A720 Sheriffhall Roundabout

DMRB Stage 2 Scheme Assessment Report

Part 1 – Engineering, Traffic and Economic Assessment
Volume 1 – Main Report

Transport Scotland

Project Number: 60470009

April 2017

Quality information

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Revision History

Revision	Revision date	Details	Authorised	Name	Position
00	February 2017	Working Draft			
01	March 2017	Draft *(Chapter 1 issued to TS – 02 Mar 17* *Chapter 3 issued to TS – 08 Mar 17* *Chapter 2 issued to TS – 10 Mar 17* *Chapter 4 issued to TS 16 Mar 17)*		Ryan Hutchison	Technical Director
02	31 March 2017	Final Draft		Ryan Hutchison	Technical Director
03	April 2017	Final		Ryan Hutchison	Technical Director

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1. Engineering

1. Introduction

1.1 Background

Junction improvements at Sheriffhall were identified as part of the Strategic Transport Projects Review (STPR), published in December 2008. Intervention 22 recommends targeted road congestions/ environmental relief schemes, including junction improvements at the Sheriffhall roundabout.

Sheriffhall is not explicitly included in the Infrastructure Investment Plan (IIP), however, the Scottish Government remains committed to undertaking improvements at the roundabout and have allocated a budget in 2017/18 to progress the detailed design and assessment (Stage 3) of the preferred option.

Atkins carried out a detailed STAG Part 1 / DMRB Stage 1 Report in 2008 that contained some elements of STAG Part 2 Report, in that it included initial economic findings. In the long term the assessment found that a simple grade separation provided the best travel time and accident savings benefits whilst minimising the impact on the environment.

There are a number of issues which impact on the potential need to upgrade Sheriffhall. These reflect its location, its role and the likely pressures being placed upon it.

Sheriffhall Roundabout is the only at-grade junction on the A720 Edinburgh City Bypass. The decision to opt for a roundabout in preference to a grade separated junction was largely because of the complex ground conditions which include a geological fault and mine workings that were being worked at the time.

There are extensive plans for residential and business development within the vicinity of Sheriffhall, including the South East Wedge (Shawfair) development. Sheriffhall also provides access to a number of growth areas, including the South East of Edinburgh where an Enterprise area has been established, and large developments along the A7 corridor. Sheriffhall also provides access from the east of Edinburgh City area to the growth areas around the West of Edinburgh and the M8 Corridor.

Underlying traffic volumes on the road network around Edinburgh are expected to increase by approximately 40% over the next 20 years. This increase is estimated from the impact of developments outlined in the emerging Strategic Development Plan. Congestion and delay on the A720 would increase, especially around key junctions such as Sheriffhall, and it is anticipated that traffic conditions around Sheriffhall Roundabout would deteriorate significantly.

1.2 Brief

AECOM was appointed by Transport Scotland in July 2013 to provide clarity on the most appropriate form of junction and to update the previous work done by Atkins in light of the following changes:

- The opening of the Dalkeith Bypass;
- Changes in traffic flows on the routes approaching Sheriffhall;
- Operation links between Sheriffhall, Millerhill and Old Craighall junctions and the A720 to the west including Gilmerton junction; and
- Growth in traffic from development in SESplan and relevant Local Development Plans.

Consideration was also to be given to the cost effectiveness of moving the location of the junction.

1.3 Scheme Objectives

The following Scheme Objectives have been set to address the main issues encountered at Sheriffhall Roundabout and have been used in the assessment to help determine the performance of the options.

A. Improve the movement of traffic on the A720 between Gilmerton and Old Craighall by providing grade-separation of the A720 at the existing Sheriffhall Roundabout

B. Reduce the conflict between strategic and local traffic

C. Minimise traffic impact of local proposed developments in Midlothian, East Lothian and City of Edinburgh on the A720 between Gilmerton Junction and Old Craighall Junction and approach roads

D. Improve road safety for all users on the A720 and approach roads between Gilmerton Junction and Dalkeith Northern Bypass

E. Minimise intrusion of the new works on the natural environment, cultural heritage and people whilst enhancing the local environment where opportunities arise

F. Facilitate integration for different modes of transport along and across the A720 corridor between Gilmerton Junction and the Dalkeith Northern Bypass

G. Reduce severance by improving accessibility across the A720 for all users.

1.4 Method of Assessment

The format for this report is based on that for a Stage 2 Scheme Assessment, as defined in the Design Manual for Roads and Bridges (DMRB) TD 37/93 Scheme Assessment Reporting. This assessment process identifies factors to be taken into account in choosing improvement schemes and to identify the environmental, engineering, economic and traffic advantages, disadvantages and constraints associated with those schemes. A DMRB Stage 1 scheme assessment was carried out on options to improve the existing road network at Sheriffhall in September 2014. A total of eight junction options underwent DMRB Stage 1 scheme assessment, four of which were recommended for further assessment in Stage 2.

This report examines the four options that were recommended for further assessment at the end of Stage 1. Assessment reports are not meant to replace technical reports on matters such as traffic or geotechnical issues. They 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 into account these effects when commenting on the proposals.

This report highlights the issues that are likely to have a major bearing on the junction improvement strategy and choice of option being implemented. Improvement options are identified and the report outlines how these have been assessed in light of the information gathered, presenting the advantages and disadvantages of the various options. Finally, this report recommends an option to be examined in greater detail at the Preferred Option stage.

1.5 Planning Policy Background

The following planning policies are considered relevant and are summarised below. Further specific policies and legislation have been noted in Part 2, Volume 1, Chapter 1 and considered in the environmental assessment.

1.5.1 Strategic Transport Projects Review

As referred to above, the Strategic Transport Projects Review (STPR) published in December 2008 included reference to improvements at Sheriffhall Roundabout. Intervention 22 Targeted Road Congestion / Environmental Relief Schemes recognised a number of corridors throughout Scotland which have been identified to reduce conflicts between strategic and local traffic. Section A222 targets specific locations on the road network where improvements would address these issues and includes measures such as junction improvements for the A720 Edinburgh City Bypass such as at Sheriffhall Roundabout. A225 also recognises that the A720 improvements would help to maintain the 60-min commutable labour market area around Edinburgh, and would provide benefits for journeys to or between two of Edinburgh's areas of economic activity, West Edinburgh and the Shawfair development. Journey time reductions of approximately 5 minutes are forecast with this improvement for all elements.

1.5.2 National Policy

As noted above, in accordance with DMRB Interim Advice Note 125/09, the relevant policies and plans for each environmental assessment have been discussed in their relevant chapters with a schedule of policies provided in Part 2, Volume 3, Appendix 1.2.

1.5.2.1 Infrastructure Investment Plan (IIP) 2015

The Infrastructure Investment Plan published in 2015 sets out why the Scottish Government invests, how it invests and what it intends to invest in up to 2035 by sector. It is intended to support the objectives set out in Scotland's Economic Strategy and the Programme for Government. The IIP recognises that "investment in transport across Scotland will deliver the best possible connectivity across the roads and public transport network, improving journey times and tackling inequality by improving accessibility of services and opportunities".

