 5.79 – Milebush Link Associated Land Take

Entity	Land take (ha)
Residential	0.13
Agricultural	1.19
Commercial	0.00
Publicly Owned/ Existing Road Bed	0.99
Total (Vesting Boundary)	**2.31**

5.5.11 Public Utilities

Initially all utility providers were contacted to confirm ownership of apparatus within the study area. This allowed the scheme to be developed minimising the potential impact to utility apparatus. At Stage 2 (Preferred Route Selection), details of the apparatus within the study area was requested, in accordance with a NIRAUC C2 request. The undertakers listed below provided details of their infrastructure in the study area:

- British Telecom plc (BT);
- Northern Ireland Electricity (NIE); and
- Northern Ireland Water Ltd (NIW);

Further utility companies including Firmus, Cable and Wireless, Virgin Media, Eircom and Phoenix Gas were also contacted however their records did not reveal the existence of apparatus within the study area for the junction.

Upon appointment of RSC to undertake the Stage 3 Assessment, a NIRAUC C3 request was submitted to each affected utility provider, seeking preliminary details of the effects on their apparatus together with budget estimates for the works and an indication of any special requirements. Drawings indicating the location of existing services have been prepared and are summarised on drawing numbers 168014-RPSB-VUT-ML-DR-HE-100-00001 to 00014 within Appendix E. The details of the information received from each statutory undertaker are given below.

5.5.11.1 British Telecom (BT)

Telecommunications apparatus belonging to BT is affected by the proposed works on Milebush Road.

BT has a network of underground services within the northern verge of the Milebush Road. These underground services will be lowered to suit the new road alignment.

The response to the C3 request for outline diversionary works costs indicated a cost of £43,634.94 (excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J2-DR-HE-100-00010 to 00013 which have been prepared for information purposes only and are contained within Appendix E.

5.5.11.2 Northern Ireland Electricity (NIE)

Electrical apparatus belonging to NIE is affected by the Milebush Link Road and associated works.

NIE has a network of both overhead services throughout the area of the works which range from MV to 11kV. The following diversion work will be required:

- 11kV - The existing overhead 11kV service line which runs across the northern end of the Milebush Link Road and serves residential properties (56 & 53). This line will need to be raised above the proposed link road by installing an intermediate pole within the extents of the road embankment.

The response to the C3 request for outline diversionary works costs indicated a cost of £9,000 (Incl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J2-DR-HE-100-00010 to 00013 which have been prepared for information purposes only and are contained within Appendix E.

5.5.11.3 Northern Ireland Water (NIW)

Water main apparatus belonging to NIW is affected by the proposed works on Milebush Road.

There is a 100mm diameter existing water main within Milebush Road which will need to be lowered and diverted to facilitate construction of the new junction with the proposed Link Road. The diversion shall be a 125mm diameter pipe and will be located within the northern verge.

The response to the C3 request for outline diversionary works costs indicated a cost of £4,676.63 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J2-DR-HE-100-00010 to 00013 which have been prepared for information purposes only and are contained within Appendix E.

5.5.12 Structures

5.5.12.1 Culverts

The proposed Milebush Link Road will cross an existing watercourse at Chainage 90 and therefore one new culvert is required. The internal dimension of this culvert is proposed at 1500mm high x 2100mm wide subject to agreement with DfI Rivers and future maintenance requirements. The culvert is 61.4m in length.

The entry and exit to the new culvert will require a headwall, flanked on each side by wingwalls, to retain the adjacent embankment. Pedestrian protection would be provided, as required. An apron section may be required between the wingwalls, for scour protection and hydraulic channel requirements. This would be confirmed at Detailed Design stage.

The structure's internal dimensions have been determined to suit the requirements of DFI Rivers subject to agreement and to allow manual inspection of the internal faces in the future. The construction methodology will have to consider the importance of minimising disturbance to the water quality and habitat during both the temporary works phase, when any temporary diversion works to allow construction to take place would be carried out, and during the permanent works phase, where a 'naturalistic' granular material bedding layer may be required above any base slab of the new construction.

It is anticipated that the culverts will be formed from box section precast reinforced concrete elements, dependant on required internal dimensions and Contractor's construction preference. It is anticipated that headwalls and wingwalls would be formed from discrete precast reinforced concrete elements or cast in-situ. A typical general arrangement drawing for a culvert is included in Appendix F.

5.5.13 Health and Safety

General health and safety issues for the scheme have been noted under the Whole Scheme section, Section 5.2.13 of this SAR; however there are some site specific risks relevant to the Milebush Link Road which are discussed below.

The construction of the link road will require demolition of 1 No. out-building to the west of the link road. Asbestos surveys (in accordance with the Control of Asbestos Regulations (Northern Ireland) 2012) may need to be carried out in advance of any demolition works.

As part of the construction of the link road the existing direct access of Milebush Road to the A1 will be closed. The contractor will be required to maintain this local access during the construction of the works for surrounding dwellings and farms. The likelihood and severity of vehicular accidents due to the proximity of site traffic, site staff and public traffic could be increased at this location.

5.6 GOWDYSTOWN ROAD

5.6.1 Introduction

The proposed Gowdystown Road junction is located approximately 4.5km south of the town of Dromore. The junction was selected as a suitable location for the construction of a CGSJ during the Stage 1 Scheme Assessment.

The Gowdystown Road junction was identified as being situated between existing grade separated junctions along the route. Therefore, based on the need to reduce roundtrips in line with DfI policy, the Stage 1 Scheme Assessment identified that some form of grade separation at this junction should be provided.

Three CGSJ options were assessed during the Stage 2 Scheme Assessment. The Green Option was favoured under the economic objective as it is the lowest cost option, has the lowest potential for engineering risk and its engineering layout suits the surrounding topography. Whilst the Pink Option performs marginally better against the environmental objective, the Green Option is considered to perform the best overall.

This section of the report considers the engineering aspects of the proposed CGSJ at Gowdystown Road as described in Chapter 3.

5.6.2 Design Standards

The design documents and standards particularly relevant to the Gowdystown Road Junction are outlined in Section 5.2.1 of this SAR.

5.6.2.1 Mainline

The section of dual carriageway on which the proposed Gowdystown Junction is to be located is designed to meet the standards appropriate to a 120Akph design speed and is classified as a Category 5 in accordance with 'Highway Link Design' (DMRB Volume 6, Section 1, Part 1, TD 9/93) Table 4 – Recommended Rural Road Layouts, it comprises two 7.3m wide carriageways with additional 1.0m hardstrips on either side and the central reserve is to be a minimum of 2.5m (widened for visibility where necessary) in accordance with 'Cross Sections and Headroom' (DMRB Volume 6, Section 1, Part 2 TD 27/05). The existing hardshoulder will taper to meet the width of the proposed hardstrips over the length of the diverge and merge tapers. Pavement edge details will comprise kerbs and gullies or concrete channels to provide positive drainage and a safety barrier will be provided in the central reserve over the full length of the junction extents and will connect into the safety barrier proposed for the Whole Scheme as discussed in Section 5.2.

The extents of the section of mainline associated with the Gowdystown Road junction starts at a point approximate 343m in a north easterly direction from the existing Gowdystown Road junction with the A1 dual carriageway to a point approximately 288m in a south westerly direction from the same junction.

5.6.2.2 **Compact Grade Separated Junction**

A CGSJ has been proposed where the dual carriageway intersects with Gowdystown Road. The Junction allows traffic from Gowdystown Road (East), Gowdystown Road (West) and Old Banbridge Road (Gowdystown) to join the dual carriageway. This facilitates closure of the Old Banbridge Road (Gowdystown) existing junction with the A1.

The junction has been designed to comply with the requirements of 'Layout of Compact Grade Separated Junctions' (DMRB Volume 6, Section 2, Part 5, TD 40/94). The junction has been designed for a design speed of 50kph as per TD40. The minimum internal radii of the compact connector road is 40m.

Compact connector roads are nominally 7.9m wide but are curve widened to accommodate large vehicles. The proposed compact connector road at the Gowdystown Junction is nominally 10.8m to accommodate not only large vehicles but also right turn lanes for access to Gowdystown Road (East), Gowdystown Road (West) and Old Banbridge Road (Gowdystown). Merge and diverge lanes and tapers provide the link to the mainline.

The merge and diverge lanes and tapers have been designed to comply with the requirements of 'Geometric Design of Major/Minor Priority Junctions' DMRB Volume 6, Section 2, Part 6, TD 42/95. The diverge has been designed as an auxiliary lane with a deceleration length of 110m with a direct taper length of 30m as per TD42. The merge has been designed as an auxiliary lane with a merging length of 130m, in addition to a merge nose of length of 40m and a taper length of 55m. The minimum width of the lane excluding hardstrips varies from 5.7m (at the nose) and 3.7m. The merge nose and auxiliary lane length is compliant with TD42, albeit TD42 specifies a merge taper as opposed to auxiliary lane and therefore a departure from standard is required. The 55m taper is compliant with the requirements of 'Layout of Grade Separated Junctions'(DMRB Volume 6, Section 2, Part 1, TD 22/06). A Design Speed of 120kph has been applied to the slip lanes.

5.6.2.3 **Side Roads**

As the side roads approach the new junction they are generally realigned to achieve the required connection to the compact connector road in terms of the horizontal approach to the connector road to achieve adequate junction spacing and also vertical alignment to tie-in with the connector road levels which have been set to achieve clearance over the existing dual carriageway.

Gowdystown Road (East) is generally regraded to the north of the existing Gowdystown Road (East), whilst Gowdystown Road (West) is generally regraded to the south of the existing Gowdystown Road (West). The Old Banbridge Road (Gowdystown) has been realigned both horizontally and vertically on a new alignment to tie into the connector road.

Geometric standards of the existing roads vary significantly; however, their replacements will be designed to comply with Category S2 of 'Highway Link Design' (DMRB Volume 6, Section 1, Part 1, TD 9/93). All side roads are subject to the National Speed Limit. Any improvements or realignments to these roads should be designed to a 100kph Design Speed; however, this may be above the speed that would be appropriate for the existing roads, some of which are much narrower than would be required by modern standards with poorer visibility. As the side roads are only affected locally, it was not considered possible or pragmatic to calculate the Design Speed in accordance with the TD 9/93 method as this would involve assessing a disproportionately longer length of carriageway than was affected. Therefore in accordance with the DEM 118/16, the Design Speeds were based on measured vehicle speeds on approach to the proposed junction to determine the 85th percentile traffic speed. The speed surveys were undertaken in accordance with the requirements of 'Vehicle Speed Measurement on All Purpose Roads' DMRB Volume 5, Section 1 TA 22/81. The measured Design Speeds and carriageway cross sections are listed in Table 5.80 below:

Table 5.80 – Junction 3 Design Speed and Carriageway Cross-sections

Side Road	Existing Width		Proposed	Minimum Proposed Width	
	Carriageway	Verge	Design Speed (kph)	Carriageway	Verge
Gowdystown Road (East)	5.10m – 6.67m	0.70m – 0.93m	70A	5.14m	2.5m LHS 1.0m RHS
Gowdystown Road (West)	4.50m – 6.90m	0.49m-2.68m	60B	4.8m	1.0m RHS 1.0m LHS
Old Banbridge Road (Gowdystown)	4.98m-5.34m	n/a	60B	7.3m	2.5m RHS 1.0m LHS

5.6.2.4 Access Lanes

There are currently 1 no. agricultural access, 1 no. field access and 3 no. side road accesses onto the mainline within the vicinity of the proposed junction.

On safety grounds, it is proposed that where possible, any existing direct access to the A1 within the vicinity of the junction, shall be closed and alternative access provided.

There are approximately 220m of access lanes and 350m of upgraded access lanes provided with a minimum width of 4.1m and verge widths of 1.0m unless a verge width of 1.9m is provided to facilitate a setback distance of 600mm from the lane edge for location of safety barrier with 1300mm working width should it be required. This provision is increased where access to commercial premises is required and as such turning movements are designed to accommodate design vehicles that vary with the anticipated usage of the laneway.

5.6.2.5 Road Drainage

Refer to Section 5.2.1.7 of this SAR for details of road drainage standards.

5.6.3 Departures from Standards

No Departures from Standard have been identified on the mainline for reduced stopping sight distance (SSD) on both the southbound or northbound carriageway. Two Departures have been identified on the mainline for the provision of 130m of auxiliary merge lane with 55m merge taper on the southbound and northbound carriageways in lieu of 130m merge taper. The departures for auxiliary lane and additional merge taper are required to maintain route consistency along the A1 and feedback received, following consultation with land owners, residents and road users.

The existing A1 mainline meets the desirable minimum standards as set out in 'Highway Link Design' (DMRB Volume 6, Section 1, Part 1, TD 9/93) for vertical profile. However, although the majority of the mainline through this junction location is on a straight section of carriageway, there are inherent Departures from Standard for sub-standard provision of superelevation on both the northbound and southbound carriageways at the northern end of the junction extents, in addition to departures relating to a combination of other Relaxations or Departures along the northbound carriageway. The superelevation provided on the northbound carriageway is -4% when -5% is required and superelevation on the southbound carriageway is 2% when 5% is required. The location of the proposed departures and relaxations on the mainline are shown on the drawings within Appendix C.

The compact connector road on the CGSJ was assessed for 30kph in accordance with 'Layout of Compact Grade Separated Junctions' (DMRB Volume 6, Section 2, Part 5, TD 40/94). One Departure has been identified on the compact connector road for carriageway width. Two Relaxations have been identified on the compact connector road for reduced SSD. The SSD has been reduced to 50m to minimise the verge widths which would have increased the requirement for fill material as well as minimise the available land within the junction for proposed sustainable urban drainage system (SuDS) retention ponds. The design for horizontal and vertical curvature both meet the desirable minimum standards as set out in 'Layout of Compact Grade Separated Junctions' (DMRB Volume 6, Section 2, Part 5, TD 40/94). The location of the proposed departures and relaxations on the compact connector road are shown on the drawings within Appendix C.

In accordance with DEM 118/16 the preset design speed value for unrestricted carriageways i.e. those on which the national speed limit applies, shall be 100Akph however it is proposed that the Design Speed shall deviate from the preset value given the sub-standard nature of the existing roads. It was not considered possible or pragmatic to calculate the Design Speed in accordance with the TD 9/93 method as this would involve assessing a disproportionately longer length of carriageway than was affected and therefore measured vehicle speeds in accordance with TA 22/81 were assessed. Refer to Table 5.80 above for measured Design Speeds.

A number of Departures and Relaxations were identified on the side roads, these are summarised in Table 5.81 below and on the drawings in Appendix E. This table also shows the design speed that the departures and relaxations were assessed to.

Table 5.81 – Junction 3 Side Road Departures and Relaxations

Side Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Gowdystown Road (East)	70Akph	Departures 4	1 No. reduction in cross section. 1 No. reduction in superelevation to 2.5%. 1 No. reduced SSD from 120m to 76m. 1 No. Reduction in Access Junction Visibility from 'x' distance of 9m to 2.0m and 'y' distance of 120m to 70m.

<table>
<tr><td></td><td></td><td>Relaxations
1</td><td>1 No. Reduction in Junction Visibility from ‘x’ distance of 9m to 4.5m.</td></tr>
<tr><td rowspan="2">Gowdystown Road (West)</td><td rowspan="2">60Bkph</td><td>Departures
2</td><td>1 No. reduction in superelevation to 2.5%.
1 No. reduction in cross section.</td></tr>
<tr><td>Relaxations
2</td><td>1 No. Reduction in Junction Visibility from ‘x’ distance of 9m to 4.5m.
1 No. Reduction in Junction Visibility from ‘x’ distance of 9m to 2.4m, for private access</td></tr>
<tr><td rowspan="2">Old Banbridge Road (Gowdystown)</td><td rowspan="2">60Bkph</td><td>Departures
3</td><td>1 No. reduction in cross section.
1 No. reduced SSD from 90m to 57m.
1 No. no increased width when horizontal radius is between 90m and 150m.</td></tr>
<tr><td>Relaxations
1</td><td>1 No. Reduction in Junction Visibility from ‘x’ distance of 9m to 4.5m.</td></tr>
</table>

5.6.4 Geotechnical Features

5.6.4.1 Bedrock

Refer to Section 2.5.1.3 of this SAR for an overview of the bedrock geology at Gowdystown Road Junction.

The rock encountered in BH01, PBH01 & PBH02 is very poor rock however the rock encountered in PBH03 is good quality. The rock encountered in BH03 has a fair to good rock quality designation. The rock in this area is also relatively shallow at a minimum depth of 3.4m bgl.

The proposed junction layout will encounter rock between Ch. 30 – 80 and again between Ch. 290 – 420 where a significant area of cut is required.

5.6.4.2 Subsoil

The typical soil profile encountered at the Gowdystown Junction is as follows;

- Topsoil: 0.0 to 0.3m bgl depth
- Made ground 0.3 to 1.6m bgl with intermittent sections of brown sandy gravelly clay/silt.
- Peat was identified at varying depths up to 2.9m bgl on the west side of the mainline. A peat probe survey was conducted in this area which is described in detail in Section 7.5.
- Soft to firm silty sandy gravel 1.8m bgl – 3.9m bgl.

Groundwater was encountered in four trial pits at varying depths of 1.1m bgl to 1.8m bgl depth.

Refer also to Section 2.5.3.3.

5.6.4.2.1 Soil Testing

The PSD testing carried out at Gowdystown indicates that the most common soil types are described as well graded sandy silty clays and silty sandy gravelly clays. Fines contents ranged from 27% to 56%.

Samples tested can be predominately classified as low to medium plastic inorganic clays in the range of between 11 and 25 for plasticity.

The plastic limit ranges from 13% to 23%, with an average plastic limit of 17.5%. The liquid limit ranged from 24% to 48% with an average liquid limit of 34.5%. The average depth tested for liquid limit and plastic limit was 1.97m bgl. Plasticity Index's ranged from 11 to 25 with an average of 16.

NMC of samples tested indicates samples ranging from 8.5% to 220%. Average NMC is 26%. A saturated sample was identified in PTP08 which is an area where peat has been identified.

In total 10 CBR tests were performed at the Gowdystown Junction. The results from the CBR tests conducted in this area are indicative of the poor soil conditions in this area. 8 out of 10 samples returned a CBR of less than 2%. Peat has been identified in this area and the CBR values confirm the need for excavation and replacement in the vicinity of the proposed Gowdystown junction. Due to the large areas of fill that are required to construct the proposed Gowdystown junction most of the material in this area will be required to be replaced.

The MCV of samples tested indicates that 3 of the 7 samples tested had an MCV less than 8. This indicates that some of the soils tested are suitable for immediate reuse without treatment. The soils to the south of the proposed overbridge had acceptable MCV values and should be suitable for reuse.

5.6.4.2.2 Chemical Testing

Chemical testing for chloride was carried out on 7 samples. The values of chloride content ranged from <1.0 to 6.7mg/l.

Chemical testing for sulphate was carried out on 7 samples. The values of sulphate content ranged from <10 to 64mg/l.

pH testing was carried out on 7 samples. pH values ranged from 7.9 – 9.0. Organic matter content was in the range from <0.1 – 4.7%.

The results of the laboratory chemical testing for aggressive chemical environment for concrete classification have been assessed in accordance with BRE Special Digest 1. Laboratory sulphate analysis undertaken on soil samples indicate that buried concrete can be designed in accordance with the design sulphate class DS-1 of ACEC class of AC-1 of BRE Special Digest 1 (2005).

5.6.4.2.3 In-Situ Testing

Standard Penetration Tests were conducted at regular intervals at the Gowdystown Junction. In total 31 SPT results were obtained from the Stage 2 & 3 ground investigations. The majority of SPT tests conducted in the area obtained SPT values of 50 or refusal. The lowest SPT value was obtained in Stage 3 PBH03 at 1.0m bgl of 6. All of the tests conducted below a depth of 4.0m bgl obtained an SPT value of at least 27. SPT tests were not conducted in the Stage 2 BH05 which is located in an identified soft spot.

5.6.5 Geology

Refer to Section 2.5 of this SAR for details of geology within the study area.

5.6.6 Geomorphology

The existing Gowdystown Junction between the A1 and the Gowdystown Road is situated approximately 2.5miles south of Dromore town centre. The site is rural and consists largely of farmland with some residential properties within the vicinity. The works will consist of new northbound and southbound on/off slip roads, an overbridge across the existing carriageway to grade-separate the junction with central pier support and reinforced earth abutments as well as associated approach embankments to the west, the slip road is in fill, while the eastern part of the slip road is in fill adjacent to the bridge but is in cutting for the majority after that. The section of fill to the west of the mainline between Ch. 40 – 230 has a maximum height of approximately 5.8m. Both the made ground and underlying peat will need to be excavated prior to construction of the embankment to the west of the A1 mainline. Excavation is likely to be required up to 3m bgl. The section of the slip road to the east of the A1 is predominantly in cutting or nearly at-grade. The maximum depth of cut is approximately 2.3m bgl, however the cut slopes are chasing the hill which exaggerates the earthworks extents on plan.

5.6.7 Climate, Topography and Land Use

5.6.7.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.6.7.2 Topography and Land Use

The junction is located to the east of the hamlet of Gowdystown which is approximately 1km away. The junction study area is within the Green Belt policy area for Banbridge. The junction is bound by improved and semi-improved grassland and arable fields, which are separated by poorly maintained hedgerows. The land surrounding the junction has dispersed rural housing and farmsteads and, in the immediate vicinity of the junction, houses are more densely concentrated along Gowdystown Road (West) than Gowdystown Road (East).

To the south of the junction the A1 lies at an elevation of 76.3m AOD and rises over a distance of 630m to an elevation of 81.5m AOD at the north end of the junction.

To the east of the junction the surrounding fields lie at an elevation of 75.41m AOD and rises over a distance of 115m to an elevation of 90.08m AOD. Gowdystown Road (East) falls from an elevation of 78.63m AOD over a distance of 214m to its intersection with the A1 at an elevation of 75.30m AOD. The residential property to the east of the junction lies at an elevation of 79.42m. The residential properties which lie to the north-east of the junction lie at elevations of 91.094m AOD and 91.627m

AOD. The fields to the south east of the junction rises over 301m from 74.17m AOD to an agricultural / residential premises which lies at elevation 100.055m AOD.

To the west of the junction the surrounding field lies at an elevation of 74.23m AOD and rises over a distance of 890m to 76.74m AOD. The residential property to the west of the junction lies at an elevation of 76.64m AOD. Gowdystown Road (West) falls from an elevation of 76.93m AOD over a distance of 194m to its intersection with the A1 at an elevation of 75.39m AOD. The Old Banbridge Road (Gowdystown) falls from 80.15m AOD over a distance of 133m to its intersection with the A1 at an elevation of 80.66m AOD.

5.6.8 Hydrology, Hydrogeology and Drainage

5.6.8.1 Drainage

The land immediately surrounding the mainline within the junction extents is predominantly permanent pasture with some scattered housing to the east and west with improved and semi-improved grassland and arable fields. The buildings within the area include residential properties. The compact connector road, merge and diverge widening and realignment of side roads will involve providing a significant area of new road construction mainly through the greenfield sites however some of the private properties are affected.

Both the mainline and side roads cross minor watercourses. There is 1 No. 900mm existing culvert within the junction extents which crosses the existing A1 carriageway just south of the proposed junction while the watercourse to the west of the junction is culverted under the existing Gowdystown Road (West) and within the adjacent field. The 900mm culvert may require extension to facilitate the merge and diverge mainline widening whilst it is proposed to replace the culvert within the field with a 1600mm pipe. The proposed compact connector road crosses an existing watercourse at two locations and therefore it is proposed to install new culverts. These culverts will be 1600mm diameter and will have lengths of 55.5m. These watercourses offer opportunities for drainage from the road scheme.

5.6.8.2 Pre-earthworks Drainage

Refer to Section 5.2.7.3 of this SAR.

5.6.8.3 Outline Road Drainage Design

Refer to Section 5.2.7.4 of this SAR.

5.6.8.4 Attenuation and Treatment

It is proposed that SuDS retention ponds will be utilised downstream of all proposed carriageway road drainage from the junction and side roads and upstream of the proposed drainage outfalls to reduce the impact of the proposed junction drainage waters on the receiving watercourse. Pre-earthworks drainage is required to intercept runoff from land which falls towards the junction and this drainage may also necessitate the provision of outfalls discharging directly to watercourses however where possible these will gravitate to the retention ponds.

The nature and shape of the proposed junction have influenced the SuDS proposals as they provide an area of land within the compact connector road on each side of the A1 mainline which lends itself to the inclusion of SuDS retention ponds. As DfI would prefer to minimise the land take and the impact of the scheme on the local landowners, retention ponds in these locations have been chosen as the preferred form of sustainable drainage system for the scheme.

5.6.8.5 Greenfield Runoff

Refer to Section 5.2.7.6 of this SAR.

5.6.8.6 Retention Ponds

The locations of proposed ponds are shown on drawing 168014-RPSB-HDG-J3-DR-D-500-00003 which is included in Appendix G.

5.6.8.7 Culvert Design

There are no designated watercourses in the immediate vicinity of the proposed junction. An undesignated watercourse flows eastwards towards the A1 then turns and runs adjacent to northbound carriageway of the A1. This watercourse is culverted under the existing Gowdystown Road (West) and within the adjacent field. It is proposed to provide 2 No. new culverts of 1600mm diameter which will carry the watercourse under the compact connector road and upgrade the section of existing culvert within the adjacent field. The other existing culvert under the A1 may need to be extended to allow the watercourses to pass beneath the new roads / road widening.

There are therefore one new culvert and one culvert replacement structure required at the proposed junction with possible requirement for extension of the existing culvert. The internal dimensions of both new culverts are at 1600mm diameter while the existing culvert is 900mm diameter. Dimensions are subject to agreement with DfI Rivers and future maintenance requirements.

Please also refer to Section 5.2.7.8 of this SAR.

5.6.9 Earthworks

To accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software. The cut and fill slopes were created at a 1:3 slope, except at a location to the North West of the junction where a 1:2 slope was applied.

5.6.9.1 Analysis and Assumptions

The volumetric analysis has been carried out for the entire junction including side roads, subdivided where necessary. The following has been assumed:

- Existing carriageways have been assumed to have a construction depth of 200 millimetres.
- Average topsoil depth of 0.35m for the entire junction; and
- For the present, traffic islands have been assumed to be treated as areas of footway.

The acceptability of the excavated soft material, which does not include topsoil, has been calculated using detailed values. Using these values and carrying out further volumetric analysis within the junction area, an acceptability percentage was calculated for each type of material encountered. A summary of the Earthworks Volumes can be seen in Table 5.82 below:

Table 5.82 – Junction 3 Bulk Earthworks Summary

Works	Volume (m^3)
Excavate, Deposit and Compact Rock	0
Excavate, Deposit and Compact – Acceptable Material	19,617
Excavate and Deposit – Topsoil	10,644
Excavate, Deposit and Compact – Landscaping Fill	1,000
Excavate and Dispose – Unacceptable Soft Material	58,135
Excavate and Dispose – Excess Topsoil	3,980
Import, Deposit and Compact Acceptable Fill	51,122
Compact Rock as Capping Material	440
Process unacceptable material, deposit and compact	1,962

5.6.9.2 Material Acceptability

5.6.9.2.1 Cut 2 – J3 Gowdystown

This cut is approximately 100m long and extends to 3.2m bgl at its maximum. Overburden is approximately 14.5m deep.

A CBR value of 2.2% was obtained from material with NMC 17% at a depth of 2.0m bgl. After the topsoil is removed, the remainder of the overburden material within this cut is expected to be reusable as a Class 2 fill. Based on the results of the lab tests described above it is expected the material will require processing.

Within this cut section there is a localised soft area at Ch. 0 - 100 which may not be suitable for reuse due to an expected high water content, low CBR and low MCV.

It is estimated that approximately 40% to 50% of the material in this cut will be suitable for re-use as general fill without significant processing.

5.6.9.3 Excavatability

Bedrock is below formation level and has been identified in PBH01 at 3.4m bgl.

From the ground investigations and lab testing, the rock is indicated to be predominantly weak and moderately weathered with RQD values generally less than 20%. There is one location where RQD values are 58-81% and some rock breaking may be required in this area.

For the most part, it is expected that the bedrock encountered will be possible to excavate with conventional plant with ripping being required at most.

Excavation in overburden is not envisaged to be problematic for conventional earthworks plant. However, it may be necessary to employ more robust plant for removal of large boulders.

5.6.10 Land and Property Take

The following section outlines the land and property take associated with the provision of a CGSJ at the Gowdystown Road. The vesting boundary land take for the scheme broken down into land categories is provided in Table 5.83 below. One residential property, associated outbuildings, and an additional shed will be demolished to allow for construction of the proposed works.

Table 5.83– Gowdystown CGSJ Associated Land Take

Entity	Land take (ha)
Residential	0.35
Agricultural	3.49
Commercial	0.05
Publicly Owned/ Existing Road Bed	3.64
Total (Vesting Boundary)	**7.54**

5.6.11 Public Utilities

Initially all utility providers were contacted to confirm ownership of apparatus within the study area. This allowed the scheme to be developed minimising the potential impact to utility apparatus. At Stage 2 (Preferred Route Selection), details of the apparatus within the study area was requested, in accordance with a Committee NIRAUC C2 request. The undertakers listed below provided details of their infrastructure in the study area:

- British Telecom plc (BT);
- Northern Ireland Electricity (NIE); and
- Northern Ireland Water Ltd (NIW);

Further utility companies including Firmus, Cable and Wireless, Virgin Media, Eircom and Phoenix Gas were also contacted however their records did not reveal the existence of apparatus within the study area for the junction.

Upon appointment of RSC to undertake the Stage 3 Assessment, a NIRAUC C3 request was submitted to each affected utility provider, seeking preliminary details of the effects on their apparatus together with budget estimates for the works and an indication of any special requirements. Drawings indicating the location of existing services have been prepared and are summarised on drawing numbers 168014-RPSB-VUT-ML-DR-HE-100-00001 to 00014 within Appendix E. The details of the information received from each statutory undertaker is given below.

5.6.11.1 British Telecom

Telecommunications apparatus belonging to BT is affected by the proposed CGSJ at Gowdystown Road associated works.

BT has a network of both overhead and underground services throughout the area of the works. The underground system is located in the eastern verge of the existing A1 and includes a spur which crosses the A1 and follows Gowdystown Road (West) and a second spur which follows Gowdystown Road (East). It is proposed to abandon section of the existing underground network which will fall within the junction extents. This includes a section on Gowdystown Road (East) and Gowdystown Road (West). New underground services will be provided in the compact connector road which will tie into the existing services at the extremities of the side road realignment works.

The response to the C3 request for outline diversionary works costs indicated a cost of £52,071.35 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J3-DR-HE-100-00002 to 00004 which have been prepared for information purposes only and are contained within Appendix E.

5.6.11.2 Northern Ireland Electricity

Electrical apparatus belonging to NIE is affected by the proposed CGSJ at Gowdystown Road and associated works.

NIE has a network of overhead services throughout the area of the works. This consists of an 11kV overhead service which runs in an east-west direction roughly parallel to Gowdystown Road (West) with an offset to the south ranging between 20m and 70m. It crosses the A1 at the south corner of the Gowdystown Road (West) / A1 junction. At this crossing point an 11kV overhead service branches off northwards to supply the properties located in Old Banbridge Road (Gowdystown) accessed from the west side of the A1. Across the A1 the 11kV service continues roughly parallel to the north-side of Gowdystown Road (East) offset by approximately 140m. The properties nearest the A1 junction on the south side of Gowdystown Road (West) are supplied by a MV service that branches off the 11kV service as described previously. Likewise the properties located at the northeast corner of the A1 junction with Gowdystown Road (East) are supplied by an MV service that branches off the 11kV overhead service. The following diversion work will be required:

- 11kV – NIE have proposed to recover the existing 11kV overhead service which runs parallel to Gowdystown Road (West), across the A1 to accommodate the new junction. In order to maintain supply and network configurement 1 No. spur line is proposed to maintain supply to residential / commercial properties on Old Banbridge Road (Gowdystown). 1 No. 11kV overhead line has been proposed, crossing the A1 and maintaining supply to properties to the east of the junction.

The response to the C3 request for outline diversionary works costs indicated a cost of £75,000 (Incl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J3-DR-HE-100-00002 to 00004 which have been prepared for information purposes only and are contained within Appendix E.

5.6.11.3 Northern Ireland Water

Water main apparatus belonging to NIW is affected by the proposed CGSJ at Gowdystown Road and associated works. The existing water main runs along Gowdystown Road (West) and crosses to the eastern verge of the A1 where it connects into a main that runs along the eastern side of the A1. Gowdystown Road (East) is serviced by a main that branches off from the same junction point on the A1 and runs within the northern verge of the road. A water main branches off the Gowdystown Road (West) at the A1 junction and runs along the western verge of Old Banbridge Road (Gowdystown) to serve the local properties.

NIW have proposed that the existing water main network will be modified following the existing alignment, along Gowdystown Road (East) and Gowdystown Road (west), running along the new connector road and connecting into the existing water main located in the verge of the southbound and northbound carriageway respectively.

The response to the C3 request for outline diversionary works costs indicated a cost of £64,300.20 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J3-DR-HE-100-00002 to 00004 which have been prepared for information purposes only and are contained within Appendix E.

5.6.12 Structures

The proposed Gowdystown Road Junction would require the construction of a number of structures, summarised below:

- One no. two-span integral overbridge structure on the compact connector road crossing the A1 Dual Carriageway;
- One new drainage culvert structure; and
- One drainage culvert extension structures, incorporating headwall elements.

5.6.12.1 Overbridges

The following summary should be read in conjunction with Drawing 168014-RPSD-SBR-J3-DR-S-1700-00001 which is included within Appendix F.

The proposed compact connector road overbridge would be a two span structure with two equal spans of 21.8m which would carry the compact connector road over the existing A1 mainline. The 20° skewed structure will be approximately 60m long and about 16.8m wide. The bridge deck would be formed from precast pre-stressed concrete beams with an in-situ reinforced concrete deck slab that would be integral with the intermediate pier and abutments. Aesthetically, it is proposed that a structure with a closed aspect would be provided and reinforced earth walls would be constructed at the east and west abutments in order to reduce the overall span.

The pier and abutments substructures would be constructed from reinforced concrete with spread footed or piled foundations, subject to ground conditions. A more detailed Geotechnical Investigation is planned to aid and inform this decision as part of the Construction Tender stage of the project.

Final selection of the structural form would depend on the Contractor's construction preferences and would be developed and finalised during the Pre-Construction Tender stage of the project.

Minimum headroom of 5.3m shall be provided below the beam soffit over the mainline carriageway.

5.6.12.2 **Culverts**

Both the mainline and side roads cross minor watercourses. The existing 900mm culvert crossing the A1 mainline will remain as existing however it may need to be extended to pass beneath the new road / road widening. The existing culvert crossing under Gowdystown Road (East) will be replaced and extended to allow the watercourses to pass beneath the new road / road widening. These watercourses offer opportunities for drainage from the road scheme.

There are therefore one new culvert and one culvert replacement structure required at the proposed junction with possible requirement for extension of the existing culvert. The internal dimensions of both new culvert and culvert replacement are 1600mm diameter while the existing culvert is 900mm diameter. The length of the new culvert is 55.5m while the length of the culvert replacement is 151m. Dimensions are subject to agreement with DfI Rivers and future maintenance requirements.

The entry and exit to each new culvert will require a headwall, flanked on each side by wingwalls, to retain the adjacent embankment. Pedestrian protection would be provided, as required. An apron section may be required between the wingwalls, for scour protection and hydraulic channel requirements. This would be confirmed at Detailed Design stage.

The structure's internal dimensions have been determined to suit the requirements of DFI Rivers subject to agreement and to allow manual inspection of the internal faces in the future. The construction methodology will have to consider the importance of minimising disturbance to the water quality and habitat during both the temporary works phase, when any temporary diversion works to allow construction to take place would be carried out, and during the permanent works phase, where a 'naturalistic' granular material bedding layer may be required above any base slab of the new construction.

It is anticipated that the culverts will be formed from pipe section precast reinforced concrete elements, dependant on required internal dimensions and Contractor's construction preference. It is anticipated that headwalls and wingwalls would be formed from discrete precast reinforced concrete elements or cast in-situ. A typical general arrangement drawing for a culvert is included in Appendix F.

5.6.12.3 Geotechnical Requirements at Structures

The A1 mainline will be at grade at this location and the overbridge abutments are recommended to be constructed as raised bankseats on shallow foundations, sitting perched within the approach embankments. The sections of the embankments underneath the bankseat foundations shall be constructed from Class 6N upfill from existing ground as a minimum. This upfill may also be required to extend below existing ground to a suitable bearing stratum, as described below.

The ground conditions in this area generally comprise soft brown slightly sandy slightly gravelly clay, overlaying highly weathered Shale as shown in Table 5.84. Groundwater was not encountered in the boreholes conducted in this area. Sulphate levels in the groundwater are up to <10 mg/l with pH of 7.5. This location is classified as ACEC Class DS-1 (Buried Concrete Classification BRE Special Digest No.1).

Table 5.84 – Gowdystown Overbridge Ground Conditions

Exploratory Position	Depth (m)	Soil/Rock Description	Depth (m) bgl	SPT (N)	C_u (kPa)
PBH03	0.3 to 0.7	Sandy gravelly CLAY			
	0.7 – 2.8	Soft brown sandy gravelly CLAY.	1 2	6	29 20
	2.8 – 5.1	Firm to soft brown sandy gravelly CLAY.	3 5	28 50	134 240
	5.1 -9.7	Highly weathered fractured SHALE			
PBH01 PBH02 PBH03	0.4 – 0.7	Soft brown sandy gravelly CLAY with rootlets.			
	0.7 – 2.8	Very soft brown slightly sandy slightly gravelly CLAY.	2	3.6	28
	2.8 – 7.3	Soft brown slightly sandy slightly gravelly CLAY.	3 3.2 4 5 6 7	7 27 33 36	137 125
	7.3 – 11.5	Highly weathered fractured SHALE			
	0.3 to 0.7	Sandy gravelly CLAY			

The embankment underneath the south east abutment will be founded on sandy gravelly clay, with a shear strength of C_u = 29kPa at 1.0m bgl and 20kPa at 2.0m bgl. The shear strength of the material increases to C_u = 240kPa at 5.0m bgl. In order to obtain a good bearing stratum it is recommended that the upper 2 to 3m bgl of overburden is excavated beneath the abutment location and the Class 6N upfill extended down to this level.

The embankment underneath the north-west abutment is located in an area of sandy gravelly CLAY. The SPT values obtained in this area are relatively low and indicate that the ground is quite soft to approximately 4.0m bgl. It is recommended that the Class 6N upfill be extended to at least this depth to ensure a suitable bearing stratum for the overlying bankseat foundation.

Note that as raised bankseats are recommended as the preferred solution for the abutments, the combination of settlements within the Class 6N upfill, the adjacent embankment materials, and the underlying ground, need to be considered at detailed design. Suitable hold points during the construction of the bridge will be required to ensure settlements are substantially complete prior to landing of bridge beams etc.

No testing was conducted in the location of the central pier, however with respect to the ground conditions in the area, it is envisaged that the overburden will consist of sandy gravelly CLAY with low SPT values to a depth of 4.0m bgl. It is assumed that rock is located at a depth of 7.3m bgl, based on adjacent boreholes. The central pier will be constructed at grade and will require excavation to at least 4.0m bgl to achieve a suitable bearing stratum from which to build up the Class 6N upfill. Further investigations at the central pier location are recommended at detailed design stage to more accurately assess the ground conditions and suitability for a shallow pad foundation.

5.6.13 Health and Safety

General health and safety issues for the scheme have been noted under the Whole Scheme section, Section 5.2.13 of this SAR; however there are some site specific risks relevant to Junction 3, Gowdystown Road which are discussed below.

The construction of the junction will require demolition of 1 No. residential property and 1 No. out-building to the east of the junction and 1 No. out-building to the west of the junction. Asbestos surveys (in accordance with the Control of Asbestos Regulations (Northern Ireland) 2012) may need to be carried out in advance of any demolition works.

As part of the construction of the junction, the existing direct access to houses 14A, 15 & 16 Gowdystown Road, 131 Halfway Road and residential / commercial properties located on the Old Banbridge Road (Gowdystown) will require the Contractor to maintain this local access for both vehicular and pedestrian movements during construction of the works. Whilst the usage will be low, the sporadic nature of access to residential and agricultural properties may have an increase on the likelihood and severity of vehicular accidents due to the proximity of site traffic, site staff, public traffic and non-motorised users on the adjacent roads at this location.

Due to the close proximity of grazing land, the Contractor is required to ensure that boundary fencing is stock proof and well maintained to prevent cattle from accessing the A1.

In addition due to the close proximity of badger setts to the north west of the junction, the Contractor is required to ensure that suitable boundary fencing is stock proof and well maintained to prevent badgers accessing the works, whilst also ensuring a 25m protection zone surrounding the badger setts is maintained throughout the works.

5.7 SKELTONS ROAD/DRUMNEATH ROAD

5.7.1 Introduction

The Skeltons Road/Drumneath Road Junction (Junction 4) is located approximately 5.3 kilometres north of Banbridge town. The junction was selected as a suitable location for the construction of a CGSJ during the stage 1 scheme assessment.

The Skeltons Road/Drumneath Road junction was identified as having a significant number of right turn movements. Therefore based on the guidance in both TD9 and RSPPG_E038, the stage 1 scheme assessment identified that some form of grade separation at this junction should be provided.

Three CGSJ options were assessed during the Stage 2 Scheme Assessment. The Purple option was favoured under the economic objective as it is the lowest cost option and was more favourable than the Green option. The Purple option also had the smallest earthworks footprint along with the least amount of cut volume this making it favourable from an engineering perspective.

This section of the report considers the engineering aspects of the proposed CGSJ at Skeltons Road/ Drumneath Road as described in Chapter 3.

5.7.2 Design Standards

The design documents and standards particularly relevant to the Skeltons Road/Drumneath Road Junction are outlined in Section 5.2.1 of this SAR.

5.7.2.1 Mainline

The section of dual carriageway on which the proposed Skeltons Road/Drumneath Road is to be located is designed to meet the standards appropriate to a 120Akph design speed and is classified as a Category 5 in accordance with “Highway Link Design” (DMRB Volume 6, Section 1, Part 1, TD9/93). Table 4 – Recommended Rural Road Layouts, it comprises two 7.3m wide carriageways with additional 1.0m hard strips on either side and the central reserve is to be a minimum of 2.5m (widened for visibility where necessary) in accordance with “Cross Sections and Headroom” (DMRB Volume 6, Section 1, Part 2 TD 27/05). The existing hardshoulder will taper to meet the width of the proposed hardstrips over the length of the diverge and merge tapers. Pavement edge details will comprise kerbs and gullies or concrete channels to provide positive drainage and a safety barrier will be provided in the central reserve over the full length of the junction extents and will connect into the safety barrier proposed for the whole scheme.

The extent of the section of mainline associated with the Skeltons Road/Drumneath Road junction starts at a point approximately 238m in a north easterly direction from the existing Skeltons Road Junction with the A1 Dual Carriageway to a point 269m in a south westerly direction from the same junction.

5.7.2.2 Compact Grade Separated Junction

A CGSJ has been provided where the dual carriageway intersects with Skeltons Road. The junction allows traffic from Skeltons Road, Drumneath Road and Tullyhenan Road (now connecting on to Skeltons Road on the North side) to join the dual carriageway.

The junction has been designed to comply with the requirements of "Layout of Compact Grade Separated Junctions" (DMRB Volume 6, Section 2, Part 5 TD 40/94). The junction has been designed for a design speed of 50kph as per TD40. The minimum internal radii of the compact connector road is 40m.

Compact connector roads are nominally 7.9m wide but are curve widened to accommodate large vehicles. The proposed compact connector road at Skeltons/Drumneath Road junction is 10.8m to accommodate not only large vehicles but also right turn lanes for access on to Skeltons Road and Drumneath Road. Merge and Diverge lanes and tapers provide the link to the mainline.

The merge and diverge lanes and tapers have been designed to comply with the requirements of 'Geometric Design of Major/Minor Priority Junctions' DMRB Volume 6, Section 2, Part 6, TD 42/95. The diverge has been designed as an auxiliary lane with a deceleration length of 110m with a direct taper length of 30m as per TD42. The merge has been designed as an auxiliary lane with a merging length of 130m, in addition to a merge nose of length of 40m and a taper length of 55m. The minimum width of the lane excluding hardstrips varies from 5.7m (at the nose) and 3.7m. The merge nose and auxiliary lane length is compliant with TD42, albeit TD42 specifies a merge taper as opposed to auxiliary lane and therefore a departure from standard is required. The 55m taper is compliant with the requirements of 'Layout of Grade Separated Junctions'(DMRB Volume 6, Section 2, Part 1, TD 22/06). A Design Speed of 120kph has been applied to the slip lanes.

5.7.2.3 Side Roads

As the side roads approach the new junction they are generally realigned to achieve the required connection to the compact connector road in terms of the horizontal approach to the connector road to achieve adequate junction spacing and also vertical alignment to tie-in with the connector road levels which have been set to achieve clearance over the existing dual carriageway.

Skeltons Road has been realigned both vertically and horizontally to allow for a connection on to the compact connector road. Likewise the Drumneath Road has been realigned vertically and horizontally.

Geometric standards of the existing roads vary significantly; however their replacements will be designed to comply with Category S2 of "Highway Link Design" (DMRB Volume 6, Section 1, Part 1, TD9/93). All side roads are subject to the National Speed Limit. Any improvements or realignments to these roads should be designed to a 100kph Design Speed; however, this may be above the speed that would be appropriate for the existing roads, some of which are much narrower than would be required by modern standards with poorer visibility. As the side roads are only affected locally, it was not considered possible or pragmatic to calculate the design speed in accordance with TD 9/93 method as this would involve assessing disproportionately longer lengths of carriageway than was affected. Therefore in accordance with the DEM 118/16, the Design speeds were based on measured vehicle speeds on approach to the proposed Junction to determine the 85th percentile traffic speed. The speed surveys were undertaken in accordance with the requirements of "Vehicle Speed Measurement on All

Purposed Roads" DMRB Volume 5, Section 1 TA 22/81. The measured Design speeds and carriageway cross sections are listed below inTable **5.85**.

Table 5.85 – Junction 4 Design Speed and Carriageway Cross-sections

Side Road	Existing Width		Proposed	Minimum Proposed Width	
	Carriageway	Verge	Design Speed	Carriageway	Verge
Skeltons Road	6.0m-7.68m	0.80m-1.50m	70Akph	7.3m	1.0m LHS 2.5m LHS
Drumneath Road	8.05m-4.80m	0.69m-8.74m	70Bkph	7.3m	2.5m LHS 1.0m RHS
Tullyhenan Road (connecting to Skeltons Road)	4.8m-2.82m	0.52m-2.22m	60Bkph	7.3m	1.0m LHS 1.0m RHS

5.7.2.4 Access Lanes

There are currently 6 no. of private accesses which accesses onto the mainline within the vicinity of the proposed Junction.

On safety grounds, it is proposed that where possible, any existing direct access to the A1 within the vicinity of the junction, shall be closed and alternative access provided.

Within the vicinity of the junction there is approximately 608m of access lanes provided with a minimum width of 4.0m and verge widths of 1.0m.

5.7.2.5 Road Drainage

Refer to Section 5.2.1.7 of this SAR for details of road drainage standards.

5.7.3 Departures from Standards

Four Departures from Standard have been identified on the mainline for reduced stopping sight distance (SSD) on the northbound and southbound carriageways on approach to the horizontal curve at the overbridge location. The reduction in SSD is limited due to the location of the safety barrier in the central reserve on the offside and landtake constraints on the nearside. Two Departures have been identified on the mainline for the provision of 130m of auxiliary merge lane with 55m merge taper on the southbound and northbound carriageways in lieu of 130m merge taper. One Departure has been identified on the mainline for the inclusion of a diverge lane on the inside of a curve. The departures for merge auxiliary lane and diverge on the inside of a curve are required to maintain route consistency along the A1.

The existing A1 mainline meets the desirable minimum standards as set out in "Highway Link Design" (DMRB Volume 6, Section 1, Part 1, TD9/93) for the vertical profile however there are a number of inherent departures from standard for sub-standard provision of superelevation on both the northbound and southbound carriageways in combination with a relaxation from standard for the horizontal curve which is one step below desirable minimum at 605m and two step relaxation in SSD from 295m to 160m. The superelevation provided on the northbound carriageway is 5% when 7% is required. The location of the proposed departures and relaxations on the mainline are shown on the drawing within Appendix C.

The compact connector roads on the CGSJ were assessed for 30kph in accordance with "Layout of Compact Grade Separated Junctions" (DMRB Volume 6, Section 2, Part 5, TD40/94). No departures from standard where noted on the CGSJ.

In accordance with DEM 118/16 the pre-set design speed value for unrestricted carriageways i.e, those on which the national speed limit applies, shall be 100Akph however it is proposed that the design speed shall deviate from the preset value given the sub-standard nature of the existing roads. It was not considered possible or pragmatic to calculate the Design Speed in accordance with the TD9/93 method as this would involve assessing a disproportionately longer length of carriageway than was affected and therefore measured vehicle speeds in accordance with TA 22/81 were assessed. Refer to Table **5.85** above for measured Design Speeds.

A number of Departures and Relaxations were identified on the side roads, these are summarised in Table 5.86 below and on the drawings in Appendix C. Table 5.86 also shows the design speed that the departures and relaxations were assessed to.

Table 5.86 – Junction 4 Side Roads Departures and Relaxations

Side Road	Design Speed	No. of Departures/ Relaxations	Departures / Relaxation Description
Skeltons Road	70Akph	Departures 2	1 No. Reduction in horizontal curvature from 1020m to 180m. 1 No. reduction in cross section.
Tullyhenan Road	60Bkph	Departures 2	1 No. reduction in horizontal curvature from 510m to 120m. 1 No. reduction in cross section.
Drumneath Road	70Bkph	Departures 2	1 No. reduction in horizontal curvature from 720m to 150m. 1 No. reduction in cross section.

5.7.4 Geotechnical Features

5.7.4.1 Bedrock

Refer to Section 2.5.1.4 of this SAR for an overview of the bedrock geology at Skeltons Road / Drumneath Road Junction.

The predominant rock type at this location is highly fractured dark grey shale. The rock head increases in depth to the south of the A1 mainline to a depth of 13.8m. The rock head is shallow close to the mainline in BH02 and BH03. The proposed junction layout will encounter rock between Ch. 340 – 440 where a significant area of cut is required.

5.7.4.2 Subsoil

The typical soil profile encountered at Skeltons Junction is as follows;

- Topsoil: 0.0 to 0.2m bgl depth
- The soil south of the mainline is light brown very gravelly fine to coarse sand with medium subangular to subrounded cobble content with depth 0.3 to 2.7m bgl. The soil to the north of the mainline consists of Light brown clayey sandy angular fine to coarse gravel.
- Clayey gravel and gravelly clay 2.6m bgl to 4.8m bgl depth.
- Groundwater was struck in one borehole and three trial pits at varying depths of 2.4m bgl to 3.5m bgl.

Refer also to Section 2.5.3.4.

5.7.4.2.1 Soil Testing

The PSD testing carried out at Skeltons indicates that the most common soil types are described as silty sandy gravelly clays and clayey sandy gravels. For the sandy gravels, fines contents ranged from 0% to 18%.

Samples tested can be predominately classified as low to medium plastic inorganic clays in the range of between 14 and 19 for plasticity. One sample taken from PWS01 indicates soil of extremely high plasticity.

The plastic limit ranges from 14% to 35%, with an average plastic limit of 18%. The liquid limit ranged from 30% to 97% with an average liquid limit of 37%. The average depth tested for liquid limit and plastic limit was 2.78m. Plasticity Index's ranged from 14 to 62 with an average of 20.

NMC of samples tested indicates samples ranging from 2.9% to 16%. Average NMC is 8.4%.

In total 5 CBR tests were conducted at the Skeltons Road Junction. The results from the CBR tests conducted to the north of the existing A1 mainline indicated soil with CBR values less than 2%. The soil in this area may be unsuitable for compaction and due to the quantity of fill that will be required to construct the overpass soil replacement may be required in this area. It is recommended that additional CBR testing be conducted during construction to determine the suitable and unsuitable soil. The CBR values obtained to the south of the mainline range from 4.3% to 10.7% therefore the soil in this area should be suitable for compaction.