1.5.2.2 National Planning Policy

The National Planning Framework (NPF3) was published in 2014 by the Scottish Government and outlines the key principles that guide the wider planning system in Scotland.

With regard to transport and infrastructure, the NPF3 acknowledges that improved internal transport links are necessary to facilitate growth. Particular attention is given to the A720 and Sheriffhall Roundabout on page 13 and the NPF3 states:

- 'the longer-term spatial strategy for delivering housing land will need to acknowledge and address the region's infrastructure constraints. To help unlock effective housing land in the city-region, strategic, cross-boundary transport infrastructure improvements are required'.
- 'road network capacity, including the A720 where interventions are being taken forward at Sheriffhall Roundabout, has particular implications for future development'.

1.5.2.3 Scottish Planning Policy (SPP) (2014)

The Scottish Planning Policy (SPP) document is a statement of the Scottish Government's policy on nationally important land use matters. Transport is addressed as a subject policy within SPP at paragraphs 269 – 291 and it is recognised that the relationship between transport and land use has a strong influence on sustainable economic growth. The strategic transport network, which includes trunk roads, is identified as being critical in supporting a level of national connectivity that facilitates sustainable economic growth.

1.5.3 Regional and Local Plans and Strategies

1.5.3.1 Strategic Development Plan: SESplan (June 2013)

The Plan highlights that the South East Edinburgh Strategic Development Area (SDA) is served by the A720 City Bypass and the Sheriffhall Roundabout. It is recognised that the road infrastructure at this location is operating close to capacity and is severely congested at peak times. The Proposed Plan therefore identifies the grade separation of the Sheriffhall Roundabout as a key transport infrastructure project which is required for existing and future development within Midlothian/Borders SDA and the Regional Core (Paragraph 74). Paragraph 45 also notes that 'The upgrading of Sheriffhall Roundabout has been identified as an intervention within the STPR'.

1.5.3.2 Proposed Strategic Development Plan: SESplan (October 2016)

The Proposed Plan sets out the vision for the city region over 20 years from 2018. When approved in 2018 it will replace the current Strategic Development Plan. The approach to some issues remains unchanged from the 2013 Strategic Development Plan. The proposed plan highlights A720 Improvements, including Sheriffhall Junction – Junction Upgrades as a potential strategic "cross-boundary" project supporting the vision for the Plan of a "better connected place".

1.5.3.3 City of Edinburgh Council Local Development Plan (Nov 2016)

The 2016 Local Development Plan contains a number of "Transport Proposals and Safeguards" and includes a direction on the Sheriffhall Junction Upgrade (Ref: T13) which states "Grade separation of existing roundabout junction on city bypass should incorporate bus priority and safe crossing of the bypass for pedestrians and cyclists".

1.5.3.4 Midlothian Council Adopted Local Plan (2008)

Policy TRAN3 of the existing Midlothian Local Plan, 'Trunk Roads (Proposal)' supports the early implementation of the upgrading of the A720 Sheriffhall Junction grade separation.

Policy TRAN4, 'Safeguards for Transportation Schemes' includes provision for safeguarding the Sheriffhall Roundabout. It is also stated that Midlothian Council attaches a "high priority to the grade separation of the A720/A7 Sheriffhall Roundabout" as the current levels of congestion at the roundabout have "a major impact on access to and from Midlothian and repercussions for its prospects for future growth and prosperity".

1.5.3.5 Midlothian Council Proposed Local Development Plan (2014)

The Midlothian LDP will replace the current Midlothian adopted Local Plan and is scheduled to be adopted in spring 2017. Upgrading Sheriffhall roundabout is included in the proposed LDP under Policy TRAN2: Transport Network Interventions. Policy TRAN3: Strategic Transport Network further supports the upgrading of Sheriffhall roundabout and states 'The Council supports the early implementation of the grade separation of the A720 Sheriffhall Junction'. Paragraphs 7.1.21 and 8.1.6 include reference to the necessity of the grade separation at Sheriffhall to allow new development in the area, as do a number of the 'settlement statements' in the proposed LDP.

1.6 Consultation

Consultation has been undertaken in a comprehensive and open manner, ensuring that the views of all parties were properly heard, recorded and taken into consideration during the study and development of the scheme.

A Stage 2 Wider Stakeholder Workshop was held on 25 October 2016. The purpose was to inform stakeholders of work to date, to understand stakeholders concerns and to obtain feedback on current options. The attendees were Transport Scotland, City of Edinburgh Council, East Lothian Council, Midlothian Council, Sustrans and SEStran.

Environmental stakeholders have also been consulted as part of the environmental assessment and details can be found in Part 2, Volume 1, Chapter 1.

An Emerging Options Public Exhibition was held locally on 6 and 7 December 2016 to inform the public of the various options being considered at this stage. This exhibition gave the local community and other interested parties a chance to consider the options and discuss any issues they may have with representatives from Transport Scotland and AECOM.

In addition to the public exhibition a presentation was given to the Federation of Midlothian Community Councils on 18 January 2017. The presentation was followed with a question and answer session to discuss and obtain feedback on the emerging options.

From the Public Exhibition and Consultations that have been held during this stage of the assessment process, it is apparent there is a high level of support for the scheme.

1.7 Report Structure

The report is structured around DMRB TD 37 'Scheme Assessment Reporting' and follows the principles set out in the guidance for the preparation of the Stage 2 Report. The reporting has been split into three parts:

This document provides Part 1 of the Stage 2 DMRB Options Assessment, containing the engineering, traffic and economic assessments of the options. This document contains the report text, figures and appendices.

Part 2 provides the Stage 2 Environmental Assessment and Part 3 provides a summary of the assessment, conclusions and recommendations for the next stage.

2. Existing Conditions

2.1 Introduction

This section of the report provides an overview of the existing engineering, environmental and traffic conditions relating to the Sheriffhall Roundabout on the A720 Edinburgh City Bypass. The overview encompasses both the issues relating to the existing road junction and those pertaining to the surrounding area. It also highlights those issues which are likely to have a major bearing on the selection of the preferred option.

2.2 Engineering Conditions

2.2.1 Existing Junction and Surrounding Roads

Sheriffhall Roundabout is a junction on the A720 Edinburgh City Bypass and connects six A-class roads of local and regional importance, namely the A7 (North), the A6106 Millerhill Road, A720 Edinburgh City Bypass (East), the A6106 Old Dalkeith Road, A7 (South), and A720 Edinburgh City Bypass (West). Sheriffhall Roundabout is a signalised roundabout and has four lanes on the circulatory carriageway. It has an Inscribed Circle Diameter (ICD) of 100m. A location plan is shown in Figure 2.2.1.

Sheriffhall Roundabout is the only at-grade junction on the A720 Edinburgh City Bypass. The six-arm roundabout has undergone various improvements including localised widening, signalisation and the provision of additional lanes to try to alleviate the delays which occur at the junction. Despite the improvements, a congestion problem persists, particularly during peak hours.