The MCV of samples tested indicates that 9 of the 11 samples returned a result of less than 8. This indicates that most of the soils tested are unsuitable for immediate reuse without some degree of improvement/stabilisation (e.g drying, lime stabilisation, etc).

5.7.4.2.2 Chemical Testing

Chemical testing for chloride was carried out on 2 samples. The values of chloride content ranged from 4.8 to 13mg/l.

Chemical testing for sulphate was carried out on 2 samples. The values of sulphate content ranged from 14 to 23mg/l.

pH testing was carried out on 2 samples. pH values ranged from 7.1 – 7.8. Organic matter content was in the range from 2.2 – 3.3%.

The results of the laboratory chemical testing for aggressive chemical environment for concrete classification have been assessed in accordance with BRE Special Digest 1. Laboratory sulphate analysis undertaken on soil samples indicate that buried concrete can be designed in accordance with the design sulphate class DS-1 of ACEC class of AC-1 of BRE Special Digest 1 (2005).

5.7.4.2.3 In-Situ Testing

Standard Penetration Tests were conducted at regular intervals at the Skeltons Road Junction. In total 27 SPT tests were conducted at the Skeltons Road Junction. The majority of SPT results obtained were greater than 30 which are indicative of good bearing soil. The dynamic cone values obtained in this area agree with the SPT values obtained indicating good bearing capacity in the soil.

5.7.5 Geology

Refer to Section 2.5 of this SAR for details of geology within the study area.

5.7.6 Geomorphology

The Skeltons Junction is located 3.5 miles north of Banbridge town centre. The site is rural and consists largely of farmland with very few residential properties within the vicinity. It is proposed to upgrade the existing at-grade junction with new northbound and southbound on/off slips, an overbridge across the existing carriageway with central pier support and reinforced earth abutments as well as associated approach embankments. The proposed junction includes a substantial area of fill to the west of the A1 mainline, and a significant cutting to the east. The fill located to the west of the A1 mainline encompasses the main slip road and the approach roads which are also constructed on fill. The main fill will have a maximum height of approximately 9.5m. The section of the slip road immediately east of the bridge location will be a fill constructed to a height of approximately 7.5m.

The section of cut on the east of the A1 covers the main slip road, the Drumneath Road approach, and the access road, which are all in cutting. The proposed cut at Ch. 330 – 470 will be a maximum depth of approximately 11.5m bgl.

5.7.7 Climate, Topography and Land Use

5.7.7.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.7.7.2 Topography and Land Use

The existing A1 and surrounding area at the Skeltons Road, Drumneath Road Junction is predominately pasture with some scattered settlements to the north and south with arable fields which are separated by poorly maintained hedgerows. One decommissioned rock quarry lies to the north of the A1. The buildings located within the study area include residential properties, industrial units and farms.

To the West of the junction the A1 lies at an elevation of 87.3m AOD and rises over a distance of 575m to an elevation of 91.8m AOD at the East end of the junction.

To the North of the junction the field lies at an elevation of 87.2m AOD falling over a distance 195m to an elevation of 90.4m AOD. The property to the North West lies at an elevation of 85.1m AOD. Skeltons Road falls from an elevation of 84.7m AOD over a distance of 263m to an elevation of 90.3m AOD where it intersects with the A1. Tullyhenan Road lies at an elevation of 88.5m AOD falling over a distance of 255m to an elevation of 87.7m AOD where it intersects with halfway road. Halfway Road lies at an elevation of 89.2m AOD where it intersects with the A1 carriageway.

To the south of the junction the fields lies at an elevation of 109.5m AOD falling over a distance of 166m to an elevation of 89.9m AOD. The property to the south west lies at an elevation of 115.3m AOD. The existing lane way to the property lies at an elevation of 90.7m AOD rising to 115.3m AOD over a distance of 290m. Drumneath Road to the south east lies at an elevation of 96.7m AOD falling over a distance of 204m to an elevation of 90.4m AOD.

5.7.8 Hydrology, Hydrogeology and Drainage

5.7.8.1 Drainage

The land immediately surrounding the mainline within the junction extents is predominantly permanent pasture with some scattered housing to the North and South with improved and semi-improved grassland and arable fields. The buildings within the area include residential properties and farms. The compact connector road, merge and diverge widening and realignment of side roads will involve providing a significant area of new road construction mainly through greenfield sites however some private properties are affected.

Both mainline and side roads cross minor watercourses. There is an existing 450mm culvert which crosses the A1 mainline at Drumneath Road in a north westerly direction towards Skeltons Road. It is proposed to extend this culvert using a 750mm diameter pipe along Drumneath Road for a length of 194m. Another minor watercourse joins the existing 450mm culvert on the north side of the junction, it is proposed to extend the 450mm culvert on this watercourse for a distance of 19.7m. This watercourse becomes an open watercourse for approximately 22m before it is proposed to culvert a further section using a 250mm diameter pipe for a distance of 35.9m. A further watercourse runs alongside the Skeltons Road and Tullyhenan Road. The road widening / upgrade works require a further two culverts. The culvert alongside the Skeltons Road is proposed to be 1500mm x 1800mm box culvert with a length of 25.7m while the culvert on the Tullyhenan Road is proposed to be a 1000mm x 1500mm box culvert with a length of 18m. The watercourses offer opportunities for drainage from the road scheme.

5.7.8.2 Pre-earthworks Drainage

Refer to Section 5.2.7.3 of this SAR.

5.7.8.3 Outline Road Drainage Design

Refer to Section 5.2.7.4 of this SAR.

5.7.8.4 Attenuation and Treatment

It is proposed that SuDS retention ponds will be utilised downstream of all proposed carriageway road drainage from the junction and side roads and upstream of the proposed drainage outfalls to reduce the impact of the proposed junction drainage waters on the receiving watercourse. Pre-earthworks drainage is required to intercept runoff from land which falls towards the junction and this drainage may also necessitate the provision of outfalls discharging directly to watercourses however where possible these will gravitate to the retention ponds.

The nature and shape of the proposed junction have influenced the SuDS proposals as they provide an area of land within the compact connector road on each side of the A1 mainline which lends itself to the inclusion of SuDS retention pond. As DfI would prefer to minimise the land take and the impact of the scheme on the local landowners, retention ponds in these locations have been chosen as the preferred form of sustainable drainage system for the scheme.

5.7.8.5 Greenfield Runoff

Refer to Section 5.2.7.6 of this SAR.

5.7.8.6 Retention Ponds

The locations of proposed ponds are shown on drawing 168014-RPSB-HDG-J4-DR-D-500-00003 which is included in Appendix G.

5.7.8.7 Culvert Design

There are no designated watercourses in the immediate vicinity of the proposed junction. An undesignated watercourse flows alongside Tullyhenan Road and Skeltons Road while a further undesignated watercourse flows alongside the Drumneath Road crossing under the A1 mainline before joining the watercourse alongside Skeltons Road. It is proposed to provide 3 No. new culverts and to extend the existing culvert under the A1 at two locations to allow the watercourses to pass beneath the new roads / road widening.

There are therefore 3 No. new culverts and 2 No. culvert extensions required at the proposed junction with possible requirement for extension of the existing culvert. The internal dimensions of the new culverts are 1000mm x 1500mm box, 1500mm x 1800mm box and a 250mm diameter pipe. The internal dimensions of the culvert extensions are 450mm and 750mm diameter pipes. Dimensions are subject to agreement with DfI Rivers and future maintenance requirements.

Please also refer to Section 5.2.7.8 of this SAR

5.7.9 Earthworks

5.7.9.1 Modelling of Skeltons, Drumneath Road Junction

To accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software, the cut and fill slopes where created using a 1:3 slope.

5.7.9.2 Analysis and Assumptions

The volumetric analysis has been carried out for the entire junction including side roads, subdivided where necessary. The following assumptions have been made:

- Existing carriageways have been assumed to have a construction depth of 250 millimetres;
- Average topsoil depth of 0.35m for the entire junction; and
- For the present, traffic islands have been assumed to be treated as areas of footway.

The acceptability of the excavated soft material, which does not include topsoil, has been calculated using detailed values. Taking these values and carrying out further volumetric analysis within the junction area, an acceptability percentage was calculated for each type of material encountered. A summary of the earthworks volumes can be seen in Table 5.87 below:

Table 5.87 – Junction 4 Bulk Earthworks Summary

Works	Volume (m^3)
Excavate, Deposit and Compact Rock	0
Excavate, Deposit and Compact – Acceptable Soft Material	55,255
Excavate and Deposit - Topsoil	16,763
Excavate, Deposit and Compact - Landscaping Fill	1000
Excavate and Dispose – Unacceptable soft material	64,750
Excavate and Dispose Excess - Topsoil	4,496
Import, Deposit and Compact Acceptable material	27,191
Compact rock as capping	0
Process unacceptable material, deposit and compact	10,028
Excavate and Dispose – Acceptable material	12,913

5.7.9.3 **Material Acceptability**

5.7.9.3.1 Cut 3 – J4 Skeltons

This cut is approximately 130m long and extends to 11.5m deep at its maximum and is located at Ch330-470. Overburden is approximately 12.5m deep.

Laboratory results were based on PBH04. NMC was found to be 16% and 14% which gave MCVs of 5.4 (2.0m bgl) and 4.0 (4.0m bgl). A CBR value of 4.5% was obtained from material with NMC 14% at a depth of 5.0m bgl.

After the topsoil is removed, the remainder of the overburden material within this cut is expected to be reusable as a Class 2 fill. Based on the results of the lab tests described above it is expected the material will require little or no processing.

It is estimated that approximately 50% to 60% of the material in this cut will be suitable for re-use as general fill without significant processing.

5.7.9.4 **Excavatability**

5.7.9.4.1.1 *J5 Skeltons Junction*

Referring to the Ground Investigation Report (168014-RPSD-HGT-XX-RP-D-00001) bedrock is below formation level and has been identified in BH01 at 3.6m bgl.

From the ground investigations and lab testing, the rock is indicated to be predominantly weak and moderately weathered with RQD values generally less than 20%.

For the most part, it is expected that the bedrock encountered will be possible to excavate with conventional plant with ripping being required at most.

Excavation in overburden is not envisaged to be problematic for conventional earthworks plant. However, it may be necessary to employ more robust plant for removal of large boulders.

5.7.10 Land and Property Take

The following section outlines the land and property take associated with the A1 Junctions Scheme for the provision of a Compact Grade Separated Junction at the Skeltons Road/Drumneath Road. The vesting boundary land take for the scheme broken down into land categories is provided in Table 5.88 below.

Table 5.88 – Skeltons/Drumneath CGSJ Associated Land Take

Entity	Land take (ha)
Residential	0.21
Agricultural	6.58
Commercial	0.04
Publicly Owned/ Existing Road Bed	3.70
Total (Vesting Boundary)	**10.53**

5.7.11 Public Utilities

Initially all utility providers were contacted to confirm ownership of apparatus within the study area. This allowed the scheme to be developed minimising the potential impact to utility apparatus. At Stage 2 (Preferred Route Selection), details of the apparatus within the study area was requested, in accordance with a NIRAUC C2 request. The undertakers listed below provided details of their infrastructure in the study area:

- British Telecom plc (BT);
- Northern Ireland Electricity (NIE); and
- Northern Ireland Water Ltd (NIW);

Further utility companies including Firmus, Cable and Wireless, Virgin Media, Eircom and Phoenix Gas were also contacted however their records did not reveal the existence of apparatus within the study area for the junction.

Upon appointment of RSC to undertake the Stage 3 Assessment, a NIRAUC C3 request was submitted to each affected utility provider, seeking preliminary details of the effects on their apparatus together with budget estimates for the works and an indication of any special requirements. Drawings indicating the location of existing services have been prepared and are summarised on drawing numbers 168014-RPSB-VUT-ML-DR-HE-100-00001 to 00014 within Appendix E. The details of the information received from each statutory undertaker is given below.

5.7.11.1 British Telecom (BT)

Telecommunications apparatus belonging to BT is affected by the proposed CGSJ at Skeltons Road / Drumneath Road and associated works.

BT has a network of both overhead and underground services throughout the area of the works. The underground system is located in the eastern verge of the A1. The underground system includes a crossing at the southern end of Halfway Road. This secondary line follows Halfway Road and then Skeltons Road. On the eastern side, a secondary spur is located on Drumneath Road. The underground system on the eastern side of the A1 will need to be diverted into the new verge of the merge and diverge lanes.

A new underground system will be provided on the proposed compact connector road which will reconnect to the existing system on Drumneath Road and then the existing system on Skeltons Road. The existing system on Halfway Road will be retained with a short section to be abandoned between Halfway Road and Skeltons Road.

To the north west of the junction, existing BT services run overhead along the edge of the Tullyhenan Road. The proposed diversion would remove a section of this overhead line and replace it with underground cable.

The response to the C3 request for outline diversionary works costs indicated a cost of £20,290.10 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J4-DR-HE-100-00010 to 00012 which have been prepared for information purposes only and are contained within Appendix E.

5.7.11.2 Northern Ireland Electricity (NIE)

Electrical apparatus belonging to NIE is affected by the proposed CGSJ at Skeltons Road / Drumneath Road and associated works.

To the north of the proposed junction, NIE has a network of services in the area of the works which include MV and 11kV lines. The 11kV line is unaffected however a small diversion to the MV network is proposed as follows:

- MV – The MV supply on Skeltons Road will be diverted locally to facilitate the realignment of Tullyhenan Road and to retain supply to the existing property (No. 68).

The response to the C3 request for outline diversionary works costs indicated a cost of £3,500 (Incl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J4-DR-HE-100-00010 to 00012 which have been prepared for information purposes only and are contained within Appendix E.

5.7.11.3 Northern Ireland Water (NIW)

Water main apparatus belonging to NIW is affected by the proposed CGSJ at Skeltons Road / Drumneath Road and associated works.

There are existing water main lines running through Skeltons Road, Drumneath Road, Halfway Road and Tullyhenan Road. The water main crosses the A1 adjacent to Drumneath Road and is typically 180mm diameter except in the Tullyhenan Road where it is 100mm diameter.

In order to facilitate the construction of the new junction, it is proposed to abandon the majority of the existing water main system in the vicinity of the roadworks. A new system of water main will be provided in the verge of the new road network tying into the existing system at the extremities of the roadworks. The new mains will be 180mm diameter with the Tullyhenan line being upgraded to 125mm diameter.

The response to the C3 request for outline diversionary works costs indicated a cost of £81,645.61 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J4-DR-HE-100-00010 to 00012 which have been prepared for information purposes only and are contained within Appendix E.

5.7.12 Structures

The proposed Skeltons Road / Drumneath Road Junction would require the construction of a number of structures, summarised below:

- One no. two-span integral overbridge structure on the compact connector road crossing the A1 Dual Carriageway;
- Three new drainage culvert structures; and
- Two drainage culvert extension structures, incorporating headwall elements.

5.7.12.1 Overbridges

The following summary should be read in conjunction with Drawing 168014-RPSD-SBR-J4-DR-S-1700-00001 which is included within Appendix F.

The proposed compact connector road overbridge would be a two span structure, with two main spans of circa 16.4m and 16.75m and would carry the compact connector road over the existing A1 mainline. The square structure will be approximately 49m long and about 16.8m wide. The bridge deck would be formed from precast pre-stressed concrete beams with an in-situ reinforced concrete deck slab that would be integral with the intermediate pier and abutments. Aesthetically, it is proposed that a structure with a closed aspect would be provided and reinforced earth walls would be constructed at the east and west abutments in order to reduce the overall span.

The pier and abutments substructures would be constructed from reinforced concrete with spread footed or piled foundations, subject to ground conditions. A more detailed Geotechnical Investigation is planned to aid and inform this decision as part of the Construction Tender stage of the project.

Final selection of the structural form would depend on the Contractor's construction preferences and would be developed and finalised during the Pre-Construction Tender stage of the project.

Minimum headroom of 5.3m shall be provided below the beam soffit over the mainline carriageway.

5.7.12.2 Culverts

The following summary should be read in conjunction with Drawings 168014-RPSD-SMN-J4-DR-D1700-00002 which is included within Appendix F.

Both mainline and side roads cross minor watercourses. There is an existing 450mm culvert which crosses the A1 mainline at Drumneath Road in a north westerly direction towards Skeltons Road. It is proposed to extend this culvert using a 750mm diameter pipe along Drumneath Road for a length of 143m. Another minor watercourse joins the existing 450mm culvert on the north side of the junction, it is proposed to extend the 450mm culvert on this watercourse for a distance of 19.7m. This watercourse becomes an open watercourse before approximately 22m before it is proposed to culvert a further section using a 250mm diameter pipe for a distance of 35.9m. A further watercourse runs alongside the Skeltons Road and Tullyhenan Road. The road widening / upgrade works require a further two culverts. The culvert alongside the Skeltons Road is proposed to be 1500mm x 1800mm box culvert with a length of 25.7m while the culvert on the Tullyhenan Road is proposed to be a 1000mm x 1500mm box culvert with a length of 18m. The watercourses offer opportunities for drainage from the road scheme.

There are therefore 3 No. new culverts and 2 No. culvert extensions required at the proposed junction with possible requirement for extension of the existing culvert. The internal dimensions of the new culverts are 1000mm x 1500mm box, 1500mm x 1800mm box and a 250mm diameter pipe. The internal dimensions of the culvert extensions are 450mm and 750mm diameter pipes. Dimensions are subject to agreement with DfI Rivers and future maintenance requirements.

The entry and exit to each new culvert will require a headwall, flanked on each side by wingwalls, to retain the adjacent embankment. Pedestrian protection would be provided, as required. An apron section may be required between the wingwalls, for scour protection and hydraulic channel requirements. This would be confirmed at Detailed Design stage.

The structure's internal dimensions have been determined to suit the requirements of DFI Rivers subject to agreement and to allow manual inspection of the internal faces in the future. The construction methodology will have to consider the importance of minimising disturbance to the water quality and habitat during both the temporary works phase, when any temporary diversion works to allow construction to take place would be carried out, and during the permanent works phase, where a 'naturalistic' granular material bedding layer may be required above any base slab of the new construction.

It is anticipated that the culverts will be formed from either box or pipe section precast reinforced concrete elements, dependant on required internal dimensions and Contractor's construction preference. It is anticipated that headwalls and wingwalls would be formed from discrete precast reinforced concrete elements or cast in-situ. A typical general arrangement drawing for a culvert is included in Appendix F.

5.7.12.3 Geotechnical Requirements at Structures

The A1 mainline will be at grade at this location and the overbridge abutments are recommended to be constructed as raised bankseats on shallow foundations, sitting perched within the approach embankments. The sections of the embankments underneath the bankseat foundations shall be constructed from Class 6N upfill from existing ground as a minimum. This upfill may also be required to extend below existing ground to a suitable bearing stratum, as described below.

The ground conditions in this area generally comprise sandy gravelly clay to a depth of 0.8 to 4.5m bgl, overlaying highly weathered Shale as shown in Table 5.89. Groundwater was not encountered in the boreholes conducted in this area. Sulphate levels in the groundwater are up to 23 mg/l with pHs of 7.1 and 7.8. This location is classified as ACEC Class DS-1 (Buried Concrete Classification BRE Special Digest No.1).

Table 5.89 – Skeltons Overbridge Ground Conditions

Exploratory Position	Depth (m)	Soil/Rock Description	Depth (m) bgl	SPT (N)	C_u (kPa)
BH02	0.2 – 2.5	Soft brown sandy gravelly CLAY.	1.2	5	24
	2.5 – 3.5	Soft brown mottled grey sandy gravelly CLAY.	3.0	9	43
	3.5 – 4.0	Firm greyish brown sandy gravelly CLAY.			
	4.8 – 12.0	SHALE			
BH03	0.3 – 1.5	MADE GROUND			
	1.5 – 7.0	Greyish brown very clayey sandy angular to subangular GRAVEL			
	7.0 - 12.0	SHALE			

The embankment underneath the north abutment will be founded on sandy gravelly clay. The SPT values obtained at this location were relatively low at shallow depths. An SPT of 5 was recorded at a depth of 1.2m bgl, another SPT value of 9 was recorded at 3.0m bgl. It is envisaged that the upper 4.0m of overburden material will be excavated to obtain bedrock to locate the abutment.

The embankment underneath the south abutment is located in an area with made ground and gravel overburden material. No SPT's were recorded in this borehole, however the underlying overburden is described as firm, and it is recommended that the made ground be excavated to 1.5m bgl beneath the abutment location and the Class 6N upfill extended down to this level.

Note that as raised bankseats are recommended as the preferred solution for the abutments, the combination of settlements within the Class 6N upfill, the adjacent embankment materials, and the underlying ground, need to be considered at detailed design. Suitable hold points during the construction of the bridge will be required to ensure settlements are substantially complete prior to landing of bridge beams etc.

No testing was conducted in the location of the central pier, however with respect to the ground conditions in the area, it is envisaged that the overburden will consist of clayey sandy GRAVEL with an SPT value of 24 at a depth of 3.0m bgl. It is assumed that bedrock is located at a depth of 4.5m bgl, based on adjacent boreholes. The central pier will be constructed at grade and will require excavation to at least 2.0m bgl to achieve a suitable bearing stratum from which to build up the Class 6N upfill. Further investigations at the central pier location are recommended at detailed design stage to more accurately assess the ground conditions and suitability for a shallow pad foundation.

5.7.13 Health and Safety

General health and safety issues for the scheme have been noted under the Whole Scheme section, Section 5.2.13 of this SAR; however there are some site specific risks relevant to Skeltons Road Drumneath Road junction which are discussed below.

The construction of the junction will require decommissioning of approximately 427m of 180mm HPPE water main and approximately 450m of 100mm HPPE Water main. These will be replaced respectively with 180mm diameter HPPE Water Main and 125mm HPPE water main. A temporary bypass will have to be constructed to maintain supply to both domestic and industrial customers.

As part of the construction of the junction the existing direct access of Skeltons Road to the A1 will be closed with a realignment of the road connecting to the proposed CGSJ. The contractor will be required to maintain this local access during the construction of the works for surrounding dwellings and farms. The likelihood and severity of vehicular accidents due to the proximity of site traffic, site staff and public traffic could be increased at this location.

5.8 WARINGSFORD ROAD

5.8.1 Introduction

Waringsford Road Junction (Junction 5), is located approximately 3.2km north of the town of Banbridge. The junction was selected as a suitable location for the construction of a CGSJ during the Stage 1 Scheme Assessment.

The Waringsford Road junction was identified as having a significant volume of right turn movements. Therefore, based on the guidance based in both TD9/93 and RSPPG_E038, the Stage 1 Scheme Assessment identified that some form of grade separation at this junction should be provided.

Three CGSJ junction options were assessed during the Stage 2 Scheme Assessment. The Brown Option was favoured under the economic objective as it is the lowest cost option and was more favourable than the Green Option under the environment objective. The Brown Option also required less fill import than the Green Option and was thus favoured from an engineering perspective.

This section of the report considers the engineering aspects of the proposed CGSJ at Waringsford Road as described in Chapter 3.

5.8.2 Design Standards

The design documents and standards particularly relevant to the Waringsford Road Junction are outlined in Section 5.2.1 of this SAR.

5.8.2.1 Mainline

The section of dual carriageway on which the proposed Waringsford Road Junction is to be located, is designed to meet the standards appropriate to a 120Akph design speed and is classified as a Category 5 in accordance with 'Highway Link Design' (DMRB Volume 6, Section 1, Part 1, TD 9/93) Table 4 – Recommended Rural Road Layouts, it comprises two 7.3m wide carriageways with additional 1.0m hardstrips on either side and the central reserve is to be a minimum of 2.5m (widened for visibility where necessary) in accordance with 'Cross Sections and Headroom' (DMRB Volume 6, Section 1, Part 2 TD 27/05). The existing hardshoulder will taper to meet the width of the proposed hardstrips over the length of the diverge and merge tapers. Pavement edge details will comprise kerbs and gullies or concrete channels to provide positive drainage and a safety barrier will be provided in the central reserve over the full length of the junction extents and will connect into the safety barrier proposed for the Whole Scheme as discussed in Section 5.2.

The extents of the section of mainline associated with the Waringsford Road Junction starts at a point approximate 203m in a north easterly direction from the existing Waringsford Road Junction with the A1 dual carriageway to a point approximately 322m in a south westerly direction from the same junction.

5.8.2.2 Compact Grade Separated Junction

A CGSJ has been provided where the dual carriageway intersects with Waringsford Road. The Junction allows traffic from Waringsford Road, Quarry Road and the public laneway (connecting to Graceystown Road) on the east side of the northbound carriageway to join the dual carriageway. This includes the commercial vehicle traffic associated with Tullyraine Quarries due to the existing quarry access being removed from the mainline.

The junction has been designed to comply with the requirements of 'Layout of Compact Grade Separated Junctions' (DMRB Volume 6, Section 2, Part 5, TD 40/94). The junction has been designed for a design speed of 50kph as per TD40. The minimum internal radii of the compact connector road is 40m.

Compact connector roads are nominally 7.9m wide but are curve widened to accommodate large vehicles. The proposed compact connector road at the Waringsford Road Junction is nominally 10.8m to accommodate not only large vehicles but also right turn lanes for access to Quarry Road, Waringsford Road and the public laneway (leading to Graceystown Road) on east side of the Northbound carriageway. Merge and diverge lanes and tapers provide the link to the mainline.

The merge and diverge lanes and tapers have been designed to comply with the requirements of 'Geometric Design of Major/Minor Priority Junctions' DMRB Volume 6, Section 2, Part 6, TD 42/95. The diverge has been designed as an auxiliary lane with a deceleration length of 110m with a direct taper length of 30m as per TD42. The merge has been designed as an auxiliary lane with a merging length of 130m, in addition to a merge nose of length of 40m and a taper length of 55m. The minimum width of the lane excluding hardstrips varies from 5.7m (at the nose) and 3.7m. The merge nose and auxiliary lane length is compliant with TD42, albeit TD42 specifies a merge taper as opposed to auxiliary lane and therefore a departure from standard is required. The 55m taper is compliant with the requirements of 'Layout of Grade Separated Junctions' (DMRB Volume 6, Section 2, Part 1, TD 22/06). A Design Speed of 120kph has been applied to the slip lanes.

5.8.2.3 Side Roads

As the side roads approach the new junction they are generally realigned to achieve the required connection to the compact connector road in terms of the horizontal approach to the connector road to achieve adequate junction spacing and also vertical alignment to tie-in with the connector road levels which have been set to achieve clearance over the existing dual carriageway.

Waringsford Road is generally re-graded on line while Quarry Road and the public laneway (leading to Graceystown Road) on east side of the Northbound carriageway have been realigned both horizontally and vertically.

Geometric standards of the existing roads vary significantly; however, their replacements will be designed to comply with Category S2 of 'Highway Link Design' (DMRB Volume 6, Section 1, Part 1, TD 9/93). All side roads are subject to the National Speed Limit. Any improvements or realignments to these roads should be designed to a 100kph Design Speed; however, this may be above the speed that would be appropriate for the existing roads, some of which are much narrower than would be required by modern standards with poorer visibility. As the side roads are only affected locally, it was not considered possible or pragmatic to calculate the Design Speed in accordance with the TD 9/93 method as this would involve assessing a disproportionately longer length of carriageway than was affected. Therefore in accordance with the DEM 118/16, the Design Speeds were based on measured vehicle speeds on approach to the proposed junction to determine the 85th percentile traffic speed. The speed surveys were undertaken in accordance with the requirements of 'Vehicle Speed Measurement on All Purpose Roads' DMRB Volume 5, Section 1 TA 22/81. The measured Design Speeds and carriageway cross sections are listed in Table 5.90 below:

Table 5.90 – Junction 5 Design Speed and Carriageway Cross-sections

Side Road	Existing Width		Proposed	Minimum Proposed Width	
	Carriageway	Verge	Design Speed (kph)	Carriageway	Verge
Quarry Road	3.66m-7.55m	1.70m-9.19m	60B	7.3m	2.5 RHS 2.0 LHS
Waringsford Road	5.76m-8.72m	0.72m-11.17m	85B	7.3m	2.5 RHS 1.25 LHS
Public Laneway (Leading to Graceystown Road)	3.16m-4.85m	0.5m-1.0m	60B	6.0m	1.25

5.8.2.4 **Access Lanes**

There are currently 6 no. private and 1 no. commercial accesses which access onto the mainline within the vicinity of the proposed junction.

On safety grounds, it is proposed that where possible, any existing direct access to the A1 within the vicinity of the junction, shall be closed and alternative access provided.

There are approximately 1280m of access lanes provided with a minimum width of 4m and verge widths of 1.25m to facilitate a setback distance of 450mm from the lane edge for location of safety barrier with 800mm working width should it be required. This provision is increased where access to commercial premises are required and as such turning movements are designed to accommodate design vehicles that vary with the anticipated usage of the laneway.

5.8.2.5 **Road Drainage**

Refer to Section 5.2.1.7 of this SAR for details of road drainage standards.

5.8.3 Departures from Standards

Two Departures from Standard have been identified on the mainline for reduced SSD on the southbound carriageway on approach to the horizontal curve at the overbridge location. Two Departures have been identified on the mainline for the provision of 130m of auxiliary merge lane with a 40m nose and 55m merge taper on the southbound and northbound carriageways in lieu of 130m merge taper. One Departure has been identified for provision of diverging tapers on the inside of a bend. The reduction in SSD is limited due to the location of the safety barrier in the central reserve while the departures for auxiliary lanes, additional merge taper and provision of diverging tapers on the inside of the bend are required to maintain route consistency along the A1.

The existing A1 mainline meets the desirable minimum standards as set out in ‘Highway Link Design’ (DMRB Volume 6, Section 1, Part 1, TD 9/93) for the vertical profile however there are a number of inherent departures from standard for sub-standard provision of superelevation on both the northbound and southbound carriageways in combination with a relaxation from standard for the horizontal curve which is one step below desirable minimum at 750m and one step relaxation in SSD from 295m to 215m. The superelevation provided on the northbound carriageway is 2.5% when 7% is required and superelevation on the southbound carriageway is -5% when -7% is required. The location of the proposed departures and relaxations on the mainline are shown on the drawings within Appendix C.

The compact connector road on the CGSJ were assessed for 30kph in accordance with ‘Layout of Compact Grade Separated Junctions’ (DMRB Volume 6, Section 2, Part 5, TD 40/94). One Departure has been identified on the compact connector road for carriageway width. Two Relaxations have been identified on the compact connector road for reduced SSD. The SSD has been reduced to 50m to minimise the verge widths which would have increased the requirement for fill material as well as minimise the available land within the junction for proposed sustainable urban drainage system (SuDS) Ponds. The design for horizontal and vertical curvature both meet the desirable minimum standards as set out in ‘Layout of Compact Grade Separated Junctions’ (DMRB Volume 6, Section 2, Part 5, TD

40/94). The location of the proposed departures and relaxations on the compact connector road are shown on the drawings within Appendix C.

In accordance with DEM 118/16 the preset design speed value for unrestricted carriageways i.e. those on which the national speed limit applies, shall be 100Akph however it is proposed that the Design Speed shall deviate from the preset value given the sub-standard nature of the existing roads. It was not considered possible or pragmatic to calculate the Design Speed in accordance with the TD 9/93 method as this would involve assessing a disproportionately longer length of carriageway than was affected and therefore measured vehicle speeds in accordance with TA 22/81 were assessed. Refer to Table 5.90 above for measured Design Speeds.

A number of Departures and Relaxations were identified on the side roads, these are summarised in Table 5.91 below and on the drawings in Appendix C. Table 5.91 also shows the design speed that the departures and relaxations were assessed to.

Table 5.91 – Junction 5 Side Road Departures and Relaxations

Side Road	Design Speed	No. of Departures / Relaxations	Departure / Relaxation Description
Quarry Road	60B kph	Departures 5	1 No. reduced SSD from 90m to 70m. 1 No. reduction in cross section. 1 No. reduction in vertical curvature K value from 17 of 10. 1 No. non provision of widening on curves of low radius 1 No. reduction in superelevation to 3.5%.
Waringsford Road	85B kph	Departures 6	1 No. non provision of superelevation for horizontal curvature. 1 No. reduction in vertical curvature K value from 20 of 13. 1 No. reduction in vertical curvature K value from 55 of 20. 1 No. reduction in cross section. 1 No. Reduction in Junction Visibility from 'y' distance of 160m to 48.6m(left) and 53m(right). 1 No. Reduction in Junction Visibility from 'y' distance of 160m to 56.5m.

5.8.4 Geotechnical Features

5.8.4.1 Bedrock

Refer to Section 2.5.1.5 for an overview of the bedrock geology at Waringsford Road Junction.

The bedrock in the vicinity is relatively shallow throughout, and generally highly weathered. The proposed junction layout will encounter rock between Ch. 80 – 165 and Ch. 360 – 400 where a significant area of cut is required.

5.8.4.2 Subsoil

The soil profile encountered in the Waringsford Junction is as follows:

- Topsoil: 0.0 to 0.4m bgl depth.
- Firm brown slightly gravelly sandy clay depth 0.4m bgl to 1.1m bgl
- Firm sandy gravelly clay 1.1m bgl to 4.5m bgl depth.
- Groundwater was not encountered in any of the test holes conducted in this location.

Refer also to Section 2.5.3.5.

5.8.4.2.1 Soil Testing

The PSD testing carried out at Waringsford indicates predominantly well graded overburden materials, generally described as gravelly sandy silty clays.

Samples were predominantly classified as low to medium plastic inorganic clays in the range of between 14 and 18 for plasticity. The plastic limit of samples tested ranges from 13% to 34%, with an average plastic limit of 21%.

The liquid limit ranged from 24% to 48% with an average liquid limit of 32%. The average depth tested for liquid limit and plastic limit was 1.78m. Plasticity Index's ranged from 8 to 14 with an average of 11.

NMC of samples tested indicates samples ranging from 5.8% to 46%. Average NMC is 16%.

In total 5 CBR tests were performed at the Waringsford Road Junction. The results from the CBR tests taken from BH03 indicated soil with a CBR value of 0.6%. This indicates potential for poor/soft ground and may require excavation particularly as it is in the vicinity of the overbridge foundation. The majority of other samples tested indicated relatively high CBR results. It is recommended that additional CBR test be conducted in the vicinity of BH03 and PTP01 to determine the suitable and unsuitable soil in this area.

The MCV of samples tested indicates that all samples returned a result of less than 8. This indicates that most of the soils tested are unsuitable for immediate reuse without some degree of improvement/stabilisation (e.g drying, lime stabilisation, etc).

5.8.4.2.2 Chemical Testing

Chemical testing for chloride was carried out on 1 sample. The value of chloride content obtained was 4.6mg/l.

Chemical testing for sulphate was carried out on 2 samples. The values of sulphate content ranged from <10 to 31mg/l.

pH testing was carried out on 2 samples. pH values ranged from 6.4 – 6.6. Organic matter content was in the range from <0.1 – 9.3%.

The results of the laboratory chemical testing for aggressive chemical environment for concrete classification have been assessed in accordance with BRE Special Digest 1. Laboratory sulphate analysis undertaken on soil samples indicate that buried concrete can be designed in accordance with the design sulphate class DS-1 of ACEC class of AC-1 of BRE Special Digest 1 (2005).

5.8.4.2.3 In-Situ Testing

Standard Penetration Tests were conducted at regular intervals at the Waringsford Junction. In total 9 SPT test were conducted at the Waringsford Road Junction. The majority of SPT results obtained values of 25 below a depth of 3.0m bgl. The values obtained indicate good bearing strata in the vicinity of the proposed Waringsford Road Junction.

5.8.5 Geology

Refer to Section 2.5 of this SAR for details of geology within the study area.

5.8.6 Geomorphology

The Waringsford Junction is located 2.7 miles north of Banbridge town centre. The site is rural / industrial and consists largely of farmland and extensive quarrying operations with very few residential properties within the vicinity. The proposed junction upgrade at this location will include an overbridge with associated slip road connecting the northbound and southbound mainline carriageways, and connect the Waringsford Road and Quarry Road to the grade-separated junction. The earthworks will be predominantly at, or close to grade, with embankments required on approach to the overbridge location. The section of the slip road on approach to the west bridge abutment will be on fill to a height of approximately 6.5m. The section of the slip road on approach to the east bridge abutment will be on fill to a height of approximately 9.5m.

5.8.7 Climate, Topography and Land Use

5.8.7.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.8.7.2 Topography and Land Use

The existing A1 and surrounding area at the Waringsford Road Junction is predominantly pasture with some scattered settlements to the north and west with improved and semi-improved grassland and arable fields, which are separated by poorly maintained hedgerows. Large rock quarries and aggregate processing machinery are prominent on the east side of the A1. The buildings within the study area include residential properties, quarry buildings, an industrial unit and farms.

To the south of the Junction the A1 lies at an elevation of 79.7 AOD and rises over a distance of 525m to an elevation of 82.6m AOD at the north end of the Junction.

To the east of the junction the surrounding field lies at an elevation of 83.6m AOD and falls over a distance of 96m to an elevation of 81.7m AOD. Quarry Road falls from an elevation of 91.1m AOD over a distance of 210m to its intersection of Waringsford Road at an elevation of 82.1m AOD while Waringsford Road falls from an elevation of 88.7m AOD over a distance of 198m to its intersection with the A1 at an elevation of 81.8m AOD. The commercial property to the north east of the junction lies at an elevation of 82.3m AOD. To the south east of the junction the existing quarry lies at an elevation of 80-81m AOD.

To the west of the junction the surrounding field lies at an elevation of 90.5m AOD and falls over a distance of 124m to an elevation of 81.0m AOD. The properties to the north west of the junction lie at an elevation of 90.2m AOD, 86.90m AOD and 84.3m AOD. The property to the south west of the junction lies at an elevation of 79.9m AOD, 86.90m AOD. The existing access lane (linking to Graceystown Road) falls from an elevation of 89.7m AOD to its intersection with the A1 at an elevation of 79.7m AOD over a distance of 200m.

5.8.8 Hydrology, Hydrogeology and Drainage

5.8.8.1 Drainage

The land immediately surrounding the mainline within the junction extents is predominantly permanent pasture with some scattered housing to the north and west with improved and semi-improved grassland and arable fields. Large rock quarries and aggregate processing machinery are prominent on the east side of the A1. The buildings within the area include residential properties, quarry buildings, an industrial unit and farms. The compact connector road, merge and diverge widening and realignment of side roads will involve providing a significant area of new road construction mainly through the greenfield sites however some of the private and commercial properties are affected.

Both the mainline and side roads cross minor watercourses. There are 2 No. 1100mm and 2 No. 1200mm existing culverts within the junction extents. One of the 1100mm culverts will be unaffected by the works and one of the existing 1200mm culverts will need to be diverted to accommodate the bridge abutment. It is also proposed to upgrade this length of culvert to 1500mm. The other existing culverts will need to be extended to allow the watercourses to pass beneath the new roads / road widening. These watercourses offer opportunities for drainage from the road scheme.

5.8.8.2 Pre-earthworks Drainage

Refer to Section 5.2.7.3 of this SAR.

5.8.8.3 Outline Road Drainage Design

Refer to Section 5.2.7.4 of this SAR.

5.8.8.4 Attenuation and Treatment

It is proposed that SuDS retention ponds will be utilised downstream of all proposed carriageway road drainage from the junction and side roads and upstream of the proposed drainage outfalls to reduce the impact of the proposed junction drainage waters on the receiving watercourse. Pre-earthworks drainage is required to intercept runoff from land which falls towards the junction and this drainage may also necessitate the provision of outfalls discharging directly to watercourses however where possible these will gravitate to the retention ponds.

The nature and shape of the proposed junction have influenced the SuDS proposals as they provide an area of land within the compact connector road on each side of the A1 mainline which lends itself to the inclusion of SuDS retention pond. As DfI would prefer to minimise the land take and the impact of the scheme on the local landowners, retention ponds in these locations have been chosen as the preferred form of sustainable drainage system for the scheme.

5.8.8.5 Greenfield Runoff

Refer to Section 5.2.7.6 of this SAR.

5.8.8.6 Retention Ponds

The locations of proposed ponds are shown on drawing 168014-RPSB-HDG-J5-DR-D-500-00003 which is included in Appendix G.

5.8.8.7 Culvert Design

There are no designated watercourses in the immediate vicinity of the proposed junction. An undesignated watercourse flows westwards adjacent to Waringsford Road before crossing underneath the A1. This watercourse has 2 No. 1100mm and 2 No. 1200mm existing culverts within the junction extents. One of the 1100mm culverts will be unaffected by the works and one of the existing 1200mm culverts will need to be diverted to accommodate the bridge abutment. It is also proposed to upgrade this length of culvert to 1500mm. The other existing culverts will need to be extended to allow the watercourses to pass beneath the new roads / road widening.

There are therefore two separate culvert extension structures and one culvert replacement structure required at the proposed junction. The internal dimensions of the two downstream culvert extensions are proposed at 1100mm and 1200mm diameter pipes while the upstream culvert replacement is proposed at 1500mm diameter pipe subject to agreement with DfI Rivers and future maintenance requirements.

Please also refer to Section 5.2.7.8 of this SAR.

5.8.9 Earthworks

5.8.9.1 Modelling of the Waringsford Road Junction

To accurately calculate the earthworks volume within the junction, the alignment was designed using MX Road design software. The cut and fill slopes were created at a 1:3 slope.

5.8.9.2 Analysis and Assumptions

The volumetric analysis has been carried out for the entire junction including side roads, subdivided where necessary. The following has been assumed:

- Existing carriageways have been assumed to have a construction depth of 200 millimetres.
- Average topsoil depth of 0.35m for the entire junction; and
- For the present, traffic islands have been assumed to be treated as areas of footway.

The acceptability of the excavated soft material, which does not include topsoil, has been calculated using detailed values. Using these values and carrying out further volumetric analysis within the junction area, an acceptability percentage was calculated for each type of material encountered. A summary of the Earthworks Volumes can be seen in Table 5.92 below:

Table 5.92 – Junction 5 Bulk Earthworks Summary

Works	Volume (m^3)
Excavate, Deposit and Compact – Rock	2,904
Excavate, Deposit and Compact – Acceptable Material	10,949
Excavate and Deposit – Topsoil	11,072
Excavate, Deposit and Compact – Landscaping Fill	1,000
Excavate and Dispose – Unacceptable Soft Material	33,043
Excavate and Dispose – Excess Topsoil	6,449
Import, Deposit and Compact Acceptable Fill	42,356
Compact Rock as Capping Material	2,323
Process unacceptable Material, Deposit and Compact	3,285

5.8.9.3 Material Acceptability

No major cuts encountered at J5 Waringsford.

5.8.9.4 Excavatability

Referring to the Ground Investigation Report (168014-RPSD-HGT-XX-RP-D-00001) bedrock is below formation level and has been identified BH02 at 1.1m bgl.

From the ground investigations and lab testing, the rock is indicated to be predominantly weak and moderately weathered with RQD values generally less than 20%.

For the most part, it is expected that the bedrock encountered will be possible to excavate with conventional plant with ripping being required at most.

Excavation in overburden is not envisaged to be problematic for conventional earthworks plant. However, it may be necessary to employ more robust plant for removal of large boulders. It is noted that an area to the north of the mainline will require extensive root content from the existing vegetation to be removed.

5.8.10 Land and Property Take

The following section outlines the land and property take associated with the A1 Junctions Scheme for the provision of a Compact Grade Separated Junction at the Waringsford Road. The vesting boundary land take for the scheme broken down into land categories is provided in Table 5.93 below. Two commercial properties (tin sheds) and a derelict stone building will need to be demolished to allow for construction of the proposed works.

Table 5.93 – Waringsford CGSJ Associated Land Take

Entity	Land take (ha)
Residential	0.17
Agricultural	1.31
Commercial	3.91
Publicly Owned/ Existing Road Bed	2.59
Total (Vesting Boundary)	**7.99**

5.8.11 Public Utilities

Initially all utility providers were contacted to confirm ownership of apparatus within the study area. This allowed the scheme to be developed minimising the potential impact to utility apparatus. At Stage 2 (Preferred Route Selection), details of the apparatus within the study area was requested, in accordance with a NIRAUC C2 request. The undertakers listed below provided details of their infrastructure in the study area:

- British Telecom plc (BT);
- Northern Ireland Electricity (NIE);
- Northern Ireland Water Ltd (NIW); and
- Firmus Energy

Further utility companies including Cable and Wireless, Virgin Media and Phoenix Gas were also contacted however their records did not reveal the existence of apparatus within the study area for the junction.

Upon appointment of RSC to undertake the Stage 3 Assessment, a NIRAUC C3 request was submitted to each affected utility provider, seeking preliminary details of the effects on their apparatus together with budget estimates for the works and an indication of any special requirements. Drawings indicating the location of existing services have been prepared and are summarised on drawing numbers 168014-RPSB-VUT-ML-DR-HE-100-00001 to 00014 within Appendix E. The details of the information received from each statutory undertaker is given below.

5.8.11.1 British Telecom

Telecommunications apparatus belonging to BT is affected by the proposed CGSJ at Waringsford Road and associated works.

BT has a network of both overhead and underground services throughout the area of the works. The underground system is located in the eastern verge of the existing A1 and crosses to the western verge just south of the existing Tullyraine Quarries access. The underground service also includes a spur across the A1 to the western verge just north of the proposed junction to serve the residential properties. These underground services will be relocated to the new verge of the proposed merge and diverge lanes.

The underground network is also present in the northern verge of Waringsford Road. It is proposed to disconnect and/or remove this service and provide a new underground service along the realigned Waringsford Road. This will connect to the existing underground service at the realignment tie-in point with a new cabinet provided at the proposed Jumpboxx access.

The underground network is also present in the verge of Quarry Road for length before it transitions to an overhead system. It is proposed to disconnect and/or remove the existing underground and overhead network on Quarry Road and place a new underground service within the verge of Quarry

Road which will connect to the existing overhead network at the tie-in point of the proposed realignment.

Underground services from both the realigned Quarry Road and Waringsford Road will connect to the diverted underground system within new verge on the A1 via the compact connector road.

The response to the C3 request for outline diversionary works costs indicated a cost of £56,518.04 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J5-DR-HE-100-00007 to 00010 which have been prepared for information purposes only and are contained within Appendix E.

5.8.11.2 **Northern Ireland Electricity**

Electrical apparatus belonging to NIE is affected by the proposed CGSJ at Waringsford Road and associated works.

NIE has a network of both overhead and underground services throughout the area of the works which range from MV to 33kV. There is also an NIE substation close to Tullyraine Quarries which will need to be relocated to accommodate the proposed access to the quarry. The following diversion work will be required:

- Western MV - The existing overhead MV service line which runs parallel to the existing A1 and serves residential properties (109 & 117) is to be relocated by NIE alongside the new access lane (up to the derelict building). The existing overhead MV service line along the western side of the A1 which serves residential properties (127,131 and 135) is to be recovered and disconnected by NIE (from the derelict building north). These are to be fed from a new transformer and mains cable which will come through the field north of the proposed junction.
- Eastern MV – The existing overhead line coming from Quarry Road to the substation is to be recovered and disconnected by NIE. A new underground cable is to be laid within the realigned Quarry Road from the existing overhead line at the realignment tie-in point to the realigned Waringsford Road via the proposed compact connector road. This cable will also connect to a new branch on the new Tullyraine Quarry Access.
- 11kV – A section of existing 11kV overhead lines on the western side of the junction will need to be raised to accommodate the new slip road, the other section of overhead poles/line which crosses over to the existing substation are to be recovered and disconnected by NIE. The removed section will be replaced with an underground cable coming from the raised 11kV pole across the A1 carriageway to the new substation. There is also an overhead line/poles coming from existing Waringsford Road to the existing substation which will also need to be recovered and disconnected by NIE.
- 33kV – The Existing 33kV overhead service which runs in a northeast direction roughly parallel to the east of the A1 will be recovered and disconnected by NIE. This will be replaced with a new 33kV cable.

The response to the C3 request for outline diversionary works costs indicated a cost of £204,000 (Incl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-

VUT-J5-DR-HE-100-00007 to 00010 which have been prepared for information purposes only and are contained within Appendix E.

5.8.11.3 Northern Ireland Water

Water main apparatus belonging to NIW is affected by the proposed CGSJ at Waringsford Road and associated works.

There are existing water main lines running through the fields and woodland area to the west of the A1 which are to be abandoned. What these serve is to be determined and designed accordingly.

The existing water main on the existing Waringsford Road is to be disconnected and removed. A new water main will be placed in the northern verge and shall connect into the existing at the tie-in point of the Waringsford Road. A water main shall also be provided in the new Jumpboxx access.

The existing water mains on the existing Quarry Road are to be disconnected and removed. A new water main will be placed in the new verge which will connect into the existing at the tie-in point of Quarry Road. A water main shall also be provided in the new Tullyraine Quarry access.

The proposed water mains on the realigned Quarry Road and Waringsford Road will connect to the existing system on the A1 via the verge of the new compact connector road.

All residential/commercial properties on the western side of the A1 carriageway are to be connected to the existing water mains in the A1. These will be placed within the verge areas where applicable.

The response to the C3 request for outline diversionary works costs indicated a cost of £48,377.81 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J5-DR-HE-100-00007 to 00010 which have been prepared for information purposes only and are contained within Appendix E.

5.8.11.4 Firmus Energy

Gas apparatus belonging to Firmus Energy is affected by the proposed CGSJ at Waringsford Road and associated works.

There is an existing gas main within the eastern verge of the A1 mainline which serves both Tullyraine and Gibson Bros Quarries. Two sections of this gas main will need to be diverted for the new works and the remainder of the gas main will require further protection.

The response to the C3 request for outline diversionary works costs indicated a cost of £102,465.23 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J5-DR-HE-100-00007 to 00010 which have been prepared for information purposes only and are contained within Appendix E.

5.8.12 Structures

The proposed Waringsford Road Junction would require the construction of a number of structures, summarised below:

- One two-span integral overbridge structure on the compact connector road crossing the A1 Dual Carriageway;
- Three retaining wall structures; and
- Three drainage culvert extension structures, incorporating headwall elements.

5.8.12.1 Overbridges

The following summary should be read in conjunction with Drawing 168014-RPSD-SBR-J5-DR-S-1700-00001 which is included within Appendix F.

The proposed compact connector road overbridge would be a two span structure, with two main spans of circa 19.57m, and would carry the compact connector road over the existing A1 mainline. The proposed structure would: be about 16.8m wide; have a skew of approximately 12 degrees and would be formed from precast pre-stressed concrete beams with an in-situ reinforced concrete deck slab that would be integral with the intermediate pier and abutments. The intermediate pier and abutments would be formed from discrete circular columns that would be protected by a suitable road restraint system. Aesthetically, it is proposed that a structure with a closed aspect would be provided and reinforced earth walls would be constructed at the east and west abutments in order to reduce the overall span.

The pier and abutments substructures would be constructed from reinforced concrete with spread footed or piled foundations, subject to ground conditions. A more detailed Geotechnical Investigation is planned to aid and inform this decision as part of the Construction Tender stage of the project.

Final selection of the structural form would depend on the Contractor's construction preferences and would be developed and finalised during the Pre-Construction Tender stage of the project.

Minimum headroom of 5.3m shall be provided below the beam soffit over the mainline carriageway.

5.8.12.2 Retaining Walls

The following summary should be read in conjunction with Drawings 168014-RPSD-SBR-JB-DR-S-1700-00002 and 168014-RPSD-SBR-JB-DR-S-1700-00003 which is included within Appendix F.

Three retaining walls of reinforced concrete construction are proposed within the area of Junction 5. Two of them, located in the North part of the Junction, facilitate construction of the local access road. They retain up to 1m of ground and have an L-shape cross-section with the base extending under the retained ground. Both walls are approximately 20m long.

The third wall, located in SE area of the junction, retains the embankment of Waringsford Road and the local access road to Jumpboxx and its total length along both roads is approx. 100m. The cross-section is an L-shape with base extending under the retained ground and short toe in front of the wall. The maximum retained height is approximately 3.3m.

All walls are envisaged to be constructed in 5-6m long sections. Expansion joints will be provided in every second joint (10-12m intervals) to accommodate thermal expansion and contraction. A granular permeable material with high value of internal shear angle (6N material) is proposed as a backfill with wall drainage to be installed at the back of the wall.

5.8.12.3 Culverts

Both the mainline and side roads cross minor watercourses. There are 2 No. 1100mm and 2 No. 1200mm existing culverts within the junction extents. One of the 1100mm culverts will be unaffected by the works and one of the existing 1200mm culverts will need to be diverted to accommodate the bridge abutment. It is also proposed to upgrade this length of culvert to 1500mm. The other existing culverts will need to be extended to allow the watercourses to pass beneath the new roads / road widening.