The A720 is a dual carriageway located south of Edinburgh which connects the A1 at Old Craighall Junction south-east of Edinburgh to the A8 at Gogar Junction west of Edinburgh. The A720 at Sheriffhall typically consists of two 7.3m carriageways, with 1.0m nearside and offside hardstrips, and a 2.5m central reserve. The A720 widens to four lanes on the immediate approaches to Sheriffhall Roundabout.

Millerhill Junction is located approximately 1.9km east of Sheriffhall Roundabout at the junction of A720 and A68 Dalkeith Road. Millerhill Junction is a dumbbell grade separated junction. Gilmerton Junction is approximately 1.5km to the west of Sheriffhall Roundabout and is a grade separated junction with west facing slips only.

The A7 connects central Edinburgh to Carlisle in the north of England. The A7 North and A7 South are both single carriageway roads, typically 7.3m wide with 1.0m hardstrips. A footway is provided in the southbound verge of the A7 North. The A7 North widens to three lanes on the immediate approach to Sheriffhall Roundabout. The A7 South widens to two lanes on the immediate approach to Sheriffhall Roundabout. There is no footway provision on the A7 South.

The A6106 connects Dalkeith to Portobello on the east of central Edinburgh. The A6106 Millerhill Road is typically 7.3m wide carriageway, with 0.5m hardstrips, with a footway provided in the southbound verge. The A6106 widens to two lanes on the immediate approach to Sheriffhall Roundabout. The A6106 Old Dalkeith Road is typically 7.3m wide carriageway, with 0.5m hardstrips, with a footway provided in the southbound verge. The A6106 Old Dalkeith Road widens to three lanes on the immediate approach to Sheriffhall Roundabout.

2.2.2 Borders Railway

The Borders Railway passes under the A720 Edinburgh City Bypass via an underbridge approximately 250m east of Sheriffhall Roundabout. The underbridge was designed such that it can accommodate a depth of up 5 metres of additional fill in anticipation of possible future improvements for grade separation of Sheriffhall.

2.2.3 Non-Motorised User Provision

The existing Non-motorised user (NMU) provision in the study area is shown on Figure 2.2.3. Current provision across the existing Sheriffhall Roundabout is poor with users having to cross the arms of the roundabout without a dedicated traffic signal phase.

2.2.3.1 Footways

Footways are located adjacent to the A7 North and A6106 Millerhill Road. Shared cycleway/footways are located adjacent to and offline from the A6106 Old Dalkeith Road and also adjacent to the A772 Gilmerton Road.

There are several Edinburgh City Council and Midlothian Council Core Paths and 'Other Paths' within the study area. In particular, the NMU provision adjacent to the A6106 Old Dalkeith Road and A772 Gilmerton Road are designated Midlothian Council Core Paths and the NMU provision adjacent to the A7 North is a designated Edinburgh City Council Core Path. Full details of Core Paths and 'Other Paths' can be found in Part 2, Volume 1, Chapter 8 of this report.

2.2.3.2 Cyclepaths

There is a network of local cycle routes within the study area. On-road cycle lanes are located on the northbound and southbound carriageways of the A7 North. Off-road shared cycleway/footways are located adjacent to and offline from the A6106 Old Dalkeith Road and also adjacent to the A772 Gilmerton Road.

2.2.3.3 Bridleways

There are no dedicated equestrian paths or trails within the study area.

2.2.4 Bus Routes

A summary of the bus routes operating in the study area is shown on Figure 2.2.3. The main bus routes at the existing Sheriffhall and Gilmerton junctions are along the A7 North and South, along the A6106 Old Dalkeith Road and along the A772 Gilmerton Road. A bus route also leaves/joins the A720 from the west at Gilmerton Junction. Furthermore, the Stakeholder consultation responses highlighted the development of the Edinburgh Orbital Bus service which would be accommodated on segregated bus lanes on the A720 Edinburgh City Bypass. Further details on existing bus routes are included in Part 2, Volume 1, Chapter 8 of this report.

2.2.5 Topography and Ground Conditions

The topography of the study area mainly consists of gently undulating ground with natural slope angles of typically around 5° to 10°. The land surrounding the site mainly consists of arable farm land with occasional small residential or industrial properties. Disused railway lines run north-south to the east of the roundabout, as does the Borders Railway line. The road infrastructure is in cutting to the west of Sheriffhall and on embankment to the east.

The ground conditions comprise superficial deposits of Glacial Till, fluvio-glacial deposits, and Glacial sands and gravels. Local deposits of alluvium may be expected along the course of Dean Burn to the south of the A720 Edinburgh City Bypass. Made ground is present at isolated locations, in particular associated with the existing road and railway earthworks, the historic mining activity of the area and existing development activity.

The bedrock underlying the site is expected to comprise strata of the Coal Measures Series and, towards Gilmerton junction south of the A720 Edinburgh City Bypass, the Passage Group Formation.

The depth to rockhead varies considerably across the site with an indicative thickness of superficial deposits of typically between 1.0 metre below ground level (mbgl) and 5.0mbgl at Gilmerton junction and between 10.0mbgl and 20.0mbgl below Sheriffhall Roundabout.

The Coal Measures strata have been extensively mined in the past and all route options are expected to be underlain to some extent by historic abandoned shallow mine workings. Numerous mine entries also occur across a large proportion of the study area.

A major geological fault zone, the Sheriffhall Fault, coincides with the existing location of the Sheriffhall roundabout and trends broadly east-west, down throwing the strata to the north by approximately 175m. Other minor faults also underlie the site. As a result the bedrock near the faulted zone is recorded to be disturbed.

The historic land use information indicates that there are potential sources of contamination. These include: pesticides/fertilizers from farming activities; colliery spoil, backfilled sand pits and/or abandoned mine entries associated with historic mine workings; existing A720 embankments constructed with fill materials derived from

blaes, colliery spoil; disused sewage treatment works; disused water works; disused and operational railway land; closed landfills; fuel dealers and a market gardening enterprise.

In summary, the roundabout is located above a geological fault and historic mine workings. The constraints imposed by these ground conditions and the potential for fault reactivation induced by deep mining operations were a key factor in grade separation not being considered for the junction at the time of A720 construction. Deep mining operations have since ceased and there are no plans as such for the future so mining induced fault movement is now considered unlikely.

2.2.6 Hydrology

There are a number of existing watercourses in the vicinity of Sheriffhall Roundabout, with the Dean Burn being the main watercourse within the study area. It is a minor tributary of the River North Esk and flows from west to east, to the south of the A720. Existing culverts carry the Dean Burn beneath the A7 South and A6106 Old Dalkeith Road to its confluence with the River North Esk to the north of Dalkeith.

The Dean Burn is classified as a small water body under the Water Framework Directive (WFD). No specific information on the condition of the Dean Burn is given within the WFD therefore the status is taken as 'moderate' in line with the River North Esk into which it flows.

A walkover study of the Dean Burn identified a number of key features within the study area to the west of Sheriffhall Roundabout. Poor water quality in the vicinity of the redundant Gilmerton Sewage works was noted but no outfall from the sewage works into the Dean Burn was identified. Downstream of this location, an outfall believed to be from a constructed wetland for contaminated mine drainage at Gilmerton was identified. Water quality close to this outfall was noted as being very poor due to the abundance of iron rich deposits from the ferrous mine drainage.

The Dean Burn flows through a number of road culverts along its course including at the A7 South and A6106 Old Dalkeith Road, south of Sheriffhall Roundabout. The Dean Burn was identified as being approximately 2m wide in the vicinity of the existing culverts.

Further east, there is a small standing water body adjacent to the A720 at Lugton Bogs with an inlet taking some flow from the Dean Burn. The poor water quality found within this pond is thought to be attributable to the mine drainage. The location of the outfall from the pond was not confirmed and no outfalls into the pond or burn from the road drainage system were identified during the walkover study.

SEPA's flood extent maps have been used to identify the flood risk within the study area. The Dean Burn and the pond at Lugton Bogs are shown to have a medium to high likelihood of flooding adjacent areas. Furthermore, a high likelihood of surface water flooding was also identified on the A720, A6106 and A7 North under the existing layout.

No detailed ground investigation data is currently available but British Geological Survey borehole records indicate that groundwater levels are approximately 4m below ground level.

2.2.7 Drainage

As-built drawings of the A720 Edinburgh City Bypass and Borders Railway, Scottish Water public utility (PU) drawings and topographical information have been reviewed to establish the extents, form and direction of flow of the existing drainage network.

Available as-built drainage plans are limited in their coverage. Information is only available for Sheriffhall Roundabout, the A720 to the west of Sheriffhall, the A720 east at the Borders Railway underpass and the A6106 Millerhill Road realigned as part of the Borders Railway project. Improvement works at Sheriffhall Roundabout have been undertaken since the production of the original as-built plans therefore the drainage network may no longer be as shown in the original plans.

The existing drainage network for the area in which as-built information is available typically consists of combined filter drains at the edge of carriageway and in the central reserve, French drains at the toe of embankment slopes and carrier drains traversing the carriageway to convey the multiple flows to a single point of discharge.

Although specific outfall locations cannot be identified from the information currently available, the general runoff flow direction was derived from as-built and topographical information as being south on the A6106 Old Dalkeith Road, north on the A6106 Millerhill Road and east on the A720 beyond the Borders Railway underpass.

Apart from the provision of filter drains, there is no evidence of any SuDS measures as part of the existing drainage system. An attenuation pond is located to the north of the A6106 Millerhill Road and treats runoff from the A6106 realigned for the Borders Railway. The total extent of the catchment for this pond could not be confirmed but the existing topography indicates that the A6106 Millerhill Road falls in the direction of the SuDS pond from Sheriffhall Roundabout. A large attenuation pond is also situated adjacent to the Sheriffhall Park and Ride but inflow and outfall details are not known.

Further investigation will be required to gain a full understanding of the wider network and outfall locations for the detailed design of the drainage layout.

2.2.8 Public Utilities

Numerous services are present within the study area. These include high voltage electricity cables, gas mains and water mains. The utility infrastructure present within the area serves not only the adjacent residential, commercial and industrial development but also similarly serves developments beyond the study area. There are also services (electricity, sewerage, cable, water, etc.) associated with all the properties within the study area and these will need to be protected or diverted as appropriate when construction takes place. The following information on the location of utilities was sourced from public utilities under procedure C2 of the “New Roads and Street Works Act 1991”.

2.2.8.1 Electricity

Details of the existing electricity apparatus provided by the electricity suppliers have been reproduced on Figure 2.2.8.1.

Scottish Power Energy Networks (SPEN) high voltage electricity lines are present throughout the study area. Overhead and underground lines exist in the immediate vicinity of Sheriffhall Roundabout and the surrounding road network. Scottish Power Energy Networks provided details of their 275kV, 33kV and 11kV overhead and underground apparatus.

275kV overhead lines cross the A6106 Millerhill Road and A7 North, north of Sheriffhall. The lines also pass over the A720 east of Millerhill Junction.

33kV overhead lines cross the eastbound approach to Sheriffhall Roundabout, intersecting the A7 both to the north and south of the junction. A second 33kV overhead line crosses the A720 at the start of the Gilmerton off-slip and continues in a north-easterly direction before relocating underground towards the A7 north of Sheriffhall.

A 33kV underground line crosses the A720 eastbound approach to Sheriffhall Roundabout. Further intersections occur on the A6106 and A7 south of the roundabout and again on the A7 North adjacent to the park and ride facility.

11kV overhead lines cross the A720 east of Sheriffhall Roundabout and also cross the A7 North and A7 South. An 11kV line, passing through the sewage works, runs parallel to the south of the A720 then crosses the A720 towards the east of Gilmerton.

11kV underground lines cross the A7 South and A6106 Old Dalkeith Road immediately south of Sheriffhall. There are further crossings of the A7 adjacent to the Garden Centre.

2.2.8.2 Scottish Water

Details of the existing Scottish Water apparatus are shown on Figure 2.2.8.2.

Scottish Water Supply and Sewer equipment is located within the study area mainly in the A772 Gilmerton Road and in the A7 North. There are also several crossings of the A720 main carriageway. A foul water sewer crosses the A720 north of the disused sewage works, which is located between the A720 and the A772 Gilmerton Road. The sewer then follows the A720 eastbound verge towards Gilmerton Junction and continues north along the A772 Gilmerton Road.

A sewer crosses the A720 just north of the Millerhill junction and then continues westwards to Millerhill Park.

Distribution Water Mains cross the A720 at the Gilmerton Junction and approximately 900m east of Sheriffhall Roundabout. The water main crossing at Gilmerton Junction follows the alignment of the A772 Gilmerton Road north and south of the junction. A further water main follows the A7 north of Sheriffhall towards the Shawfair Roundabout.

2.2.8.3 Gas

Details of the existing Scotland Gas Networks apparatus are shown on Figure 2.2.8.3.

A medium pressure gas main is located in the verge of the A7 South from the Gilmerton Road Roundabout to Sheriffhall Roundabout. The medium pressure gas main then crosses the A720 mainline on the eastbound approach to Sheriffhall and continues in the verge of the A7 North towards Shawfair Park.

A low pressure gas main links to the Summerside properties from the medium pressure gas main on the A7 North.

2.2.8.4 Telecommunications

Details of the existing apparatus belonging to BT Openreach, Virgin Media and the mobile service providers are shown on Figure 2.2.8.4.

Underground cable ducts cross the Sheriffhall Roundabout and follow the A7, A6106 Millerhill Road and A6106 Old Dalkeith Road to the north and south of the junction. A further A720 crossing is located at the Gilmerton Junction overbridge. Underground Virgin Media ducts follow the A772 and cross the A7 South on the northbound approach to the Gilmerton Road Roundabout.

Overhead lines are present adjacent to the A7 North, along the A6106 Old Dalkeith Road south of Sheriffhall, and also in both verges of the A772 Gilmerton Road north and south of Gilmerton Junction.