There are therefore two separate culvert extension structures and one culvert replacement structure required at the proposed junction. The internal dimensions of the two downstream culvert extensions are proposed at 1100mm and 1200mm diameter pipes while the upstream culvert replacement is proposed at 1500mm diameter pipe subject to agreement with DfI Rivers and future maintenance requirements. If an appropriate pipe dimension is not commercially available to match the existing 1100mm dia culvert, then the extension should be provided using a 1200mm dia pipe and an appropriate manhole provided at the connection point.

The exit to each culvert extension will require a headwall, flanked on each side by wingwalls, to retain the adjacent embankment. Pedestrian protection would be provided, as required. An apron section may be required between the wingwalls, for scour protection and hydraulic channel requirements. This would be confirmed at Detailed Design stage.

The structure’s internal dimensions have been determined to suit the requirements of DFI Rivers subject to agreement and to allow manual inspection of the internal faces in the future. The construction methodology will have to consider the importance of minimising disturbance to the water quality and habitat during both the temporary works phase, when any temporary diversion works to allow construction to take place would be carried out, and during the permanent works phase, where a ‘naturalistic’ granular material bedding layer may be required above any base slab of the new construction.

It is anticipated that the culverts will be formed from pipe section precast reinforced concrete elements, dependant on required internal dimensions and Contractor’s construction preference. It is anticipated that headwalls and wingwalls would be formed from discrete precast reinforced concrete elements or cast in-situ. A typical general arrangement drawing for a culvert is included in Appendix F.

5.8.12.4 Geotechnical Requirements at Structures

The A1 mainline will be at grade at this location and the overbridge abutments are recommended to be constructed as raised bankseats on shallow foundations, sitting perched within the approach embankments. The sections of the embankments underneath the bankseat foundations shall be constructed from Class 6N upfill from existing ground as a minimum. This upfill may also be required to extend below existing ground to a suitable bearing stratum, as described below.

The ground conditions in this area generally comprise sandy gravelly clay to a depth of 0.3 to 4.0m bgl, overlaying highly weathered Shale as shown below in Table 5.94. Made ground is present at the south abutment to a depth of approximately 1.5m bgl. Groundwater was not encountered in the boreholes conducted in this area. Sulphate levels in the groundwater are up to 31 mg/l with pH of 6.4. This location is classified as ACEC Class DS-1 (Buried Concrete Classification BRE Special Digest No.1).

Table 5.94 – Waringsford Overbridge Ground Conditions

Exploratory Position	Depth (m)	Soil/Rock Description	Depth (m) bgl	SPT (N)	C_u (kPa)
BH02	0.2 – 0.6	MADE GROUND			
	0.6 – 1.1	Soft brown sandy gravelly CLAY			
	1.1 – 2.1	highly fractured SHALE	1.2	50	
BH03	0.0 – 0.3	MADE GROUND			
	0.3 – 0.9	Soft brown sandy organic CLAY			
	0.9 – 3.3	Firm grey slightly sandy slightly gravelly silty CLAY.	1 2 3	6 2 24	42
	3.3 – 4.0	Soft grey sandy gravelly CLAY.	4	50	
	4.0 – 8.3	Highly weathered highly fractured SHALE			

The embankment underneath the north abutment will be founded in an area of made ground to a depth of 1.2m. It is recommended that the made ground be excavated and Class 6N upfill extended down to this level. Note that weathered bedrock is shallow here, underneath the made ground.

The embankment underneath the south abutment will be founded on silty CLAY. The SPT values recorded in this area are relatively low with an SPT of 24 located at a depth of 3.0m bgl. In order to obtain a suitable bearing stratum it is recommended that the upper 3m of overburden is excavated beneath the abutment location and the Class 6N upfill extended down to this level.

Note that as raised bankseats are recommended as the preferred solution for the abutments, the combination of settlements within the Class 6N upfill, the adjacent embankment materials, and the underlying ground, need to be considered at detailed design. Suitable hold points during the construction of the bridge will be required to ensure settlements are substantially complete prior to landing of bridge beams etc.

No testing was conducted in the location of the central pier, however with respect to the ground conditions in the area, it is envisaged that the overburden will consist of sandy gravelly silty CLAY with an SPT value of 24 at a depth of 3.0m bgl. It is assumed that bedrock is located at a depth of 4.0m bgl, based on adjacent boreholes. The central pier will be constructed at grade and will require excavation to at least 3.0m bgl depth to achieve a suitable bearing stratum from which to build up the Class 6N upfill. Further investigations at the central pier location are recommended at detailed design stage to more accurately assess the ground conditions and suitability for a shallow pad foundation.

5.8.13 Health and Safety

General health and safety issues for the scheme have been noted under the Whole Scheme section, Section 5.2.13 of this SAR; however there are some site specific risks relevant to the Waringsford Road Junction which are discussed below.

The construction of the junction will require an existing NIE substation at the north east corner of Tullyraine Quarry to be relocated. The existing substation includes an 800kVA G/M transformer which is to be recovered by NIE with a new 800kVA G/M transformer to be provided at a new location adjacent to the new private access to the quarry.

The construction of the junction will require decommission of approximately 200m of 250mm and 180mm diameter 4 bar gas main. This will be replaced with new mains to allow construction of the flyover. A temporary bypass to maintain supply to both domestic and commercial customers will have to be constructed while each of the alterations takes place.

As part of the construction of the junction, the existing direct access from Tullyraine Quarry to the A1 will be closed with a new private access to the quarry provided from Quarry Road. The contractor will be required to maintain this local access during the construction of the works and due to significant HGV traffic associated with the Quarry, the likelihood and severity of vehicular accidents due to the proximity of site traffic, site staff, public traffic and non-motorised users on the adjacent roads could be increased at this location.

As part of the construction of the new junction, it is proposed to realign Quarry Road to connect it to the proposed compact connector road. This realignment will require the demolition of approximately 325m² of agricultural / commercial outbuildings. Given the nature of these buildings, the demolition process should not be complicated however to minimise risk a specialist demolition contractor should be employed as well as using well established techniques. Asbestos surveys (in accordance with the Control of Asbestos Regulations (Northern Ireland) 2012) may need to be carried out in advance of any demolition works

5.9 CASTLEWELLAN ROAD ON-SLIP

5.9.1 Introduction

The Castlewellan Road runs east from Banbridge town centre towards Castlewellan. It crosses over the A1 via an existing overbridge adjacent to Chinauley Park estate. It is within the Green Belt policy area for Banbridge.

The Old Manse Road connects to the Castlewellan Road just east of the existing overbridge. This short link road provides an at-grade junction with the A1 and enables traffic to access both northbound and southbound carriageways of the A1, while also providing access to Banbridge and Castlewellan Road for A1 traffic travelling in both directions.

This at-grade junction was identified as having a significant volume of right turning traffic coming from the Castlewellan Road and wishing to access the A1 northbound carriageway. To facilitate this movement of traffic, it is proposed to include a slip road to the northbound carriageway from the Castlewellan Road on the west side of the existing overbridge. This will require facilitating an auxiliary lane within the existing cut slope adjacent to Chinauley Park estate, and particular retaining solutions to minimise impact on the estate, which are discussed further in this Section 5.9.12.

It is acknowledged that the closing of the central reserve at Old Manse Road will eliminate northbound A1 traffic to access the Castlewellan Road. Traffic travelling northbound wishing to access the Castlewellan Road will have to do so via the previous junction at Rathfriland Road.

5.9.2 Design Standards

The design documents and standards particularly relevant to the Castlewellan Road Junction are outlined in Section 5.2.1 of this SAR.

5.9.2.1 Mainline

In order to facilitate additional space for the Castlewellan Road slip road, and to minimise impact on Chinauley Park, it is proposed to realign the mainline carriageway further east into the central reserve. The realigned section of dual carriageway is designed in accordance with TD 9/93 – Highway Link Design. This standard classifies the upgraded mainline as a Category 6 Dual 2 Lane All Purpose Carriageway (D2AP). The standards set out the required carriageway width in Table 4 – Recommended Rural Road Layouts, with two 7.3m carriageways, 1.0m hard strips on both sides, and a central reserve with a minimum width of 2.5m.

5.9.2.2 Castlewellan Road Slip Road

The design of the Castlewellan Road slip road is designed in accordance with TD 22/06 – Layout of Grade Separated Junctions. The connector road is a parallel merge which uses an auxiliary lane and taper to allow traffic merge with northbound traffic on the A1 mainline while giving way. Adequate forward visibility is also provided in accordance with TD 9 – Highway Link Design. The possible adverse effects on forward visibility of features such as mature vegetation, lighting columns, signs and vehicle restraint systems were all considered at an early stage in the design.

5.9.2.3 Chinauley Park Junction

The realigned junction between Chinauley Park and the Castlewellan Road is designed in accordance with TD 42/95 – Geometric Design of Major/Minor Priority Junctions. The junction takes the form of a left hand splay skew junction (TD 42/95, Figure 1/5). It is an at-grade junction, at which the Chinauley Park entrance approaches the Castlewellan Road at an oblique angle and terminates at the intersection.

5.9.2.4 Drainage

Refer to Section 5.2.1.7 of this SAR for details of road drainage standards.

As the construction of the Castlewellan Road slip road is predominantly a greenfield development (i.e. not overlying existing road), it will increase the contributing hard surface area when compared with existing conditions. This additional flow will feed into the existing drainage network and will increase the loading of highway pollutants on the receiving watercourses. However, this may be offset to a small extent through increased dilution. No watercourses pass under either new or existing road within the site area.

Positive drainage is provided on both the mainline and the on-slip by means of a kerb and gully system. This system ties into the existing mainline drainage. DfI policy does not allow the use of filter drains adjacent to the carriageway as a means of providing surface water drainage and the drainage design is in keeping with this policy.

5.9.3 Departures from Standards

A departure has been identified on the A1 mainline due to inadequate median width. TD 9/93 requires a minimum median width of 2.5m. However, the proposed median runs as narrow as 1.8m in width at Ch. 225.

A relaxation is required for visibility at the Chinauley Park Junction. With a design speed of 60 kph, the desirable minimum SSD set out in TD 9/93, Table 3 is 90m. This is not achievable for vehicles exiting Chinauley Park as sightlines are obstructed by the bridge parapet on the northern side of the Castlewellan Road overbridge. A SSD of 70m, which is one step below desirable minimum, is achievable.

A departure has also been identified for the vertical alignment between Ch. 0 – Ch. 50 in Chinauley Park. The desirable maximum gradient set out in TD 9/93 is 6%. No relaxations are allowed for in the standards. As the design for this section has a gradient of 7.6%, a departure will have to be applied for.

A Departure is required for verge width on the Castlewellan Onslip as a result of the constrained landtake availability.

Refer to departure drawings 168014-RPSD-HAC-J6-DR-HE-100-00001 to 00002 included in Appendix C.

5.9.4 Geotechnical Features

5.9.4.1 Bedrock

Refer to Section 2.5.1.6 of this SAR for an overview of the bedrock geology at Castlewellan Road junction.

The bedrock in the vicinity of the Castlewellan Junction decreases in depth towards the north of the junction and is moderately weathered throughout. The proposed junction layout will encounter rock between Ch. 100 – 550 where cut is required. The proposed piled retaining walls will encounter rock and will require rock socketing.

5.9.4.2 **Subsoil**

The soil profile encountered in the Castlewellan Junction is as follows:

- Sandy gravelly silt 0.0m to 1.0m bgl
- Very stiff grey brown sandy gravelly silt with some cobble and boulders 1.0m bgl to 4.0m bgl
- Groundwater was not encountered in any of the test holes conducted in this location.

Refer also to Section 2.5.3.6.

5.9.4.2.1 Soil Testing

The PSD testing carried out at Castlewellan indicates a well graded overburden, generally described as sandy gravelly silts and clays, with a fines content of approximately 30%.

Samples were predominantly classified as low to medium plastic inorganic clays. The plastic limit ranges from 17% to 22%, with an average plastic limit of 19.5%.

The liquid limit ranged from 32% to 42% with an average liquid limit of 36%. The average depth tested for liquid limit and plastic limit was 1.75m. Plasticity Index's ranged from 15 to 20 with an average of 17.25.

NMC of samples tested indicates that the samples have NMC's ranging from 8.1% to 20%. Average NMC is 14.8%.

CBR tests were not carried out on samples taken from Castlewellan Road.

The MCV of samples tested indicates that all samples had an MCV greater than 8. This indicates that the soils tested are suitable for immediate reuse without treatment.

5.9.4.2.2 Chemical Testing

Chemical testing was not conducted on the samples taken from the Castlewellan Junction.

5.9.4.2.3 In-Situ Testing

Standard Penetration Tests were conducted at regular intervals in the exploratory holes at Castlewellan Road. In total 13 SPT test were conducted. The majority of SPT results obtained were lower than 20 up to a depth of 7.0m bgl. The values obtained indicate a poor bearing strata in the overburden, however it is noted that rock head is relatively shallow in this area, rising in a northerly direction to approximately 3.5m bgl.

5.9.5 Geology

Refer to Section 2.5 of this SAR for details of geology within the study area.

5.9.6 Geomorphology

The Castlewellan Road Junction is located approximately 1 mile east of Banbridge town centre. The site is near residential developments particularly Chinauley Park estate which is directly west of the proposed junction. The Castlewellan Road junction consists of a northbound slip road from the existing Castlewellan Road overbridge linking to the A1 northbound carriageway. The slip road will be partially cut into the existing mainline cut slope and proposed to be supported by a piled retaining wall to minimise the extent of cutting into Chinauley Park.

5.9.7 Climate, Topography and Land Use

5.9.7.1 Climate

The climate in relation to the whole scheme is discussed in Section 5.2.6 of this SAR.

5.9.7.2 Topography and Land Use

Land use in the vicinity of the proposed junction is primarily residential with Chinauley Park and Bramblewood Drive located to the west of the A1. On the south-west side of the bridge, the land falls away towards the River Bann. The south side of Castlewellan Road is built up on embankment. The hillside immediately southeast of the bridge is open pasture with views across the valley from Castlewellan Road.

Apart from the residential dwellings, semi-improved and improved grassland is the dominant land-cover type. The River Bann is also present to the south of the proposed junction location. The agricultural land which occupies the southern section of the study area consists primarily of improved grassland with hedgerows.

At the southern end of the site, the A1 lies at an elevation of 61.5m OD and rises over a distance of 800m to an elevation of 78.0m OD at the northern extremity of the site.

5.9.8 Hydrology, Hydrogeology and Drainage

5.9.8.1 Drainage

The land immediately surrounding the mainline within the junction extents is predominantly a built up area comprising roads and residential properties. The proposed On-slip and merge lane will provide a significant area of new road construction mainly through the existing verges greenfield / verge areas.

There are no watercourses within the vicinity of the proposed On-Slip however there is an existing drainage system within the A1 mainline carriageway. This existing drainage network provides an opportunity for discharge of drainage from the road scheme.

5.9.8.2 **Pre-earthworks Drainage**

Refer to Section 5.2.7.3 of this SAR.

5.9.8.3 **Outline Road Drainage Design**

The construction of the proposed Castlewellan Slip Road is not considered to significantly increase road run-off in this vicinity. The slip road is already being constructed in the footprint of the original earthworks cutting. While there will be an increase in the impermeable area due to the slip road pavement itself, it is considered that the percentage increase in the context of the receiving drainage network on the A1 is very minor. The existing A1 road catchment is approximately 40,000m2, which spans from the River Bann crossing at the low point to approximately 1.4 km to the north at the high point. The additional pavement area created by the slip road is approximately 2,600m2 which represents an increase in the order of 0.065% of the overall catchment area draining via the same outfall.

The drainage system on Castlewellan slip road is proposed to comprise of a kerb and gully system, outfalling to manholes and connecting to the existing pipe network running in the verge of the A1 carriageway. Sub-surface drainage is proposed to include narrow filter drains to keep the sub-base and capping free draining, and this can outfall to each manhole chamber.

Additional flow control, can be incorporated at the outfall to ensure no increase in run off rate into the River Bann at this location. Furthermore, the pollution control facilities can be upgraded to cater for treatment of the additional run off.

Refer also to Section 5.2.7.4 of this SAR.

5.9.8.4 **Attenuation and Treatment**

It is proposed that online storage attenuation will be utilised as a SuDS solution immediately downstream of all proposed carriageway road drainage from the On-slip to reduce the impact of the existing A1 drainage network.

5.9.8.5 **Greenfield Runoff**

Refer to Section 5.2.7.6 of this SAR.

5.9.9 Earthworks

5.9.9.1 **Bulk Earthwork Quantities**

Table 5.95 provides a summary of the bulk earthworks quantities at J6 Castlewellan Road.

Table 5.95– Junction 6 Bulk Earthworks Summary

Works	Volume (m^3)
General excavation	3,870.00
Extra Over for Excavation in Hard Material (rock)	301.05
General fill	1,000.00
Capping	1,770.80
Disposal of excavated material (non-hazardous)	3,870.00

5.9.9.2 Material Acceptability

5.9.9.2.1 Cut 4 – J6 Castlewellan

Few testing results are available for the material in Cut 6 at Castlewellan Slip Road. However there is unlikely to be significant material being excavated here as part of the permanent works, particularly if a piled retaining wall solution is pursued. The new cut slope for the slip road will effectively chase the grade of the existing.

5.9.9.3 Excavatability

Referring to the Ground Investigation Report (168014-RPSD-HGT-XX-RP-D-00001) bedrock is below formation level and has been identified BH03 at 3.5m bgl.

No RQD values are available from the available archive exploratory hole data for this location, which was not investigated as part of the most recent ground investigation works. In the absence of such site-specific ground information, however, which is required, it is envisaged that the rock could be similar to the rest of the scheme

For the most part, it is expected that the bedrock encountered will be possible to excavate with conventional plant with ripping being required at most.

Excavation in overburden is not envisaged to be problematic for conventional earthworks plant. However, it may be necessary to employ more robust plant for removal of large boulders.

5.9.10 Land and Property Take

All land take required for the construction of an On-Slip Road at Castlewellan Road junction consists of land which is already publicly owned. Land take is being carried out in order to update the registered owner to the Department for Infrastructure. A total land area of 4.38 hectares is being vested to provide the On-Slip at Castlewellan Road. Surrounding landowners may be affected by temporary works, accommodation works and impacts due to noise and vibration.

5.9.11 Public Utilities

Initially all utility providers were contacted to confirm ownership of apparatus within the study area. This allowed the scheme to be developed minimising the potential impact to utility apparatus. At Stage 2 (Preferred Route Selection), details of the apparatus within the study area was requested, in accordance with a NIRAUC C2 request. The undertakers listed below provided details of their infrastructure in the study area:

- British Telecom plc (BT);
- Northern Ireland Electricity (NIE); and
- Northern Ireland Water Ltd (NIW);

Further utility companies including Firmus, Cable and Wireless, Virgin Media, Eircom and Phoenix Gas were also contacted however their records did not reveal the existence of apparatus within the study area for the junction.

Upon appointment of RSC to undertake the Stage 3 Assessment, a NIRAUC C3 request was submitted to each affected utility provider, seeking preliminary details of the effects on their apparatus together with budget estimates for the works and an indication of any special requirements. Drawings indicating the location of existing services have been prepared and are summarised on drawing numbers 168014-RPSB-VUT-ML-DR-HE-100-00001 to 00014 within Appendix E. The details of the information received from each statutory undertaker is given below.

5.9.11.1 British Telecom (BT)

Telecommunications apparatus belonging to BT is affected by the proposed On-slip at Castlewellan Road and associated works.

BT has a network of both overheads and underground services on Castlewellan Road. The underground network is also present in Chinauley Park. Subject to further consultation with the statutory undertaker, the underground service crossing the Castlewellan Road at Ch. 160 may need to be diverted as it crosses below the south western end of the proposed slip road. It is not anticipated that any further works will be required.

The response to the C3 request for outline diversionary works costs indicated a cost of £10,489.51 (Excl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J6-DR-HE-100-00010 to 00012 which have been prepared for information purposes only and are contained within Appendix E.

5.9.11.2 Northern Ireland Electricity (NIE)

Electrical apparatus belonging to NIE is affected by the proposed on-slip at Castlewellan Road and associated works.

NIE has a network of underground services throughout the area of the works which range from MV to 33kV. There is also an overhead 33kV line on the east side of the A1 carriageway running roughly parallel with the A1. The following diversion work will be required:

- 33kV – The existing 33kV underground service which runs in an easterly direction in the northern footway of the Castlewellan Road is to be disconnected and recovered between Chinauley Park and the east side of the bridge. This will be replaced with a new 33kV cable laid at a suitable depth.

The response to the C3 request for outline diversionary works costs indicated a cost of £18,000 (Incl. VAT). The response was supplemented with drawings indicating the location of proposed diversionary works. The location of the proposed diversions are summarised on drawing numbers 168014-RPSB-VUT-J6-DR-HE-100-00010 to 00012 which have been prepared for information purposes only and are contained within Appendix E.

5.9.11.3 Northern Ireland Water (NIW)

No protection works or diversions are envisaged for NIW services within the study area. However, considerable care will be required while working in proximity of the two water mains on the southern side of Castlewellan Road. Considerable care will also be required for the water main running along the north western side of Chinauley Park.

5.9.11.4 Firmus Gas

A Firmus Gas supply main is located in the existing A1 northbound verge. It is approximately 1.3m – 1.4m away from the kerb line. The location of this service coincides with the location of the proposed on-slip merge onto the A1. The gas line in this area is a 250mm PE 100 4 bar N. The following are the protection cover values required by Firmus Gas;

- Carriageway: 1.0m
- Carriageway (absolute minimum): 0.6m (with steel plate protection)
- Grass / Verge: 0.75m

It is highlighted that the two piled retaining walls are proposed to be constructed in the vicinity of this gas main. These structures comply with the statutory undertaker's requirement to be a minimum of 0.5m from the gas line. The north western structure passes within 2.78m of the line while the south eastern structure is a minimum distance of 8.47m away from the service.

Although the structures do not impact directly on the pipe, their construction poses considerable risk to the gas main. Considerable care should be taken and stringent safety measures implemented by the contractor during all piling and rock excavation activities in the area.

In order to maintain minimum cover under the proposed slip road, it may be required to provide concrete slab or steel plate protection to the gas pipeline. This will need to be agreed with Firmus Gas. Subject to consultation with Firmus Gas, it may otherwise be required to lower the gas main from Ch. 250 – Ch. 500 along the mainline in order to achieve minimum cover of 0.6 – 1.0m below carriageway level on the proposed merge lane.

For any sections of pipeline from Ch. 250 – Ch. 500 where adequate cover (0.6m) can be achieved without the need for lowering, concrete slab or steel plate protection should be provided.

5.9.12 Structures

5.9.12.1 Retaining Walls

The following summary should be read in conjunction with Drawings 168014-RPSD-SBR-J6-DR-S-1700-00009 to 00011 which are included within Appendix F.

450m and 40m long secant pile retaining walls will be required to allow construction of the slip road within the confines of the existing embankment. The walls will vary from approximately 0.5m to 5m in height.

The embedment depth of piles will be determined by the extent to which they need to socket into the shallow bedrock, which ranges from approximately 7m to 3.5m bgl. This will typically be in the region of 5m.

Buildability of the piled walls and stability of a temporary working platform are discussed in Section 5.9.12.3 below.

The existing embankment has mature planting and all possible effort will be made to retain as much of the existing vegetation as possible. Existing screening will be replaced following completion of the road and retaining wall construction.

Due to the removal of existing vegetation and the construction of a new slip road between Chinauley Park and the existing A1 carriageway, a noise/visual screen is proposed to be installed along the extent of the slip road, within Chinauley Park.

5.9.12.2 Ground Conditions

The ground conditions in this area comprise of overburden of sandy gravelly silt with occasional cobbles and boulders, to a depth of between 3.5m bgl to 8.7m bgl. Weathered Shale is beneath this, and is rising towards the north of the slip road. Refer to Table 5.96 below. Groundwater was not encountered in the boreholes conducted in this area. Chemical testing was not conducted on the samples taken from these boreholes.

Table 5.96 – Castlewellan Retaining Wall Ground Conditions

Exploratory Position	Depth (m)	Soil/Rock Description	Depth (m) bgl	SPT (N)	C_u (kPa)
PBH01	0.0 – 8.7	Very stiff gravelly SILT with cobbles and boulders	1.7 3.4 5.0 6.4 7.9	38 31 32 37 50	
	8.7 – 14.0	Moderately weathered SHALE			
PBH02	0.0 – 6.8	Very stiff gravelly SILT with cobbles and boulders	1.1 2.9 4.4 5.9 6.9	25 47 37 50 50	
	6.8 – 12.0	Moderately Weathered SHALE			
PBH03	0.0 – 5.3	Very stiff gravelly SILT with cobbles and boulders	1.9 4.1 5.5	50 47 50	
	5.3 – 9.5	Moderately Weathered SHALE	5.3	65	
PBH04	0.0 – 3.5	Very stiff gravelly SILT with cobbles and boulders	3.6	50	

5.9.12.3 Buildability

5.9.12.3.1 Retaining Wall Construction

It is proposed that the retaining walls on either side of the slip road will be secant pile walls. Continuous Flight Auger (CFA) piling of 900mm diameter piles is one possible construction method which has been considered. In order to construct the retaining wall on the north western side of the slip road, a temporary working platform is likely to be needed. A technical note assessing the feasibility of constructing a temporary granular embankment to support a piling rig is included in Appendix F to this report. This note includes drawings indicating the proposed construction method for the temporary platform.

An extract from the slope stability assessment for the temporary working platform is shown in Figure 5.12. It is proposed that from Ch. 100 – Ch. 300 along Castlewellan Slip Road that the platform should be constructed with a 1V:1.5H side slope. From Ch. 300 – Ch. 500, the platform should have a 1V:1H side slope, due to tighter space constraints. Selected granular fill with a minimum shear angle (Ø’) of 45° is assessed to be required to construct the temporary working platform.