There is one mobile telecommunications mast within the study area. A shared T-Mobile and 3 Mobile mast is located approximately 280m west of Sheriffhall.

2.3 Environmental Conditions

The majority of the land located within the study area is agricultural and Green Belt land and consists of a mixture of arable and grazing land. Woodlands are also present within the study area, in Dalkeith Country Park to the east of Sheriffhall and woodland to the west and south of Sheriffhall.

A number of properties, including residential, are located within the study area. These include a number of listed buildings, the closest being Summerside Farm which is approximately 100m north of Sheriffhall Roundabout, and Sheriffhall Farmhouse which is approximately 150m south-east of Sheriffhall Roundabout. Both are Category B listed. There are nine Scheduled Monuments within the study area, the closest being Melville Grange which is located south of the A772 Gilmerton Road, a Roman Camp which is located south of the A6106 Old Dalkeith Road and a Roman Fort which is located on the north side of B6392 Gilmerton Road.

Dalkeith Oakwood Site of Special Scientific Interest (SSSI) is the only nationally designated site within the study area (due to the presence of lichen) and is located close to Millerhill Junction, approximately 0.5km south of the A720 Millerhill Junction and south of the River Esk, and approximately 2km from Sheriffhall Roundabout. This area of woodland is also listed on the ancient woodland inventory (AWI).

The protected species records indicate the possibility of bat roosts, badger setts, red squirrel dreys and otter refuges within or near the study area. There are also four Gardens and Designed landscapes within the study area.

Further details on the environmental conditions can be found in Part 2 of this report.

2.4 Traffic Conditions

A programme of data collection surveys was undertaken in October 2014 within the study area to assist in establishing current traffic conditions. The surveys included manual classified counts (MCCs), queue surveys

and the measurement of typical journey times. The 12-hour 2-way traffic flows on the A720 were found to be 39,500 west of Sheriffhall Roundabout and 41,660 east of Sheriffhall Roundabout. The 12-hour 2-way traffic flows on the roads surrounding Sheriffhall were found to be 6,690 on the A772 Gilmerton Road North; 14,260 on the A772 Gilmerton Road South; 16,140 on the A7 Old Dalkeith Road (North); 11,300 on the A7 South and 9,490 on the A6106 Old Dalkeith Road. It should be noted that the A6106 Millerhill Road was closed during the period of survey.

The results of the October 2014 surveys indicate that 59,040 vehicles passed through the at-grade Sheriffhall Roundabout during the 12-hour survey period. In comparison, 57,670 vehicles were recorded passing through the junction in October 2013.

Sheriffhall signalised roundabout can lead to significant localised queuing, especially during the AM and PM Peak periods. In the AM Peak, the heaviest queuing was observed on the A720 (East) approach to Sheriffhall Roundabout with an observed queue length of 72 Passenger Car Units (PCUs). In the opposite direction on the A720 (West), a maximum queue length of 32 PCUs was observed in the AM Peak. In the PM Peak, the maximum queue length was observed on the A720 (West) approach to Sheriffhall Roundabout with a queue length of 195 PCUs. In the opposite direction on the A720 (East), a maximum queue length of 51 PCUs was observed on the approach to Sheriffhall Roundabout.

In the eastbound direction on the A720, the average recorded speed during the PM period was 40mph which is significantly lower than the speed recorded during the AM and Inter-Peak periods. In contrast, in the westbound direction on the A720, the average recorded speed during the AM period was 35mph which is significantly lower than the speeds recorded during the PM and Inter-Peak periods. Examination of the average daily directional speeds indicates that eastbound speeds between Straiton and Gilmerton are around 60mph but reduce to 29mph on the approach to Sheriffhall Roundabout and increase thereafter to around 60mph towards Millerhill. Examination of the average daily directional speeds also indicates that westbound speeds are around 60mph at Millerhill, but reduce to 39mph on the approach to Sheriffhall Roundabout and thereafter increase to 53mph. The variation between the minimum and maximum speeds recorded on the A720 provides a clear indication of the effects of delays and congestion on the approach to Sheriffhall Roundabout compared to the other sections of the A720.

To assist in assessing conditions in the A720 study area, information on all road traffic accidents on the A1, A68, A7 and A720 involving personal injury accidents for the ten-year period between 2004 and 2013 were obtained from Transport Scotland. Data for 2014 was also available from January 2014 to October 2014. An analysis of recent trends in road traffic collisions was undertaken as part of this assessment to identify road sections and specific locations which have higher than average road traffic collisions involving personal injury. Analysis of road traffic accidents on the A720 study area (between approximately 1 kilometre to the west of Gilmerton Junction to Old Craighall Junction on the A1 and in addition a 3-kilometre section of the A68 Dalkeith Bypass) indicates that the total number of personal injury accidents between 2004 and 2013 has fluctuated between 10 accidents in 2005 and 25 accidents in 2012 and 2013 with an annual average of 20 accidents.

Further details of the existing traffic conditions can be found in the A720 Sheriffhall Roundabout DMRB Stage 2 Traffic and Economic Assessment Report.

3. Description of Options

3.1 Introduction

This section presents a summary of the scheme options developed for the Stage 2 Scheme Assessment in accordance with DMRB TD 37/93 (DMRB 5.1.2).

3.2 DMRB Stage 1 Scheme Assessment

A total of eight junction options underwent DMRB Stage 1 scheme assessment:

- Option 1 – Dumbbell Grade Separation at Sheriffhall;
- Option 2 – All slip roads provided at Gilmerton, no connection at Sheriffhall;
- Option 3 – Squareabout at Gilmerton, A7 bridged over A720;
- Option 4 – Collector Distributor, no connection at Sheriffhall;
- Option 5 – Combined Gilmerton and Sheriffhall junctions;
- Option 6 – Grade Separation at Sheriffhall;
- Option 7 – Dumbbell Grade Separation at Sheriffhall, Gilmerton slips closed; and
- Option 8 – Dumbbell Grade Separation west of Sheriffhall.

Options 1 to 6 were based on those which were reported in the A720 Sheriffhall Roundabout, Feasibility Study STAG 1. Options 7 and 8 were developed during the DMRB Stage 1 Inception Workshop. The eight options were subject to an engineering, environmental and traffic and economic assessment in accordance with DMRB Stage 1 Assessment.

Options 1, 6 and 8 all addressed the central objective of providing grade separation at Sheriffhall without significantly changing the existing points of access to the A720 City Bypass at Sheriffhall and the adjacent Gilmerton and Millerhill junctions. In contrast Options 2, 3, 4, 5 and 7 all resulted in a significant change to the main points of access to that which currently prevails.

Initial appraisal showed that Option 3 had no clear advantage over Option 2 but because Option 2 had more roundabouts it was considered to be a more complex arrangement and was therefore sifted out. Similarly, Option 7 and Option 1 were alike but because Option 7 reduced access options to the A720 City Bypass by closing the existing Gilmerton slip roads, it was also ruled out.

Option 4 removed the direct connection at Sheriffhall, replacing it with a collector distributor road between the west facing slips at Gilmerton and east facing slips at Millerhill. Whilst this option reduced the current level of access to and from the A720, its main attraction was the additional capacity it provided to the A720, effectively adding another lane in each direction. However there was a greater risk that Option 4 would generate high levels of opposition compared to other options and together with the significantly larger land footprint and the high capital cost, it was decided that this option should also be rejected.

Option 5 had the same central elements as Option 1 but because it had a greater capital cost, reduced connectivity at Sheriffhall and an increased land footprint it was, for similar reasons to Option 4, concluded that it should not be taken forward to Stage 2.

Although Option 2 had many of the same disadvantages that Options 4 and 5 had, Option 2 had a much lower capital cost and therefore was considered worthy of further assessment at Stage 2.

The Stage 1 Scheme Assessment recommended that Options 1, 2, 6 and 8 were taken forward for further assessment at Stage 2. Further details can be found in the DMRB Stage 1 Scheme Assessment Report.

3.3 DMRB Stage 2 Option Development

3.3.1 Initial Option Development at Stage 2

A significant level of design development was undertaken at Stage 2 to refine the layouts that emerged from Stage 1 to enable a detailed comparative assessment of the options and ultimately identification of an overall preferred junction layout.

Detailed LIDAR survey information was obtained for the study area and the vertical and horizontal geometry of layouts were revised to ensure a best fit with the topography.

For Options 2 and 8 at Stage 1, it was initially proposed that the re-aligned A6106 Millerhill Road would form a simple T-junction with the A7 North. However, following consideration of more detailed traffic flow information it was decided that a roundabout would be required to improve operation.

The roundabout layouts for all options were developed in line with the requirements of DMRB TD 16/07. Development of the roundabout entry and exit arrangements led to further amendment of the horizontal geometry of side and slip roads to ensure deflection and layout requirements could be achieved.

A geometry review of each layout was undertaken in accordance with DMRB TD 9/93. Due to the constrained nature of the study area, relaxations in both vertical and horizontal geometry were included where necessary to minimise the impact on the environment. Opportunities to improve the level of standard provided were considered as the design layouts progressed.

3.3.2 Value Management Workshop 2a – Sifting of Option 2

An initial Stage 2 Value Management Workshop (VfM2a) was held in March 2015. Information on the initial outcomes of the ongoing study was provided to the members of the project team and representatives from Transport Scotland in attendance.

A comparative scoring exercise of the options against the scheme objectives was undertaken at the Workshop. On conclusion of this exercise, it was agreed that Option 2 did not sufficiently meet the scheme objectives and that it should therefore not be taken forward for further Stage 2 assessment. The main issues identified with Option 2 were as a result of the proposal to merge both Sheriffhall and Gilmerton Junctions into one at Gilmerton and it was agreed that this could not be mitigated with the option. Further details can be found in the VfM2a Workshop report, provided within Part 1, Volume 3, Appendix 1 of this report.

3.3.3 Further Development of Remaining Options

The design options were renamed as follows for the remainder of the Stage 2 Scheme Assessment:

- Option A – Dumbbell Grade Separation at Sheriffhall (previously Option 1)
- Option B – Grade Separation at Sheriffhall (previously Option 6)
- Option C – Dumbbell Grade Separation west of Sheriffhall (previously Option 8).

As part of the scheme development, a review was undertaken of the relative merits of keeping the A720 City Bypass at-grade with elevated side roads carried over the bypass in comparison to carrying an elevated A720 City Bypass on embankment and bridge over at-grade local roads.

The review considered the implications on adjacent properties, nearby watercourses, material quantities, scheme land requirements, the Borders Railway and buildability. It was found that retaining the A720 at-grade for Options A and B resulted in a small reduction in the volume of imported materials required and also had a lesser impact on the Borders Railway. In contrast an at-grade City Bypass resulted in a larger overall land footprint, increased impact on the adjacent properties and watercourses and introduced greater difficulty maintaining traffic flows during construction. The optimum solution was found to be that the proposed A720 mainline should be elevated on embankment and bridged over the at-grade side roads for Options A and B.

Option C adopts an offline layout with the A720 at-grade and side roads raised on embankment. No benefit in terms of buildability was apparent in the adoption of at-grade side roads and a raised A720 for Option C.

A review of stopping sight distance (SSD) was undertaken for Options A, B and C in accordance with DMRB TD 9/93. Verge widening was applied to the design layouts as required to ensure the full visibility envelope was contained within the carriageway and verge where possible.

Further consideration was given to buildability in the refinement of the design options. Opportunities to minimise potential delays during construction were considered. As a result, the merge and diverge slips on Options A and B were lengthened to meet the A720 where the mainline design remains at-grade. The extended slips would enable traffic to be re-routed off the existing A720 for the construction of the new section of A720 on embankment across the existing Sheriffhall junction. Option C retains the A720 at-grade through Sheriffhall therefore no buildability refinements were applied to the design option.

Non-motorised user (NMU) provision was also incorporated into the design with offline routes using the bypassed sections of the A7 and A6106 carriageways where possible. Option C presents the best opportunity for segregated provision across the existing junction as the new Sheriffhall Junction is relocated west. Options A and B present a more significant challenge with a number of at-grade crossings required to retain provision close to the existing junction and desire line. An underpass below the A720 and the west facing slips was considered for Option B however the resultant additional NMU route length was negatively received at the Emerging Options Public Exhibition. Further consideration of opportunities to improve NMU provision on the preferred option will be given at the next design stage.

3.4 Option A

Option A – Dumbbell Grade Separation at Sheriffhall

Option A is a grade separated dumbbell arrangement at Sheriffhall with the A720 elevated and passing over the A7 carried by a new overbridge with a span of approximately 35m. The 80m diameter dumbbell roundabouts and local roads would remain approximately at-grade. The north roundabout is a 5-arm roundabout which connects the A720 eastbound diverge slip, the A7 North, the A6106 Millerhill Road, the A720 eastbound merge slip and the A7 Link. The south roundabout is a 5-arm roundabout which connects the A720 westbound merge slip, the A7 Link, the A720 westbound diverge slip, the A6106 Old Dalkeith Road, and the A7 South.

The A720 mainline would be raised up on embankments up to 9.5m high on approach to the A7 crossing. Vertical and horizontal realignment of the A720 would be required over an approximate length of 1600m.

The A720 eastbound merge slip and A720 westbound diverge slip cross the Borders Railway and would therefore require the existing railway underbridge structure to be extended by approximately 19m. The A720 would also be raised in level at this point, compared to the existing layout. The existing railway underbridge has been designed such that it can accommodate an additional 5m depth of fill material. Therefore the A720 mainline level increase at this location is understood to be achievable without strengthening work to the existing structure.

NMU facilities would be incorporated in the form of a shared footway/cycleway which utilises the existing carriageway as far as possible. NMU routes would generally be offline from live carriageway. NMU routes would be provided on the existing A7 North, A7 South, A6106 Old Dalkeith Road and A6106 Millerhill Road. Where NMU routes run adjacent to the carriageway, shared facilities would be provided within the road verge and offset a minimum of 1.5m from the carriageway. At-grade crossings of A7 Link Road, A720 eastbound diverge slip, A720 eastbound merge slip, A720 westbound diverge slip and A720 westbound merge slip would be provided.