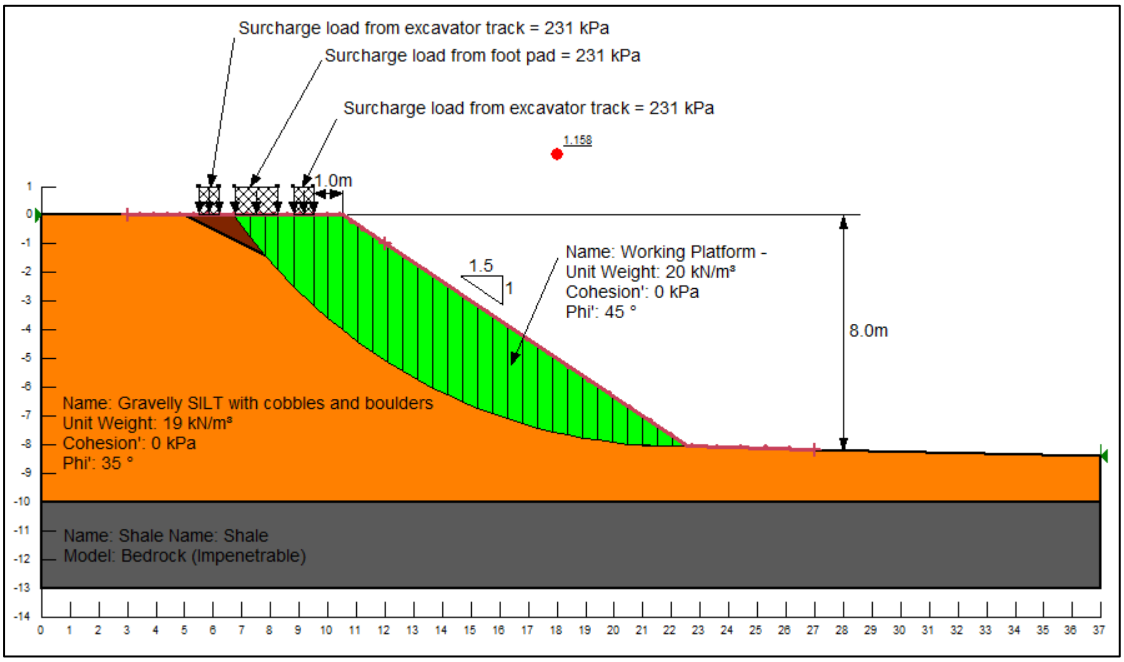


Figure 5.12 – Castlewellan Road On-Slip – Temporary Working Platform Slope Stability

5.9.12.4 **Construction Sequence**

The most significant elements of construction at Castlewellan junction are the piled retaining walls for the slip road. These walls will need to be constructed early in the sequencing. Once a sufficient level of site clearance has been done (noting that trees are to be retained where possible), the temporary working platform for the piling rig should be built up. This will allow the western (longer) piled wall to be constructed first. The eastern (shorter) piled wall can be constructed once excavation is carried out to a suitable level in front of the western wall.

Once the walls are completed, the slip road can be constructed. The realignment of the A1 northbound mainline carriageway will need to be completed prior to the completion of the slip road tie-in works.

The remaining works at Chinauley Park will include the amendments to the junction layout and the landscaping and environmental screening works adjacent to the mainline cut slope.

5.9.13 Health and Safety

General health and safety issues for the scheme have been noted under the Whole Scheme section, Section 5.2.13 of this SAR; however there are some site specific risks relevant to the Castlewellan Road Junction which are discussed below.

The gas main in the western verge of the A1 poses a significant hazard. Firmus Energy should be liaised with, as protection works or diversions may have to be carried out during the construction of the slip road and the retaining walls.

Hazards posed by other public utilities are considered to be minimal for this junction. However, the overhead powerlines crossing the Castlewellan Road to the east of the A1 mainline do pose a threat to machinery with extending arms such as excavators and piling rigs. These cables are clearly visible on site and the risk can be minimised using well established techniques.

6 ENVIRONMENTAL ASSESSMENT

6.1 INTRODUCTION

As outlined in DMRB TD 37/93 Preparation of the Stage 3 Report, the Environmental Assessment of the scheme has been undertaken and reported on within the Environmental Impact Assessment Report, Document No. 168014-RPSB-EGN-XX-RP-EN-00002.

7 TRAFFIC ASSESSMENT

7.1 INTRODUCTION

This chapter provides an overview of existing traffic conditions, transport model development, traffic forecasting and potential impacts of the proposed scheme, compared to a Do-Minimum scenario.

The following sections of this chapter describe existing traffic conditions, modelling assumptions, traffic forecasting, and the assessment of effects of the proposed development on the road network.

7.2 METHODOLOGY

The traffic and economic assessment of the proposed scheme was undertaken using a spreadsheet model developed during the Stage 2 assessment. This spreadsheet model was refined following a data collection exercise which updated the model to a base year of 2016.

The model was used to assign forecasts of travel demand to determine the effects of the proposed scheme compared to the Do-Minimum scenario, with an assumed 2021 year of opening for the scheme, and a 2036 design year (15 years post-opening). The model has been used to inform the design of the proposed scheme, and undertake the traffic-related operational, environmental and economic assessments.

The model has been used to determine changes to traffic flows. These outputs were then input to the DfT COBA (***CO***st ***B***enefit ***A***nalysis) software version 11.19.0.1 to identify the economic benefits of the proposed scheme compared to the Do-Minimum scenario. Outputs from the model have also been provided for the air quality, and traffic noise and vibration assessments.

The following sections of this chapter describe existing traffic conditions, modelling assumptions, traffic forecasting, and the assessment of effects of the proposed scheme on the road network.

7.3 EXISTING TRAFFIC CONDITIONS

Refer to Section 2.3 of this SAR for details of existing traffic conditions within the study area.

7.4 TRAFFIC IMPACT ASSESSMENT

7.4.1 Traffic Modelling

A comprehensive data collection exercise was undertaken in 2016 and 2017 to inform traffic modelling. More detail on these surveys is available in the A1 Traffic Data Collection Report in Appendix H.

The traffic model has been developed based on the existing road network and scheme proposals. The implications for traffic movements arising from the scheme primarily affect those who currently turn right onto or off the dual carriageway. The traffic assessment has considered how these movements reassign when the scheme is in place at each respective public road junction. Given the scale of likely overall impacts to traffic of the scheme, a spreadsheet model approach is considered proportionate. A fixed demand approach is also considered appropriate as it is not anticipated that introduction of the scheme would result in induced demand or changes to mode choice.

For the purposes of the assessment, assumptions have been made about how vehicles will reassign. Right turns onto the A1 that would be prevented as a result of the scheme have been reassigned to either turn left onto the A1 and then u-turn at a suitable junction or use the minor road network to access the A1 further downstream, depending on which route is most attractive in terms of time, distance or road suitability.

Right turns off the A1 that would also be prevented as a result of the scheme have been reassigned to either travel further down the A1 to u-turn at a suitable junction or leave the A1 earlier and access via the minor road network, again depending on which route is most attractive. Each junction location has been considered individually. The resulting flows at each of the existing and proposed grade separated junctions along the A1 have also been calculated.

It is assumed that demand is fixed between the Do-Minimum (without scheme) and Do-Something (with scheme) scenarios. All changes to flows between the two scenarios are due to local reassignment for right-turning vehicles that must divert with the scheme in place. A full diagram of traffic flows and turning movements for the study area for all modelled scenarios has been presented in the Scheme Assessment Report in Appendix H.

7.4.2 Traffic Forecasting

Forecast traffic flows are required for various assessments in the Stage 3 process at both the scheme opening year (2021) and the design year which is fifteen years after opening (2036).

In order to predict traffic growth, ideally it is necessary to provide an estimation of potential growth in housing, population and employment from the present time to the forecast years. These factors are used to define future car ownership and usage and hence the potential growth in traffic between areas.

In the UK, this process uses TEMPRO (Trip End Model Presentation Program) software which has been developed by the DfT for predicting the growth in travel demand but excludes Northern Ireland. A bespoke version of TEMPRO for Northern Ireland, known as TEMPRO-NI, was developed in 2011.

The DfI have advised that TEMPRO-NI is currently undergoing an update and is not currently available for use on this project. Traffic growth assumptions have therefore been based on growth trends from local ATC data. Annual growth for local ATC sites is presented in Table 7.1 below.

Table 7.1 – Annual Growth for local ATC Sites

AADT		Year											
Site No	Location	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Site 522	Lisburn		10.8%	0.6%	5.2%	-0.3%	2.0%	-2.4%	-0.1%	4.5%			5.1%	
Site 530	Hillsborough		3.3%	6.3%	3.3%	3.5%			6.7%	-0.9%	-3.4%	10.5%	-1.3%	
Site 410	Dromore		0.9%	4.0%	5.9%	0.7%						3.8%	2.9%	4.5%
Site 411	Banbridge		-1.2%	4.4%	8.6%	2.3%	1.8%	-2.9%	3.5%	3.3%	-1.1%	8.0%	2.4%	
Site 419	Loughbrickland		0.6%			4.3%	-0.5%	3.1%	6.1%	2.7%	1.3%	5.7%	6.1%	4.2%

An average annual growth factor for 2005 to 2016 has been determined from the local ATC sites. This has been calculated as 3.02% growth per annum. This period includes a recession and period of recovery. This observed growth rate exceeds forecasts predicted in the National Road Traffic Forecasts (NRTF) 1997, which have been replaced by forecasts from the DfT’s National Transport Model. The observed local growth rate has been used to produce the core forecast scenarios for opening and design years.

To account for the uncertainty inherent in forecasting and in line with WebTAG guidance, the Do Something Scenario comprises Core, Low Growth, and High Growth Scenarios. All Do Something scenarios incorporate the proposed changes to the network, which include junction closures, the banning of right turn movements, and junction improvements.

High and low growth scenarios can be used to account for the uncertainty inherent within national trends of GDP growth, fuel price trends and vehicle efficiency changes. This allows testing of whether a scheme is still effective or creates adverse effects under high demand assumptions or if it is still economically viable under low demand assumptions.

The high growth scenario consists of forecasts that are based on a proportion of base year demand added to the demand from the core scenario.

The proportion of base year demand to be added is based on a parameter p. The proportion is calculated as follows:

- for 1 year after the base year, proportion p of base year demand added to the core scenario;
- for 36 or more years after the base year, proportion 6*p of base year demand added to the core scenario;
- Between 1 and 36 years after the base year, the proportion of base year demand should rise from p to 6*p in proportion with the square root of the years. (So, for example, 16 years after the base year the proportion is 4*p).

For highway demand at the national level, WebTAG advises the value of p should be 2.5%.

The local growth rate (3.02% per annum) will be used to produce ‘Core’ forecast flows at 2021 and 2036 starting from a base year of 2016. This core scenario also includes elements of planned development that can reasonably be expected to be delivered by the specified forecast year.

To calculate growth between the 2016 base year and 2021 opening year, a 3.02% per annum rate would equate to 16.04% growth over the five year period. Multiplying ±2.5% by the square root of five years (2.236) would give 5.59%, therefore meaning that the ‘Low Growth’ scenario growth rate would effectively be 10.45% over the five years and 21.63% over the five years for the ‘High Growth’ scenario.

The three growth scenarios for a 2021 opening year are as follows:

- 'Core' local growth of 3.02% per annum (i.e. 16.04% growth from 2016 to 2021);
- 'Low Growth' i.e. 10.45% growth from 2016 to 2021; and
- 'High Growth' i.e. 21.63% growth from 2016 to 2021.

The three growth scenarios for a 2036 design year are as follows:

- 'Core' local growth of 3.02% per annum (i.e. 81.31% growth from 2016 to 2036);
- 'Low Growth' i.e. 70.13% growth from 2016 to 2036; and
- 'High Growth' i.e. 92.49% growth from 2016 to 2036.

WebTAG advises that local sources of uncertainty categorised as near certain should be included in the core scenario, whilst all sources categorised as hypothetical should be excluded. Between these two categories, an element of judgement may be required, but usually it would be expected that those inputs categorised as more than likely will be included in the core scenario, whilst those categorised as reasonably foreseeable will be excluded.

An uncertainty log is a record of assumptions made for a transport model that will affect travel demand and supply. The purpose of the uncertainty log is to record the central forecasting assumptions that underpin the core scenario and record the degree of uncertainty around these central assumptions. These assumptions will be the basis for developing a forecast scenario.

Developments have been classified in the uncertainty log as follows:

Table 7.2 – Uncertainty Log for A1 Junctions Phase 2 (Stage 3)

PROBABILITY OF THE INPUT	PROPOSED DEVELOPMENTS
Near certain	- Bridgewater Park – Retail and Industrial Park - Smaller developments within Lisburn and Banbridge Area Plans
More than likely	- Smaller developments within Lisburn and Banbridge Area Plans
Reasonably foreseeable	
Hypothetical	- Sprucefield Application

The Bridgewater Park – Retail and Industrial Park has been included in the core scenario. It is assumed that smaller developments listed in the Lisburn and Banbridge Area Plans will be accounted for within the local growth rates. Development flows have been added to forecast scenarios in addition to background growth.

Resultant traffic flows from the forecasting process at key locations are presented in Table 7.3 – Forecast Two-way AADT Flows. A full diagram of traffic flows and turning movements for the study area for all modelled scenarios has been presented in Appendix H.

Table 7.3 – Forecast Two-way AADT Flows

	Low		Core		High	
	2021	2036	2021	2036	2021	2036
Lisburn	49550	75239	51948	80035	54346	84831
Hillsborough	42205	63856	44221	67888	46238	71921
Dromore	38988	58502	40816	62157	42644	65813
Banbridge	34550	51402	36129	54559	37707	57716
Loughbrickland	30589	46533	32082	49519	33575	52506

7.4.3 Construction

The proposed construction period for the scheme is approximately 30 months. It has been assumed that construction activities would be undertaken during the daytime (08.00 to 19.00 Monday to Friday and 8.00 to 16.30 on Saturday). The bulk earthworks generate the most HGV movements to and from the site, a cut / fill balance will try to be achieved where possible, to limit the impact of haulage onto the road network. Left in left out junctions and closure of the central reserve cannot be undertaken until an alternative route is available for traffic i.e. new compact junctions.

A hypothetical worst-case scenario for construction traffic assumes the following:

Operation 1:

- Bulk earthworks quants associated with J1-J6 = 407,530m^3 (compact grade separated junction)
- 3 months period for earthworks

Operation 2:

- Bulk earthworks quants associated with LILOs, gaps etc. = 202,120m3
- 3 months period for earthworks

- 10hr working day
- Assume 10 m^3 capacity per vehicle
- AADT in 2021 at Hillsborough = 44,200
- AADT in 2021 at Loughbrickland = 35,000

This results in a maximum of 679 one-way trips per day, and 1358 trips per day when considering return trips. This equates to an extra 136 trips per hour. This will result in an additional impact of 3% at Hillsborough or 4% at Loughbrickland, depending on the direction construction traffic would take.

7.4.4 Traffic Mitigation During Construction

The scheme construction is anticipated to be undertaken in a sequence that minimises disruption to existing traffic on the trunk road and local connections. A Traffic Management Plan will be developed by the contractor detailing a phased construction programme. During construction existing capacity would generally be maintained on the A1 in both directions so that disruption would be minimal. There may be occasional exceptions to this where short-term lane closures would be required to allow certain elements of work to be completed. Occasional night and Sunday working would be required for some activities (e.g. carriageway tie-ins) to minimise traffic disruption on the local road network. Construction activities would create additional traffic movements and some activities would require traffic management measures. Noise limits would be controlled by requirements in the contract documents.

7.4.5 Operational Traffic Effects

The improvements to the A1 and its junctions will improve junction capacity and the reliability and safety of the strategic transport network in the area. The scheme will provide a more consistent route and improved safety by closing gaps in the central reserve to ban right turn and u-turn manoeuvres. Provision of a central reserve barrier along the length of the corridor will improve safety as errant vehicles will no longer be able to drift across the central reserve towards oncoming traffic. This is predicted to have a moderate beneficial effect. Other benefits include a more consistent route design and more reliable journey times.

The proposals prohibit all right turn, u-turn and crossover movements through the installation of a continuous central reserve barrier, upgrading at grade junctions to LILO's and the provision of new compact grade separated junctions (CGSJ). The proposals remove central reserve and cross over manoeuvres at 21 at grade junctions, with a further 9 junctions fully closed and 6 junctions incorporated into 4 new CGSJ's, a new slip road and a new link road to an existing CGSJ, adding to the existing 8 grade-separated junctions within the study area.

A degree of re-routing will occur as a result of the improvements leading to increases in flows in some sections and longer journey times and distances travelled for some trips. However, it is assumed that the operational effect of this will be minimal with affected traffic exiting at the closest available junction and performing a u-turn, and traffic from side roads re-routing to the nearest available junction. Any increase in traffic due to this re-routing is anticipated to be well within the operating capacity of the local road network. The model shows that re-routing traffic will form less than 10% of the overall flow on the mainline at any point on the scheme and is considered to have a negligible effect. The junctions with the largest change in flow are the existing and proposed grade-separated junctions, due to U-turns for trips to partially-closed and fully-closed junctions.

Vehicles that currently slow down to turn right off the A1 will be re-routed, thereby removing delays for vehicles travelling in the offside lane. This is expected to marginally improve overall journey times for strategic traffic, thereby improving reliability as a minor beneficial effect. Network reliability will also be enhanced by a reduction in the number of collisions, which will in turn reduce the number of major incidents requiring partial or full closures of the A1.

7.4.6 Chinauley Park Microsimulation

During public consultation, local residents of the Chinauley Park Estate raised concerns that the proposed Castlewellan Road northbound merge slip would adversely affect the operation of the adjacent junction with Chinauley Park, restricting access to the Chinauley Estate during peak times. A microsimulation model has been developed using Paramics Discovery software to assess the operation of the proposals at this location for the opening year. The model represents traffic flows during the peak hours of 0800-0900 and 1700-1800.

A microsimulation traffic model is a time-step and behaviour-based computer simulation representing individual vehicles on a road network. The model network is constructed to scale using detailed mapping. Roads and junctions are simulated using a network of nodes and links. Additional coding represents speed restrictions, give-way rules and traffic signals, which simulated vehicles will adhere to. Micro-simulation models seek to represent the random variability of traffic networks. Each simulation run of a model is different and shows a possible outcome for the modelled system. To provide a robust set of results, a number of simulation runs are undertaken and statistics are collected from all runs.

An Automatic Number Plate Recognition survey was undertaken in April 2018 to provide existing traffic movements in the area, shown in Figure 7.1. This provided origin-destination data at the existing priority junction of Castlewellan Road and Chinauley Park. The ANPR survey also provided journey times between survey points for use in validation of the model. Queue length data was also taken to understand whether there are any existing capacity issues at this location and for use in calibration of the model.

Figure 7.1 – ANPR Survey Locations

A base model was constructed using Ordnance Survey background mapping and aerial photography. The base model has been calibrated and validated to WebTAG Unit M3.1 criteria. 100% of traffic flow comparisons to observed data exceed WebTAG criteria with GEHs less than 5 and less than 100 vehicles difference. 100% of journey time comparisons to observed data exceed WebTAG Unit M3.1 criteria of being within 15% or 1 minute. Full calibration and validation data is presented in Appendix H. The base model is deemed to be a good representation of existing conditions and fit for the purpose of assessing changes proposed at this location.

Forecast traffic flows from the spreadsheet model have been applied to the Paramics model to create 2021 Do Minimum and Do Something scenarios. The Do Minimum model represents a scenario with 2021 traffic flows and no proposed scheme is in place i.e. vehicles continue to access the A1 northbound via the existing junction with Old Manse Road. The Do Something represents a scenario with 2021 traffic flows and the proposed scheme in place. Northbound vehicles access the A1 via the proposed northbound merge slip and the right-turn from Old Manse Road to A1 northbound is closed. The northbound slip is assumed to operate as a priority junction with Castlewellan Road. A comparison of the Do Minimum and Do Something Paramics model scenarios allows an operational assessment of impacts of the scheme at this location. The Do-Minimum and Do Something model networks are illustrated in Figures 7.2 and 7.3.

Figure 7.2 – Paramics Model – Do Minimum Scenario

Figure 7.3 – Paramics Model – Do Something Scenario

Movement references used for the journey time routes are presented in Figure 7.4. The journey time data presented in Tables 7.4 and 7.5 indicate that journey times for vehicles travelling through the Castlewellan Road/Chinauley Park junction have either decreased or remained similar after the introduction of the scheme. The modelling predicts either an improvement or very similar operation of the existing junction with the scheme in place for different journey time routes.

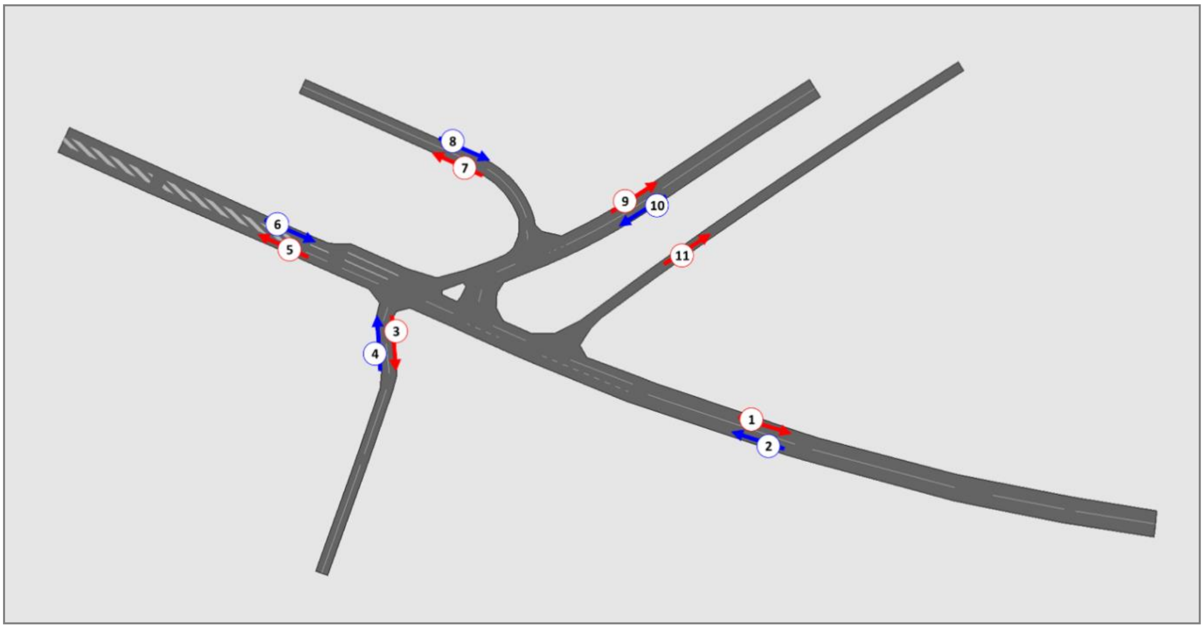


Figure 7.4 – Journey Times Movement References

Table 7.4 – AM Journey Times through Castlewellan Road/Chinauley Park

		Journey Time (s)			
	Movement	**BASE AM**	**DoMin AM**	**DoSom AM**	**DoSom - DoMin**
0800-0900	2-3	18	18	17	-1
	2-5	20	20	20	0
	2-7	21	22	20	-2
	2-9	23	23	22	-1
	4-1	23	29	18	-11
	4-5	15	16	11	-5
	4-7	-	-	-	-
	4-9	-	-	-	-
	6-1	20	20	20	0
	6-3	17	17	11	-6
	6-7	13	13	13	0
	6-9	15	16	13	-3
	8-1	22	24	23	-1
	8-3	-	-	-	-
	8-5	21	24	22	-2
	8-9	-	-	-	-
	10-1	22	23	25	2
	10-3	-	-	-	-
	10-5	23	24	21	-3
	10-7	-	-	-	-

Table 7.5 – PM Journey Times through Castlewellan Road/Chinauley Park

		Journey Time (s)			
	Movement	**BASE PM**	**DoMin PM**	**DoSom PM**	**DoSom - DoMin**
1700-1800	2-3	18	18	17	-1
	2-5	20	20	20	0
	2-7	20	20	23	3
	2-9	24	24	24	0
	4-1	23	26	19	-7
	4-5	14	14	11	-3
	4-7	-	-	-	-
	4-9	19	22	13	-9
	6-1	20	20	20	0
	6-3	13	14	11	-3
	6-7	13	13	13	0
	6-9	16	16	14	-2
	8-1	22	23	30	7
	8-3	-	-	-	-
	8-5	25	27	24	-3
	8-9	-	-	-	-
	10-1	24	29	25	-4
	10-3	24	34	17	-17
	10-5	26	29	23	-6
	10-7	-	-	-	-

Queue location references are presented in Figure 7.7 on the following pages. The queue data presented in Figures 7.5 to 7.8 indicate that maximum queue lengths at this location have either decreased or remained similar after the introduction of the scheme. The longest modelled queues occur at Queue Routes 2 and 6 which are the Kids Academy Access Road/Castlewellan Road and Chinauley Park/Castlewellan Road. Do Something queues are predicted to remain under 15m which is equivalent to approximately 3 light vehicles at the busiest time during the peak hours. The modelling predicts either an improvement or very similar operation of the existing junction with the scheme in place.