3.5 Option B

Option B – Grade Separation at Sheriffhall

Option B provides a grade separated roundabout at Sheriffhall, and has the least land-take of all emerging options. Vertical and horizontal realignment of the A720 would be required over an approximate length of 1600m and the A720 would be carried across the Sheriffhall Roundabout by two new bridges each with a span of approximately 40m. The A720 mainline would be raised up on embankments up to 9.9m high on approach to the Sheriffhall Roundabout crossings. The Sheriffhall Roundabout layout would be retained, but would be enlarged and become an 8-arm roundabout, connecting the A7 North, the A6106 Millerhill Road, the A6106 Old Dalkeith Road, A7 South and all A720 east and west facing slips.

The A720 eastbound merge slip and A720 westbound diverge slip cross the Borders Railway and would therefore require the existing railway underbridge structure to be extended by approximately 47m. The roundabout at Sheriffhall would be enlarged to 150m dimeter but is retained at its existing location, and would be reduced to three lanes in width. Minimal realignment of the roundabout arms would be required, with the exception of the A6106 Millerhill Road to the north which would be realigned over an approximate length of 550m.

NMU facilities would be incorporated in the form of a shared footway/cycleway and generally provided in the road verge and offset a minimum of 1.5m from the carriageway. NMU routes would be provided within the verge of A7 North, A7 South and A6106 Old Dalkeith Road. An NMU route, offline from the carriageway, would be provided on the existing A6106 Millerhill Road. At-grade crossings would be located on all roundabout arms and make use of splitter islands where available.

3.6 Option C

Option C – Dumbbell Grade Separation west of Sheriffhall

Option C provides a dumbbell grade separated junction west of Sheriffhall, with the A7 carried over the A720. The A7 would be realigned and carried over the A720 by a new overbridge located approximately 250m west of the existing Sheriffhall Roundabout and with an approximate span of 40m. The 80m diameter dumbbell roundabouts, located north and south of the A720, would be raised on embankments up to 9.8m in height.

The dumbbell roundabout to the north of the A720 would be a 4-arm roundabout, connecting the A720 eastbound diverge slip, the A7 North, the A720 eastbound merge slip and the A7 Link. The A7 North would be realigned for an approximate length of 585m tying in to the existing Shawfair Park roundabout. The A7 North would have embankments up to 5m in height on its approach to the north dumbbell roundabout.

The roundabout to the south of the A720 would be a 5-arm roundabout, connecting the A720 westbound merge slip, the A7 Link, the A720 westbound diverge slip, the realigned A6106 Old Dalkeith Road, and the realigned A7 South. The A7 South would be realigned over an approximate length of 250m tying into the existing Gilmerton Road roundabout. The realigned A6106 Old Dalkeith Road would be realigned for approximately 530m, and would have embankments up to 9.7m in height.

The A6106 Millerhill Road would be realigned for a length of approximately 760m. A 3-arm roundabout would be provided at the junction of the A6106 Millerhill Road and the realigned A7 North. The A6106 Millerhill Road would be largely at-grade with minimal embankments.

The A720 would be at-grade through Sheriffhall. The east facing slips would tie into the existing A720 mainline to the west of Borders Railway therefore no works would be required at the Borders Railway underbridge.

NMU facilities would be incorporated in the form of a shared footway/cycleway which utilises the abandoned sections of carriageway as far as possible. NMU routes would generally be offline from the live carriageway. NMU routes would be provided on the existing A7 North, A7 South, A6106 Millerhill Road and A6106 Old Dalkeith Road. Where NMU routes run adjacent to the carriageway, shared facilities would be provided within the road verge and offset a minimum of 1.5m from the carriageway. Grade separated crossing facilities would be provided with a dedicated NMU overbridge over the A720 and an NMU underpass below the new A6106 Old Dalkeith

Road. An at-grade crossing on the A6106 Millerhill Road would be provided close to the new A7 North roundabout.

3.7 Cost Estimate

3.7.1 Introduction

The following section provides an initial cost estimate for all scheme options. The following assessment has been carried out:

a. an initial capital cost estimate is provided for construction works, including preparation and supervision, using rates indexed up to quarter 4 2016;

b. the quantifiable items of the works have been measured and a cost per unit has been applied based on rates from Spons 2017 Price Book and comparable schemes;

c. other works elements have been assessed as a percentage of the total works costs; percentage allowances are detailed in the sections below;

d. preliminaries have been quantified as a percentage of the Roadworks costs in line with similar schemes. Percentage allowances have also been made at a scheme level for optimism bias; percentage allowances are described in the sections below; and

e. a review of the cost implications of risks associated with each of the schemes has been carried out in a Value Management Workshop (VfM2b). A value has been calculated to take account of risk and this has been added to each of the schemes based on the results of the workshop.

3.7.2 Preliminaries

Allowances for preliminaries have been estimated using a standard cost multiplier of 30% applied to the roadworks sub-total for each option.

3.7.3 Pavement

Full pavement construction has been considered when estimating the cost of pavements. Construction depth and composition varies across the A720 mainline, side roads and non-motorised user (NMU) routes. The areas of carriageway required were derived from the three dimensional MX model. The pavement costs are summarised in Table 3.7.3.

Table 3.7.3 - Pavement Cost Estimate

Option	New A720 carriageway (m)	New Side Roads (m)	New NMU Routes (m)	A720 Pavement Cost (£M)	Side Roads Pavement Cost (£M)	NMU routes Pavement Cost (£M)	Total Pavement Cost (£M)
Option A	37,795	50,681	7,069	3.442	3.515	0.216	7.173
Option B	37,850	41,722	5,562	3.447	2.894	0.170	6.511
Option C	35,348	48,562	6,993	3.219	3.368	0.214	6.801

3.7.4 Ancillaries

The costs of ancillary items associated with a road construction project are most easily expressed as a price per linear metre. For this cost estimate, a total ancillary cost for each option has been developed. Ancillary items at this stage include: site clearance; soiling and seeding; lighting; fencing; safety barriers and parapets; signs; road markings; kerbs and road drainage. The total estimated ancillary costs are summarised in Table 3.7.4.

Table 3.7.4 - Ancillaries Cost Estimate

Option	Total Ancillary Cost (£M)
Option A	4.552
Option B	4.042
Option C	4.376

3.7.5 Earthworks

Earthworks quantities were derived from the three dimensional MX model used to create the design options. Cut slopes are designed as 1 in 3 slopes and embankment slopes as 1 in 2 slopes. Areas of cutting that could potentially yield reusable material have been identified and it has been assumed that 70% of material excavated from these areas will be reused as fill. The cost estimates for all earthworks required by the options being considered are shown in Table 3.7.5.