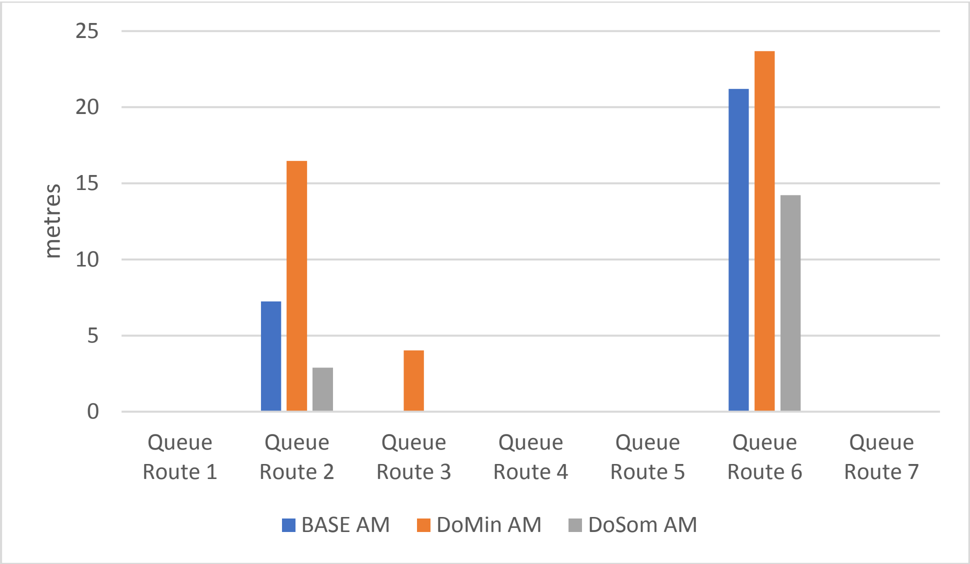


Figure 7.5 – AM Average Queues 0800 - 0900

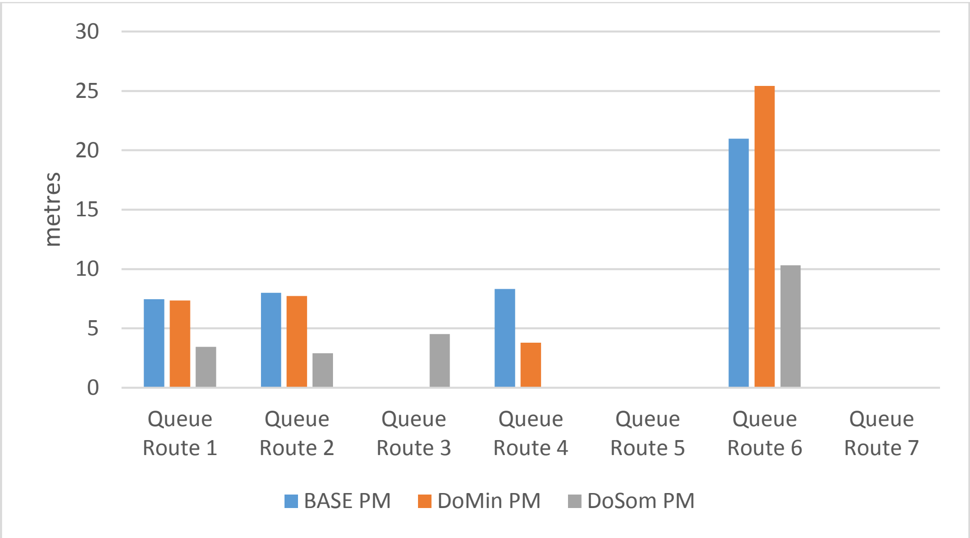
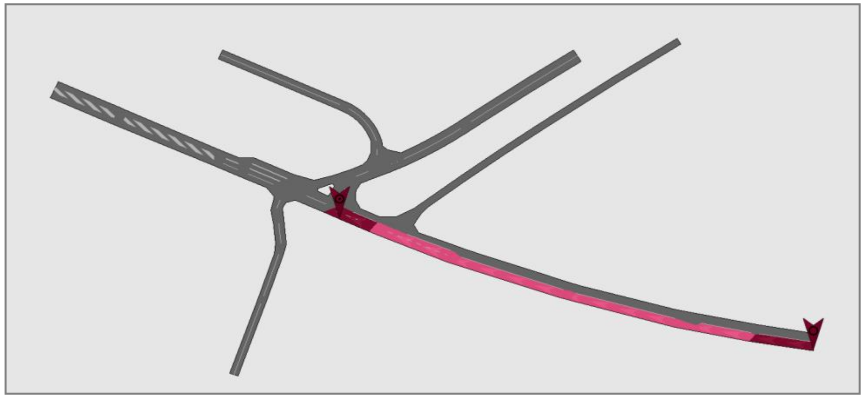
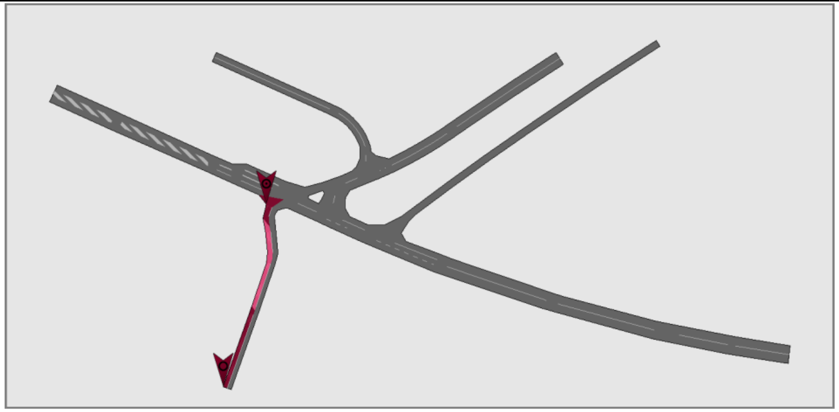
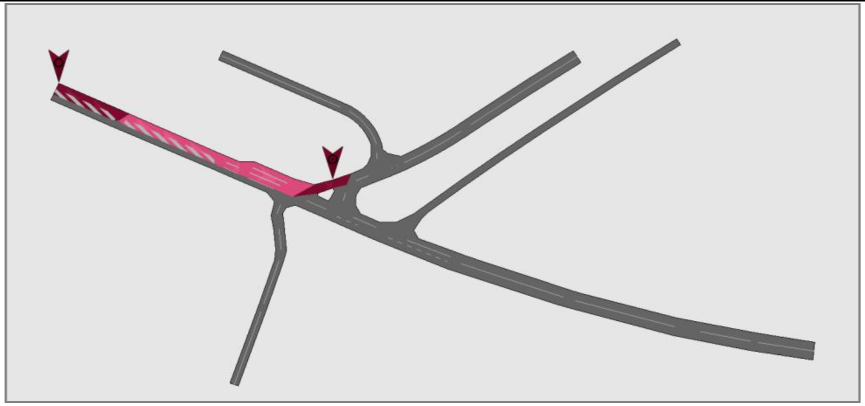
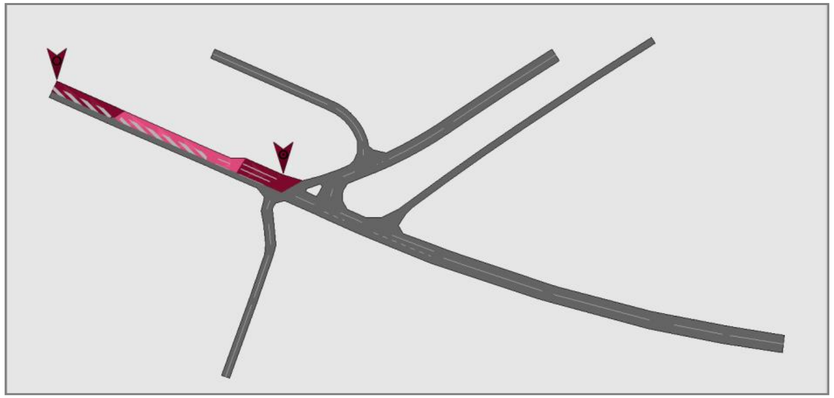
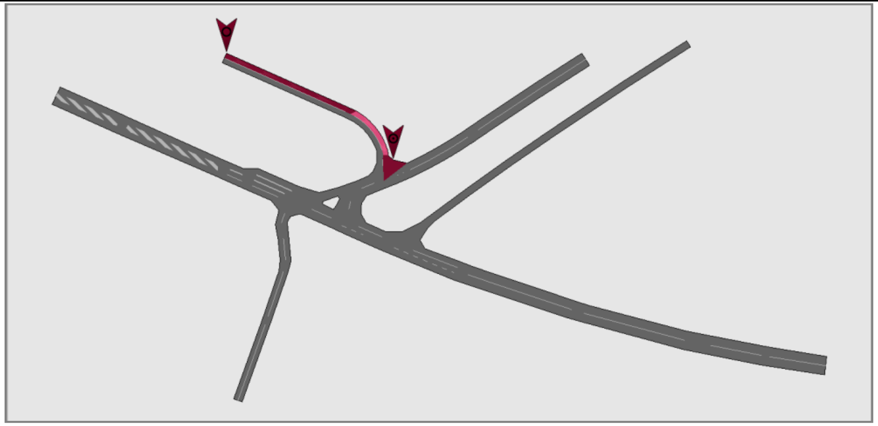
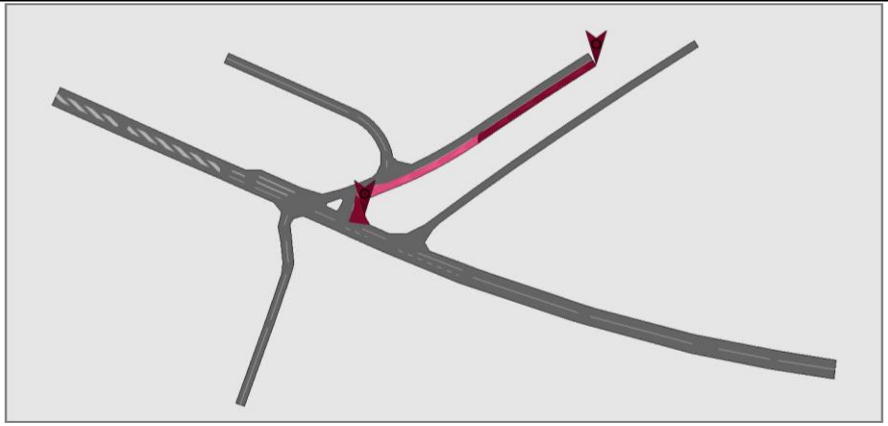
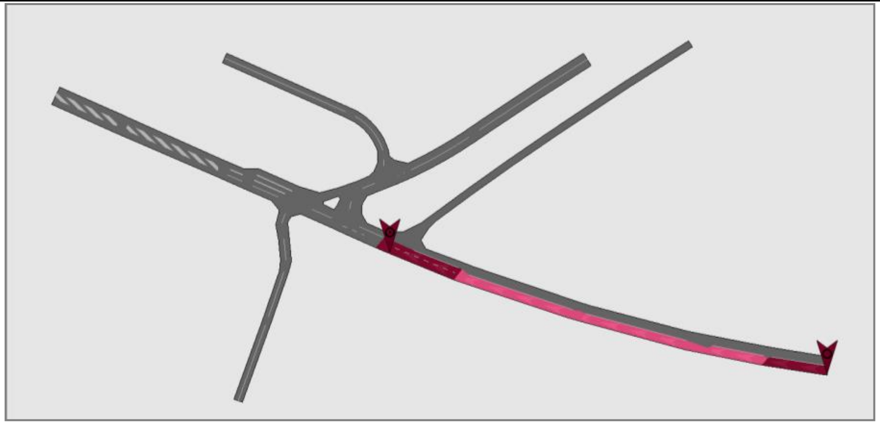


Figure 7.6 – PM Average Queues 1700 - 1800

Figure 7.7 – Queue Locations

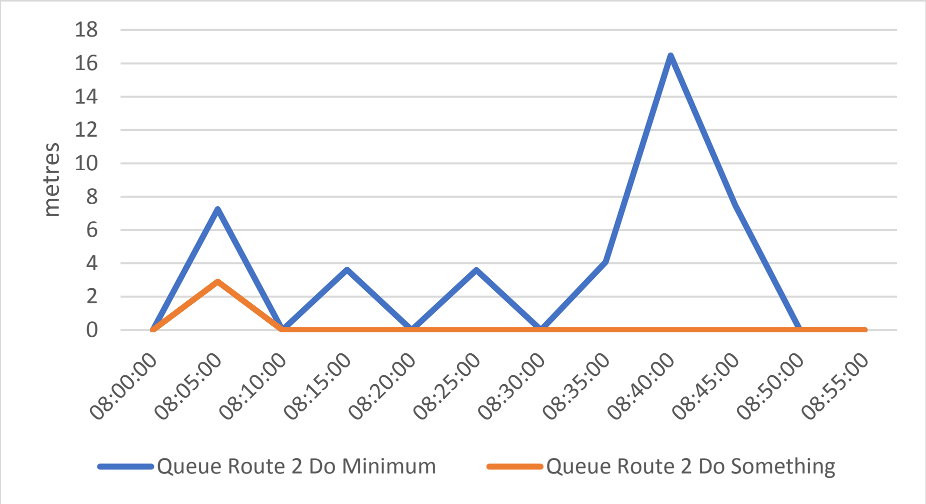
 Queue Route 1	 Queue Route 2
 Queue Route 3	 Queue Route 4

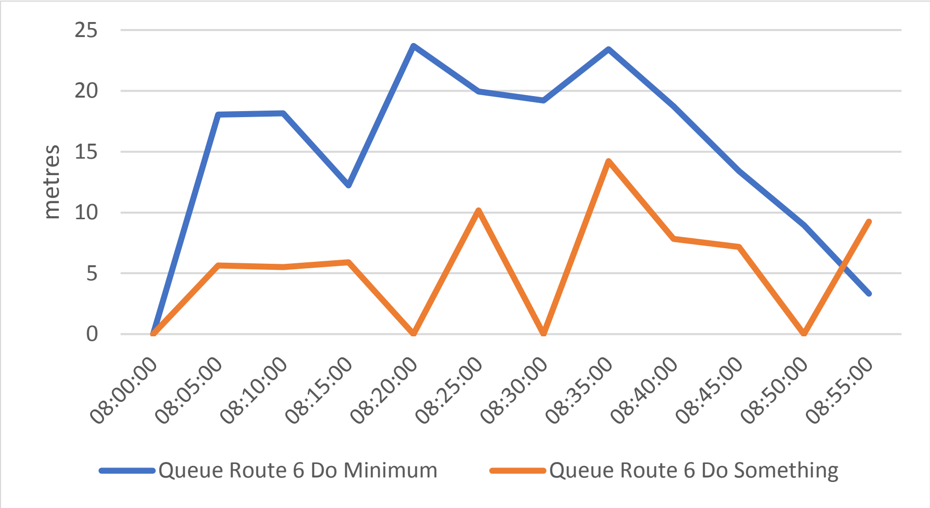
 Queue Route 5	 Queue Route 6

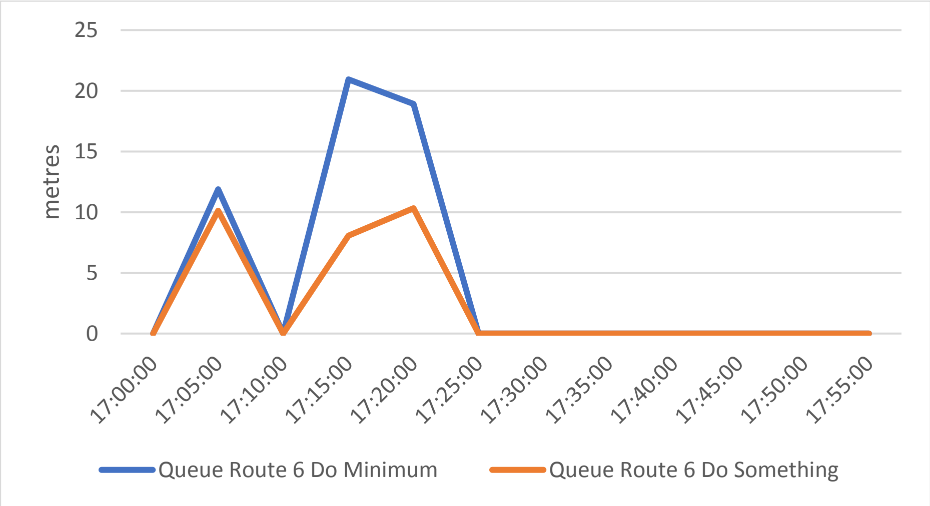


Queue Route 7

Figure 7.8 – Queue Results







7.5 MONITORING

Post-construction monitoring and evaluation of the development against Specific, Measurable, Attainable, Relevant and Timed (SMART) objectives is important for demonstrating value for money and providing evidence for future investments.

Recommended monitoring for this development would include data from:

- Permanent ATC sites;
- Journey time surveys; and
- Accident statistics.

7.6 SUMMARY

- This chapter has presented the Stage 3 traffic assessment, including an overview of existing conditions, traffic model development, traffic forecasting, and predicted future operation of the road network.
- A spreadsheet model has been developed to illustrate predicted traffic flows on the network and determine the effects of rerouting associated with the scheme. The purpose of the traffic model is to provide predicted traffic flow data for economic, environmental and operational assessment.
- ATC data has been used to determine a local growth rate and a core forecast. In order to acknowledge uncertainty inherent in forecasting low and high growth scenarios have also been developed in line with WebTAG guidance. An uncertainty log has also been presented to classify proposed developments in terms of their likelihood to proceed.
- Forecast traffic flows at key locations have been presented.
- An overview of operational traffic effects of the scheme has been presented, based on the reassignment of traffic due to diversions and improved safety and journey time reliability.
- Results from a microsimulation model of proposals for a northbound merge slip to the A1 at Castlewellan Rd have predicted no adverse impacts to the operation of the existing junction at Castlewellan Road/Chinauley Park.
- Proposed mitigation measures for construction include minimising traffic disruption by a phased construction programme, scheduling necessary short-term lane closures to short periods, applying traffic management measures and applying limits in contract documents.
- Post-construction monitoring of the development should consider permanent ATC sites on the route, journey time surveys, and collection of accident statistics.

8 ECONOMIC ASSESSMENT

8.1 INTRODUCTION

Within the Department for Transport's website guidance on the conduct of transport studies, five objectives for transport schemes are identified: Environment, Economy, Safety, Accessibility and Integration, in line with the assessment undertaken as Stage 2. The Economy Objective is concerned with improving the economic efficiency of transport. The Economy Objective was developed from the principles of A New Deal for Transport (DETR, 1998), the Government's White Paper on transport. Congestion and unreliability of journeys add to the costs of business, undermining competitiveness particularly in towns and cities where traffic is concentrated and there are competing demands for the available road space.

The Economy Objective has five sub-objectives:

- to demonstrate good value for money in relation to impacts on public accounts;
- to improve transport economic efficiency for business users and transport providers;
- to improve transport economic efficiency for consumer users;
- to improve reliability; and
- to provide beneficial wider economic impacts.

The economic assessment of a transport scheme is based on a comparison of the total benefits generated by the scheme with its total associated costs. The following three elements have been considered in the assessment of the scheme:

- The impacts of the scheme on road traffic accidents in the study area: estimated using COBA 2017 methodology and changes in traffic levels forecast by the traffic assignment model;
- The impacts of the scheme on travel times and costs for trips affected by the scheme together with the associated impacts on revenue and indirect tax levels: estimated using the COBA program; and
- The capital costs associated with the scheme.

The stage 3 economic analysis of the A1 Junctions Phase 2 proposals with the inclusion of the preferred options at each location has been completed using COBA (Cost Benefit Analysis) 2017 version 11 revision 19.0.1. COBA compares the capital cost of a scheme against the associated user benefits arising from reduced journey times and accident savings from the intervention. COBA assesses the costs and user benefits over a 60-year period after scheme opening.

QUADRO (Queues And Delays at Roadworks) has also been used as part of the stage 3 economic analysis. QUADRO provides a method for assessing the total cost of major road maintenance works in terms of travel time, vehicle operating and accident costs on the users of the section of road affected.

8.2 THE COBA MODEL

The COBA (Cost Benefit Analysis) program is an economic assessment tool which can be used to assess the transport economic efficiency and accident impacts of proposed projects. In particular, COBA compares the costs of a proposed highways scheme with the benefit derived by road users (in terms of time, vehicle operating costs and accidents), and expresses the results in terms of a monetary valuation. The output contributes to the appraisal process in the following ways:

- 'Transport Economic Efficiency': Time and Vehicle Operating Cost (VOC) changes:
- 'Accidents': Changes in Accident Costs and Casualties;
- 'Greenhouse Gases': Changes in the amount of fuel used to assist in determining changes in carbon dioxide emissions.

COBA calculates the user costs on the network in terms of changes in time, changes in operating costs and changes in accidental costs. The total costs of the scheme are considered in terms of capital costs and changes in the capital cost of maintenance of the network.

8.2.1 Cost Estimates

The estimated construction costs for the various proposed interventions have been calculated based on current market rates for projects of a similar nature and value. It is believed that these rates reflect construction costs within the current economic climate. Land, property and compensation costs are based on rates provided by Land and Property Services (LPS) in July 2018.

The following assumptions have been made in preparing cost estimates:

- Costs represent prices at Q1 2018 base rate;
- Preliminaries @ 15%;
- Contractor Fee @ 5%;
- Professional Fees @ 12%;
- Optimism Bias @ 7.5%;
- Construction Price Inflation 14.1%

Table 8.1 details the cost elements.

8.2.2 Assessment of Optimism Bias

Optimism bias is defined as the systematic tendency for project appraisers to underestimate their scheme's cost (and therefore overestimate the strength of its economic case). In line with this guidance, the cost estimates have been uplifted by 7.5% to allow for optimism bias. No optimism bias has been applied to lands and compensation costs.

Table 8.1 – Costs Estimates for the Preferred Scheme (Q1 2018 Prices)

Cost Element	Cost (£k)
Listullycurran Road/Backnamullagh Road CGSJ	£4,469
Gowdystown Road CGSJ	£4,710
Skeltons Road/Drumneath Road CGSJ	£4,226
Waringsford Road CGSJ	£5,208
Castlewellan Road Onslip	£2,060
Milebush Road Link to Hillsborough Road CGSJ	£1,398
Minor Junction Works	£8,381
Mainline Works inc. central reserve VRS, crossing closures, road closures / turning heads	£1,548
Archaeology / Environmental / Geotechnical	£323
Accommodation Works	£1,191
Statutory Undertakers - Civils Works	£397
Communications / ITS	£677
Preliminaries	£5,188
Contractors Fee	£1,989
Statutory Undertakers Works - C3 Estimates	£1,552
Construction Cost Sub Total	**£43,316**
Preparation and Supervision (Future Costs incl FY 2018)	£4,813
Risk Allowance	£3,643
Construction Cost Sub Total inc Preparation & Supervision and Risk Allowance	**£51,772**
Optimism Bias (7.5%)	£3,883
Lands & Compensation (incl contingency)	£6,988
Costs incurred to date(incl advanced VRS works, Managed Services, Consultants Costs, Site Investigatory Works and Other costs)	£4,031
Scheme Cost Estimate	**£66,674**

It is noted that the Scheme Cost Estimate identified above and in Chapter 4 of this Scheme Assessment Report (i.e. £66,674k) does not include Construction Price Inflation. However, for the purposes of the COBA and QUADRO economic assessments, Construction Price Inflation does need to be included. Construction Price Inflation has been determined at 14.1% and when applied to the construction elements (£43,316k) amounts to £6,108k. Therefore, for the purposes of the COBA and QUADRO assessments, the Cost Estimate of the Preferred Scheme, including Construction Price Inflation, is £72,782k (Q1 2018 prices).

8.2.3 Transport Business Case

The COBA assessment has utilised the following data and parameters:

- Annual Average Daily Traffic AADT (7-day) 2021 has been used for the traffic flow input;
- Local traffic accident rates;
- Default traffic composition;
- Daily turning movement proportions at each junction; and
- Link and junction details for the Do-Minimum and Do-Something scenarios.

8.2.4 Model Validation

Journey time measurements are required to both calibrate and validate the COBA assessments, and aid in assessing any re-assignment effects resulting from the improvement of the A1 route. Journey time surveys were undertaken along the A1 between Hillsborough Roundabout and Loughbrickland grade separated junction on Tuesday 22nd November 2016 between 11:00-14:00. The journey time data collected was compared to the journey time outputs from the COBA model on the same sections of the road.

To demonstrate that the model provided a platform for testing of proposals, the 2016 observed and modelled journey times were compared in accordance with the WebTAG criterion, which states that 85% of journey times routes are to be within 15% or one minute if greater. It should be noted that the modelled journey time produced by COBA is aggregated to give an average for all vehicle types whereas a car was used for the journey time surveys therefore the speeds are inevitably going to be higher in the survey results compared to the modelled results.

As shown in Table 8.2 the overall journey time difference along the scheme length is within 15%, which is considered acceptable.

Table 8.2 – COBA Journey Time Model Validation (2016)

NODE - LINKS	NORTHBOUND				SOUTHBOUND			
	COBA (SEC)	SURVEY (SEC)	DIFFERENCE (SEC)	% DIFFERENCE	COBA (SEC)	SURVEY (SEC)	DIFFERENCE (SEC)	% DIFFERENCE
Hillsborough Roundabout - Moira Road	59	56	3	5%	59	57	2	3%
Moira Road - Dromore GSJ	27	23	4	14%	27	24	3	12%
Dromore GSJ - Dromore Road	81	66	15	18%	80	68	12	15%
Dromore Road - Listullycurran Road	43	36	7	17%	43	37	6	14%
Listullycurran Road - Grove Road	60	51	9	16%	61	53	8	13%
Grove Road - Hillsborough GSJ	34	30	4	11%	34	33	1	4%
Hillsborough GSJ - Church Street	80	78	2	3%	79	75	4	5%
Church Street - Banbridge Road	43	40	3	6%	44	40	4	10%
Banbridge Road - Boals Lane	63	57	6	10%	61	55	6	9%
Boals Lane - Gowdystown Road	28	25	3	11%	29	25	4	12%

Gowdystown Road - Skeltons Road	109	92	17	16%	109	92	17	16%
Skeltons Road - Waringsford Road	69	59	10	14%	68	59	9	13%
Waringsford Road - Dromore Street	41	37	4	9%	41	39	2	6%
Dromore Street - Castlewellan Road	69	64	5	7%	69	65	4	6%
Castlewellan Road - Rathfriland Road	22	21	1	3%	21	21	0	2%
Rathfriland Road - Newry Road GSJ	75	72	3	4%	74	74	0	0%
Newry Road GSJ - Old Newry Road	70	66	4	6%	69	60	9	12%
Old Newry Road - Loughbrickland GSJ	37	30	7	18%	36	31	5	13%
Total	1009	903	106	10%	1004	908	96	10%

8.3 COBA RESULTS

8.3.1 Transport Economic Efficiency Results

The COBA results for the scheme are shown in Table 8.3.

Diagrams of the COBA network for both the Do Minimum and Do Something schemes are presented in Appendix I.

Table 8.3 – TEE COBA Results for Scheme Proposals (£k)

Stage 3 Economic Assessment	Preferred Route
Expenditure	
(A) Operating Costs	£0
(B) Investment Costs	£53,955
Present Value of Costs A+B = PVC	£53,955
Benefits	
(C) Consumer User Benefits	£11,152
(D) Business Benefits	£11,807
(E) Private Sector Provider Impacts	£61
(F) Accident Benefits	£97,859
(G) Indirect Tax Revenues	£-2,299

(H) Emissions Benefits	£397
Present Value of Benefits C+D+E+F+G = PVB	£118,976
Overall Impacts	
Net Present Value (PVB – PVC = NPV)	£65,021
Benefit/Cost Ratio (PVB / PVC = BCR)	2.21

*All costs are 2010 values and 2010 prices. A discount rate of 3.5% per annum has been applied to the first 30 years after scheme opening, followed by 3.0% per annum thereafter.

8.3.2 Present Value of Costs (PVC)

The PVC is the expenditure of the scheme and consists of two aspects – operating costs and investment costs. PVC is shown in real prices using the DfT's base year of 2010. These adjustments have been taken from values given in the WebTAG Databook May 2018. Therefore, the capital costs of construction (incl. lands and inflation) i.e. £72,782k (Q1 2018) are adjusted to the PVC value of £53,955k (2010).

8.3.3 Present Value of Benefits (PVB)

The PVB includes user benefits and accident benefits. The user benefits are categorised into three sections, consumer user benefits, business benefits and private sector provider impacts. The model outputs reflect the additional costs to users who have to u-turn via the A1 and in some instances the reduced volumes on the A1 from people diverting onto the side road network.

Accident benefits show a significantly positive value of £97,859k, which is attributable to median closures with banned right turns, safer grade separated junctions at various locations, junction closures and junctions improved from give-ways to merges.

Indirect tax revenues and emissions benefits are also part of the PVB calculation. The indirect tax revenue is detailed as a negative value of £2,299k, arising from reduced fuel consumption from fewer delays. Emission benefits are positive at £397k. The PVB is estimated at £118,976k.

8.3.4 Net Present Value (NPV)

The NPV is calculated by subtracting the PVC from the PVB which gives a value of £65,021k. A positive NPV is achieved as the benefits are greater than the capital costs.

8.3.5 Benefit to Cost Ration (BCR)

In order to calculate the BCR of the scheme the benefits are divided by the costs (£118,976k/ £65,021k = 2.21). The COBA BCR of 2.21 for the scheme is considered value for money as it is over the value of 1.

8.3.6 Detailed Costs and Benefits

User costs and benefits are shown in Table 8.4. These figures do not include an adjustment for the market price unit of account i.e. Indirect taxes are excluded.

Table 8.4 – User Costs and Benefits (£k)

ELEMENT	DO MINIMUM COST	DO SOMETHING COST	BENEFIT
Link Transit Costs	£2,411k	£2,407k	£5k
Junction Delay Costs	£253k	£240k	£13k
Vehicle Operation Costs	£709k	£705k	£4k

*All costs are 2010 values and 2010 prices. A discount rate of 3.5% per annum has been applied to the first 30 years after scheme opening, followed by 3.0% per annum thereafter.

8.3.7 Link Transit Costs

Link Transit costs are the costs of travel incurred by users on links. The costs in the Do Minimum and Do Something are compared in order to calculate benefit. The Do Something has a slight decrease in link transit costs in comparison to the Do Minimum from £2,411k to £2,407k. This can be explained by savings in vehicle operating costs in the Do Something.

8.3.8 Junction Delay Costs

Junction Delay costs are those associated with users having to wait/slow down to use junctions. The Do Something junction delays are lower than Do Minimum delays. The removal of right turn manoeuvres decreases delays. Therefore the overall costs decrease from £253k in the Do Minimum to £240k in the Do Something resulting in an overall scheme benefit of £13k.

8.3.9 Vehicle Operating Costs

The change in vehicle operating costs depends on changes in the distance travelled by vehicles and on average link speeds and includes impacts on items such as fuel, oil and tyres. Decreases in vehicle operating costs that are incurred by traffic using the Do-something road network compared to the Do Minimum network are recorded as a benefit resulting from a road improvement.

Vehicle operating costs decrease with the inclusion of the preferred scheme option which can be attributed to the decrease delays associated with certain journeys. Costs decrease slightly from £709k in the Do Minimum scenario to £705k in the Do Something scenario therefore resulting in an overall scheme benefit of £4k.

8.3.10 Accident Costs

The impact of the scheme on the number of accidents within the study area was estimated using COBA V11 R19. The numbers and costs of accidents at junctions and on links have been estimated separately. The estimated value of impacts for the forecast years was converted to an estimated Net Present Value (NPV) of accident savings in 2010 prices and values over a 60 year appraisal period (2021-2080). The results of this calculation are shown in Table 8.5 – Accident Benefits.

Accident benefits were calculated for the A1 using default national accident rates in the study area. The headline £97,859k benefit has already been reported within the TEE table in Table 8.3. A further breakdown is detailed in Table 8.5.

Table 8.5 – Accident Benefits

	Element	Do Minimum	Do Something	Scheme Benefit
Preferred Route	Accident Numbers – Links	1054	1071	-17
	Accident Numbers – Junctions	2889	1175	1713
	Accident Numbers – Total	3943	2246	1697
	Accident Costs – Links	£59,187k	£60,146k	£-959k
	Accidents costs – junctions	£159,888k	£61,070k	£98,818k
	Casualties – Slight	5682	3113	2569
	Casualties – Serious	644	335	309
	Casualties – Fatal	82	47	35
	Casualties – Total	6408	3495	2913
	Accident Costs	£219,075k	£121,216k	£97,859k

All costs are in £k 2010 Prices, discounted to 2010, 3.5% discount rate for 30 years, thereafter 3.0%.

There is an increase in the number of predicted accidents on links. This results in an increase of seventeen accidents (a negative benefit of £959k) over the 60-year appraisal period. This is due to an increase in vehicle kilometres travelled with the scheme in place.

The number and cost of accidents at junctions reduces by nearly 60% as a result of junction improvements, closures of the median crossovers and conversion of existing junctions to left-in, left-out arrangements. This generates a £98,818k benefit arising from the junction accidents savings. Overall, the number of accidents on links and at junctions decreases by 43% (1,697) over the 60-year appraisal period.

The number of casualties reduces by 45% (2,913), with 2,569 fewer slight casualties, 309 fewer serious casualties and 35 fewer fatalities. Accordingly, the costs associated with these accidents reduce from £219,075k in the Do Minimum to £121,216k in the Do Something. This produces an overall accident benefit for the scheme of £97,859k.

8.3.11 Alternative Scenarios

TAG Unit M4 "Forecasting and Uncertainty" states that the 'core' forecasting scenario should form the basis for the analysis in the Appraisal Summary Table. The core traffic forecasting scenario for the A1 Junctions Phase 2 scheme utilises the observed 3.02% per annum background traffic growth rate, representing background growth of 16.04% between the 2016 base year and 2021 scheme opening year. The core scenario also includes the development traffic associated with the Bridgewater Park proposals.

The core scenario is therefore considered to be the most realistic and plausible reflection of future year conditions. In terms of the Economic Assessment, the COBA analysis utilises the 2021 opening year Do Minimum and Do Something flows and reverts to default national central growth rates after this date. This results in a NPV of £65,021k and BCR of 2.21 for the core scenario.

However, TAG Unit M4 notes that there is no guarantee that the outturn will match the assumptions made for the core scenario. Where traffic demand is higher than anticipated then a particular scheme may not be as effective in reducing congestion and adverse safety or environmental effects may be experienced. Conversely, in a low demand scenario, a particular scheme may not be economically viable.

TAG Unit M4 therefore recommends that alternative scenarios consider both high and low growth situations. The alternative scenarios are discussed in further detail in the previous chapter. The Low growth scenario utilises a 10.45% growth rate between 2016 and 2021 and the High growth scenario utilises a 21.63% growth rate for the same period. In both scenarios, the development traffic associated with the Bridgewater Park proposals is also included. The growth rate again reverts to default national central growth rates in COBA after this date. Local accident rates have also been assumed in these scenarios.

Table 8.6 present the results of the COBA assessments for the Low, Core and High growth scenarios. For the Low growth scenario, the assessments show that a positive NPV of £58,366k and BCR of 2.08 is generated. The lower number of users on the network results in lower benefits overall.

Table 8.6 – TEE COBA Results for Scheme Proposals – Low and High Growth Scenarios (£k)

STAGE 3 ECONOMIC ASSESSMENT	LOW	CORE	HIGH
Expenditure			
(A) Operating Costs	£0	£0	£0
(B) Investment Costs	£53,955	£53,955	£53,955
Present Value of Costs A+B = PVC	£53,955	£53,955	£53,955

Benefits			
(C) Consumer Benefits	£8,929	£11,152	£9,623
(D) Business Benefits	£9,746	£11,807	£10,601
(E) Private Sector Provider Impacts	£41	£61	£45
(F) Accident Benefits	£95,042	£97,859	£99,902
(G) Indirect Tax Revenues	£-1,737	£-2,299	£-1,915
(H) Emissions Benefits	£299	£397	£330
Present Value of Benefits C+D+E+F+G = PVB	£112,321	£118,976	£118,587
Overall Impacts			
Net Present Value (PVB – PVC = NPV)	£58,366	£65,021	£64,632
Benefit/Cost Ratio (PVB / PVC = BCR)	2.08	2.21	2.20

*All costs are 2010 values and 2010 prices. A discount rate of 3.5% per annum has been applied to the first 30 years after scheme opening, followed by 3.0% per annum thereafter.

The assessments for the High growth scenario also show a positive NPV of £64,632k and BCR of 2.20. The NPV and BCR is similar to that of the Core growth scenario but marginally lower; the increase in traffic results in an increase in accident benefits however this is offset by reduced consumer and business benefits resulting in the marginally lower NPV and BCR figures when compared to the Core growth scenario.

The alternative scenarios produce BCRs ranging from 2.08 to 2.21 based on the COBA assessment. This shows that the scheme would generate benefits even in alternative growth scenarios.

8.4 THE QUADRO MODEL

As part of the Stage 3 economic assessment a Queues And Delays at Roadworks (QUADRO) model was constructed to assess the costs to road users of both regular maintenance with and without the proposed scheme and scheme construction.

The Quadro programme works in a similar manner to COBA, in that it quantifies the value of time to roads users. When these road users experience delay, the additional time that they are delayed for is costed. While COBA calculates the benefits that road users experience because of a highway improvement, QUADRO calculates the costs to users who are delayed during maintenance and construction works. E.g. delays due to reduced speed limit/diversionary works.

8.4.1 Methodology

A QUADRO Assessment has been undertaken to evaluate construction delay effects on road users and to also quantify any changes in future maintenance works delays in the 60 - year scheme evaluation period. The results calculated in the COBA analysis for the scheme itself are included within the

Quadro results to produce an overall impact of the scheme in terms of costs to be borne by both the department and the costs incurred by road users. This then gives a comprehensive economic impact assessment of the highway scheme.

QUADRO assesses three scenarios;

- The ‘Do – Minimum’ maintenance programme; which refers to maintenance required on the existing road, with no improvements in place;
- The ‘Do – Something’ maintenance programme; which refers to maintenance required following the new road scheme implementation; and
- The Do-Something Construction programme; construction costs exclude the capital costs of construction, as these costs are already assessed within the COBA analysis.

In a typical Do – Something scenario, there is often a saving in terms of maintenance costs to both the Employer (lower costs) and road users (fewer delays). In the ‘Do – Something’ scenario below, the scheme length includes the existing A1 and the additional grade separated junctions, merge and diverge lanes (9.2 kilometres), which brings the total scheme length from 25.2kilometres to 34.4 kilometres.

8.4.2 Methodology

Maintenance costs and durations have been derived from Table 4/1 in Chapter 4, Part 2, Section 1 of Volume 14 of the Design Manual for Roads and Bridges (DMRB). This table gives typical maintenance profiles, together with the associated values for the cost and duration of those profiles, for various classes of road cross – section.

It is assumed that two lanes of traffic on either side of the dual carriageway will be available to users throughout the maintenance works, with an associated speed limit of 80kph. It is also assumed that lane widths will be reduced to 3 metres per lane. Verge widths are also reduced to 1 metre. The Do minimum maintenance programme includes 25.2km of dual carriageway with the Do something maintenance programme including 25.2km of dual carriageway and 9.2km of single carriageway. Maintenance works on the additional 9.2 km of single carriageway are assumed to be undertaken using a shuttle system, with an associated speed limit of 50kph and a maximum queueing delay of 1 minute. A typical junction in the middle of the scheme has been chosen for assessment. Maypole Hill, which is located near the middle of the scheme, has an AADT flow of 445, which is deemed to be representative of the average flow for a LILO Junction within the scheme. It is assumed that lane widths will be reduced to 3 metres per lane, and verge widths also reduced to 1 metre for the assessment.

Maintenance and associated roadworks are assumed to take place during the hours of 0700 – 1900, Monday – Friday. No diversions will be in place during the maintenance period.

It is assumed that both the Do Minimum and Do Something maintenance cycles will commence in 2021, and run in ten-year intervals from 2032 – 2072. Maintenance profiles can be seen in Table 8.7 and 8.8.

Table 8.7 – Do Minimum Maintenance Profile

Scheme Length	25.2	Kilometres				
Year	2021	2032	2042	2052	2062	2072
Works	New	Thin Surfacing	Inlay	Inlay	Inlay	Inlay
Cost (£'000)		3528	7434	12096	7434	7434
Duration (days)		151	176	302	176	176
Duration (weeks)		22	25	43	25	25

Table 8.8 – Do Something Maintenance Profile

Scheme Length	25.2	Kilometres				
Year	2021	2032	2042	2052	2062	2072
Works	New	Thin Surfacing	Inlay	Inlay	Inlay	Inlay
Cost (£'000)		4034	9274	12602	93660	7940
Duration (days)		188	267	339	287	213
Duration (weeks)		27	41	48	41	30

8.4.3 Construction Profile

The primary construction activities anticipated relate to the construction of CGSJ, and the upgrading of existing at grade priority junctions to LILO junctions. Therefore, a large majority of construction works will be offline.

It is assumed that two lanes of traffic on either side of the dual carriageway will be available to users throughout the construction period, with an associated speed limit of 64kph. It is also assumed that lane widths will be reduced to 3 metres per lane. Verge widths are also reduced to 1 metre.

Construction and associated roadworks are assumed to take place during the hours of 0700 – 1900, Monday – Friday. No diversions will be in place during the construction period.

It is assumed that the overall duration of construction will be approximately 2 years and there will be no temporary diversions during the construction period.

8.4.4 QUADRO Results

The results for the preferred scheme are shown in Table 8.9 below, combined with the respective COBA results detailing the improvement to the overall scheme BCR.

Table 8.9– Combined COBA and QUADRO Results

Costs in 2010 Values and Prices (£)	Do Minimum Maintenance	Do Something Maintenance	Do Something Construction
Net Consumer Impact	10,645,116	10,683,214	684,729
Net Business Impact	5,481,993	5,505,604	377,959
Fuel Carbon Emission Costs	- 5,119	- 5120	46
Indirect Tax Revenues	843,322	843,689	- 34,329
PVB (Consumer + Business Impact + Carbon Emission + Indirect Tax Revenues)	-16,965,312	-17,027,387	-1,028,405
PVC (Maintenance Costs)	16,087,000	18,017,000	-
COMBINED QUADRO PVB (Do Som PVB + Construction PVB – DoMin PVB)	-1,090,480		
COMBINED QUADRO PVC (Do Som PVC + Construction PVC – DoMin PVC)	1,930,000		
COMBINED QUADRO NPV (PVB - PVC)	-3,020,480		
Combined COBA and QUADRO Results	Costs in 2010 Values and Prices (£)		
COMBINED PVB	117,886,000		
COMBINED PVC	55,885,000		
COMBINED NPV	62,001,000		
COMBINED BCR	2.11		

8.5 CONCLUSIONS

The investment cost of the scheme is estimated to be £72,787k (Q1 2018 prices), including an Optimism Bias allowance of 7.5% and Construction Price Inflation of 14.1%. (It is noted that the cost estimates identified in Chapter 4 of this Scheme Assessment Report do not include Construction Price Inflation, however, this figure is required to be included in the COBA and QUADRO economic assessments.) When re-based and discounted to 2010 values and prices and converted to the market factor unit of account this Present Value Cost is £53,955k (2010 prices). The Core forecast scenario with scheme is estimated to provide a Net Present Value of £65,021k, producing a COBA Benefit-to-Cost Ratio of 2.21.

Accident benefits were calculated for the scheme using the default accident rates within COBA. The number of accidents is predicted to reduce by approximately 1,700 with a corresponding reduction in casualties of 2900 over the 60-year appraisal period. This is a result of closures of the median crossovers and conversion of many of the existing junctions to left-in, left-out arrangements. This generates £97,859k of benefit over the appraisal period.

Considering the additional costs for users during construction and maintenance in QUADRO, analysis reduces the NPV to £62,001k. This generates a BCR of 2.11, which is considered value for money.

9 APPRIASAL FRAMEWORK

9.1 INTRODUCTION

A method of summarising the findings of the Environmental Assessment and this Stage 3 Scheme Assessment Report is presented in the form of an Appraisal Summary Table (AST).

This AST records the degree to which the five Central Government objectives (Environment, Safety, Economy, Accessibility and Integration), as set-out in the 'New Approach to Appraisal' (NATA) published by the Department of the Environment, Transport and the Regions (DETR) in July 1998, are achieved and provides a comprehensive summary of the impacts of the improvement option. While, in April 2011, the Coalition Government decided that the term NATA should no longer be used, its principles and key elements of the framework remain in analysis guidelines. The NATA guidance has been used to assess the Scheme at both Stage 1 and Stage 2 of the Scheme Assessment process and this has been continued at Stage 3, however where appropriate the assessment criteria has been enhanced based on the updated guidance contained within the WebTAG, Transport Appraisal Process guidance (2014).

It is intended that decision-makers use the information provided in the AST to make a judgement about the overall value for money of the scheme.

The results of the appraisals are displayed in the AST included in Appendix J.

9.2 ENVIRONMENTAL OBJECTIVE

The Environmental Assessment of the scheme was carried out in accordance with the criteria set out in the DMRB (Volume 11: Environmental Assessment) with the aim of protecting the built and natural environment. As a result, the following sub-objectives were adopted for the Environmental Assessment:

- Noise;
- Local Air Quality;
- Greenhouse Gases;
- Landscape;
- Townscape;
- Heritage of Historic Resources;
- Biodiversity;
- Water Environment;
- Physical Fitness; and
- Journey Ambience.

9.3 SAFETY OBJECTIVE

The Safety Assessment takes into account the need to reduce the loss of life, and reduce injuries and damage to property resulting from transport accidents.

It is common in the UK to place a financial value on the cost of casualties and accidents, which are included in the standard cost/benefit analysis. These values include the direct and indirect costs of accidents (loss of output, hospital, police, insurance, damage to property, etc) as well as an allowance for the pain, grief and suffering of those involved. However, as this form of analysis does not fully illustrate the direct safety performance of the system proposed, it is therefore deemed useful to estimate accident numbers also. As a result, the assessment includes the following sub-objectives.

- Collisions – Number of accidents, deaths, serious accidents and slight accidents by severity, over the 60 year assessment period, determined using the COBA standard DETR cost benefit analysis software.
- Security – Assessment of the proposed scheme how it impacts on crime reduction in the area ensuring better public safety, security and health.

9.4 ECONOMY OBJECTIVE

The aim of the Economic Assessment is to ensure that schemes under consideration improve both the economic efficiency of the transportation options and the efficiency of economic activity in the area.

The assessment is concerned mainly with maximising the economic efficiency of the transport system and increasing the net benefits of the transport options considered. This is determined using the COBA11 standard DETR cost benefit analysis software to assess the traffic demand and travel costs for the year of opening and beyond. The journey time reliability is also considered.

The assessment is divided into five sub-objectives:

- Public Accounts – Quantitative assessment of net economic savings to society from the implementation of the proposed scheme, determined using COBA11 standard DETR cost benefit analysis software. The assessment also includes the journey time savings for the year of opening.
- Business Users and Providers – Assessment of the extent to which journeys can be made within a reasonable time and at reasonable cost, focusing on improvement in end to end journey times and money costs, for freight, business and commuters.
- Consumer Users - Assessment of the extent to which journeys can be made within a reasonable time and at reasonable cost, focusing on improvement in end to end journey times and money costs, for local users.
- Reliability – The proposal’s impact on the objective to improve journey time reliability for transport users, including both passengers and freight.
- Wider Economic Impacts- Assessment of the extent of the how the proposed scheme can contribute to wider economic benefits outside of the local area.

9.5 ACCESSIBILITY OBJECTIVE

The purpose of the Accessibility Assessment is to improve access to facilities for people with disabilities or without a car and to reduce severance. The assessment is divided into three sub-objectives.

- Option Values – Qualitative assessment on the numbers of multi modal transport options within the area.
- Severance – Qualitative assessment on the separation of residents from facilities and services they use within their community caused by new or improved roads or changes in traffic flows. Alternatively, if a new road diverts traffic and makes an existing road easier for people to cross, community severance may be reduced. Quantitative assessment of number of facilities directly affected.
- Access to Transport System – Qualitative assessment on numbers of public transport users and Transport changes in the duration, and quality of access, to public transport, determined by the availability of access to a vehicle for private use.

9.6 INTEGRATION OBJECTIVE

The Integration Assessment is the least prescriptive of the key assessments. It deals less with the impact of any specific option, concentrating more on the processes by which the option was developed; ensuring decisions are taken in the context of the Government's integrated transport policy. It requires that, during scheme development, the potential for all modes of transport be considered, along with the ability to transfer people and freight between those modes.

For the purpose of the scheme, three sub-objectives were developed to assist in the assessment of the Integration Objective.

- Transport Interchange - Qualitative assessment of impacts to both passenger and freight transport interchange methods as a result of the proposed scheme.
- Land Use Planning - Qualitative assessment of the proposed scheme, ensuring it conforms to relevant planning policy.
- Other Government - Qualitative assessment, ensuring the scheme promotes the concepts Policies and ideals of an inclusive society, promoting equality of opportunity between people of differing social, economic and political standing.

10 CONCLUSIONS AND RECOMMENDATIONS

10.1 SUMMARY

RSC has been appointed to assist DfI publish Statutory Orders for a scheme to improve a section of the KTC which links the Belfast to Dublin.

10.1.1 Key Objective

The proposed A1 Junctions Phase 2 Scheme contributes to DfI's key objective of providing a modern, sustainable and safe transportation system, which will benefit society, the economy, the environment and contribute to social inclusion and an improved quality of life.

10.1.2 Development of the Preferred Route Option

Prior to this commission and as detailed in Chapter 1, the Proposed Scheme has been developed through the various stages of assessment defined on the DMRB TD37/93 Scheme Assessment Reporting. This has involved assessment of a number of route corridors and route alternatives, detailed scheme appraisal and extensive liaison with statutory consultees, public utility companies and affected land and property owners, which led to the announcement of the Preferred Route in March 2014 in the Stage 2 Scheme Assessment Report as prepared by AECOM.

The Proposed Scheme has been subjected to a Stage 3 assessment which has involved:

- Further environmental assessment, predicting the environmental effects that the Proposed Scheme will have and identifying appropriate mitigation resources (presented in the Environmental Impact Assessment Report);
- Preparation of a scheme cost estimate, including construction, property and land costs;
- Development of the engineering aspects of the Proposed Scheme; and
- Further economic appraisal of the scheme, incorporating an assessment of existing conditions and an assessment of the Proposed Scheme.

It is acknowledged that in the interests of safety, the A1 will continue to be monitored, in the same way that all roads are monitored, and that there may be a need in the future for further safety measures that may include minor road closures.

It is noted that any future requirement for safety measures, including minor road closures, would require appropriate assessment and consultation at that time.

10.1.3 Engineering Assessment

The Engineering Assessment, detailed in Chapter 5, analysed various aspects of the Proposed Scheme. The geometric design of the proposed junctions and side roads have undergone further development and every effort has been made to comply with the standards defined in the DMRB, while limiting impact on adjacent land and residential and commercial properties. Where appropriate, Departures and Relaxations from Standards have been identified and submitted to DfI for broad approval.

Consultation with public utility companies has also been undertaken to identify apparatus in conflict with the works. Where necessary, suitable diversionary resources have been identified and agreed with the utility companies and C3 cost estimates provided.

Consideration has been given to the method of construction to reduce impact to the existing road network and limit disruption. It is considered that the scheme design would not pose any major problems to a competent contractor during construction subject to a suitable traffic management strategy being adopted.

10.1.4 Traffic & Economic Assessment

The traffic and economic assessment, detailed in Chapters 7 & 8, has involved further development of the models created during previous stages of the project to present an economic appraisal of the Proposed Scheme. This assessment has concluded that the implementation of the scheme will provide the following benefits:

- Reduced journey times for strategic A1 traffic;
- Improve journey time reliability for strategic A1 traffic; and
- Contribute positively to transport economic efficiency; and
- Contribute positively to road safety; and
- Achieve value for money.

The economics of the scheme has been assessed using the COBA program and it has calculated a positive NPV of £65,021k and a BCR of 2.21 for the Proposed Scheme under the predicted traffic growth forecast over the 60 year economic life of the scheme.

Considering the additional costs for users during construction and maintenance in QUADRO, analysis reduces the NPV to £62,001k. This generates a BCR of 2.11.

This is considered to demonstrate that the scheme would provide a good return and therefore offers value for money.

10.2 CONCLUSIONS

The development of the Preferred Route has been carried out in accordance with the requirements of the Department and the need to comply with relevant standards, and which has resulted in a scheme which:

- Is economically robust;
- Provides the least environmental impact; and
- Justifies the land contained within the Vesting Order to be acquired to enable the scheme to be constructed.

10.3 RECOMMENDATIONS

Implementation of the Proposed Scheme would greatly improve conditions for both strategic and local road users. It is therefore recommended that the scheme is taken forward through Statutory Order publication stages.

ADDITIONAL FIGURES

APPENDIX A

Proposed Scheme Layout Drawings

APPENDIX B

Plan and Profile Drawings

APPENDIX C

Departure and Relaxation Summary Drawings

APPENDIX D

Junction Plans with GI Results

APPENDIX E

Public Utility Drawings

APPENDIX F

Structures Drawings

APPENDIX G

Drainage Outfalls

APPENDIX H

A1 Traffic Data Collection Report

A1 Traffic Model Flow Diagrams

Chinauley Park Microsimulation

APPENDIX I

COBA Network Do-Minimum & Do-Something Diagrams

APPENDIX J

Appraisal Summary Tables