Table 3.7.5 - Earthworks Cost Estimate

Option	Total Cut Volume (m^3)	Total Fill Volume (m^3)	Excavate, deposit & compact (m^3)	Import Fill & Compact (m^3)	Excavate & Deposit (m^3)	Total Earthworks Cost (£M)
Option A	89,422	471,021	26,386	444,636	63,036	16.918
Option B	41,153	456,293	7,746	448,547	33,407	15.447
Option C	32,086	353,561	8,934	344,627	23,152	11.763

3.7.6 Additional Geotechnical Works

Allowance has also been made for additional geotechnical works. Preliminary costs are included for mine working and mine entry treatment and other geotechnical works which support construction. The cost estimates for all earthworks required by the options being considered are shown in Table 3.7.6.

Table 3.7.6 – Additional Geotechnical Works Cost

Option	Mine Working Treatment (£M)	Mine Entry Treatment (£M)	Other Geotechnical Works (£M)	Total Cost of Additional Geotechnical Works (£M)
Option A	4.100	1.750	0.313	6.163
Option B	2.300	1.500	0.313	4.113
Option C	8.100	1.630	0.313	10.043

3.7.7 Structures

Structures will be required where the A7 crosses the A720 and where the A720 crosses the A7 or Borders Railway. An allowance for potential future widening of the A720 has been made to the proposed bridge layouts. A dedicated NMU structure over the A720 and an NMU underpass under the A6106 Old Dalkeith Road have been incorporated into Option C. Bridge costs are based on deck area rates from comparable schemes. A percentage allowance of 25% of bridge costs has been included to estimate the cost of piles. The estimated structure costs are summarised in Table 3.7.7.

Table 3.7.7 - Structures Cost Estimate

Option	Overbridges (£M)	Borders Rail Bridge (£M)	Pile Foundations (£M)	Retaining Walls (£M)	Culverts (£M)	Total Structures Cost (£M)
Option A	1.260	0.827	0.521	0.365	0.026	2.999
Option B	3.040	2.045	1.271	0.300	0.013	6.669
Option C	3.354	-	0.838	0.093	0.026	4.311

3.7.8 Landscaping, Accommodation Works and Statutory Undertakers

Comparable road schemes have been referenced to develop assumptions covering Accommodation Works, Statutory Undertakers and Landscaping costs. Accommodation Works have been estimated as 3% of the pavement, ancillaries, earthworks, additional geotechnical works and structures sub-total. Landscaping has been estimated as 1.5% of the pavement, ancillaries, earthworks, additional geotechnical works and structures sub-total. Statutory Undertaker costs have been estimated as being 10% of the pavement, ancillaries, earthworks, additional geotechnical works, structures, landscaping and environmental and accommodation works sub-total. The costs are summarised in Table 3.7.8.

Table 3.7.8 – Accommodation Works, Landscaping & Statutory Undertakers Cost Estimates

Option	Accommodation Works (£M)	Landscaping & Environment (£M)	Statutory Undertakers (£M)
Option A	1.134	0.567	3.950
Option B	1.103	0.551	3.843
Option C	1.118	0.559	3.897

3.7.9 Risk

As part of the assessment process, risk for design, procurement and construction stages was assessed for each option at the Stage 2 Value Management Workshop (VfM2b). The risks to the project were identified in a risk register and then categorised and assessed using a 5X5 Probability/Impact matrix. Further details can be found in the VfM2a Workshop report, provided within Part 1, Volume 3, Appendix 2 of this report.

Based on a probability of occurring, financial risks were quantified to output the minimum, most likely, and maximum costs associated with the risk. Cost parameters were reviewed in order to quantify the cost impact for the purposes of a quantified risk assessment and inclusion in the scheme cost estimate. The risk costs are summarised in Table 3.7.9.

Table 3.7.9 - Risk Estimate

Option	Risk (£M)
Option A	4.796
Option B	4.866
Option C	5.414

3.7.10 Land

The categorisation of zones for the cost estimate of land costs is based on the proposed local development plan. The District Valuer has provided an initial estimate of the land acquisition and compensation costs associated with each of the land use categories. The land cost estimate is based on the scheme footprint area plus an additional 3m from the toe of embankment or top of cut slopes to account for construction and maintenance requirements. The land costs are summarised in Table 3.7.10.

Table 3.7.10 - Land Cost Estimate

Option	Agricultural land (£M)	Agricultural land NW Quadrant (£M)	Development - Business (£M)	Total Land Cost (£M)
Option A	0.115	0.363	9.218	9.696
Option B	0.092	0.313	5.280	5.685
Option C	0.136	1.326	5.507	6.969

3.7.11 Optimism Bias

The scheme cost estimates also includes for optimism bias. Optimism bias is the demonstrated systematic tendency for appraisers to be overly optimistic about key parameters. For this reason, an uplift is applied to the risk adjusted cost. The uplift applied is dependent upon the nature of the scheme and the stage to which the scheme relates. Due to the incorporation of a risk value for each scheme option it has been decided that a 25% cost factor should be used for road and land cost items and a 44% cost factor used for bridges at this stage. Optimism bias costs are summarised in Table 3.7.11.

Table 3.7.11 - Optimism Bias Estimate

Option	Optimism Bias – Roads at 25% (£M)	Optimism Bias – Bridges at 44% (£M)	Optimism Bias – Land at 25% (£M)	Optimism Bias - Total (£M)
Option A	9.225	1.148	2.424	12.797
Option B	8.020	2.797	1.421	12.238
Option C	8.695	1.845	1.742	12.282

3.7.12 Professional Fees

An estimate of professional fees likely to be incurred throughout the duration of the project has been included. For scheme preparation, an industry standard fee of 9% of the Construction & Land Cost has been included, and 5% has been included for construction supervision. The professional fees estimate is summarised in Table 3.7.12.

Table 3.7.12 - Professional Fees Estimate

Option	Preparation at 9% (£M)	Supervision at 5% (£M)	Professional Fees - Total (£M)
Option A	7.434	4.130	11.564
Option B	6.894	3.830	10.724
Option C	7.130	3.962	11.092

3.7.13 Cost Estimate Summary

A summary of the cost estimates developed for each junction option, indexed to a quarter 4, 2016 price base, is shown in Table 3.7.13.

Table 3.7.13 - Cost Estimate Summary

	Option A (£M)	Option B (£M)	Option C (£M)
Prelims (30%)	11.852	11.531	11.692
Pavement	7.173	6.511	6.801
Ancillaries	4.552	4.042	4.376
Earthworks	16.918	15.447	11.764
Additional Geotechnical Costs	6.163	4.113	10.043
Structures	2.999	6,669	4.311
Landscaping & Environmental (1.5%)	0.567	0.552	0.559
Accommodation Works (3%)	1.134	1.103	1.119
Statutory Undertakers (10%)	3.951	3.844	3.897
Risk	4.796	4.866	5.414
Civils Sub-total	**60.106**	**58.678**	**59.975**
Optimism Bias (25% roads, 44% bridges)	10,372	10.817	10.540
Construction Total	**70.478**	**69.495**	**70.515**
Land (Including 25% OB)	12.121	7.106	8.711
Construction & Land Total	**82.599**	**76,601**	**79.226**
Preparation (9%)	7.434	6.894	7.130
Supervision (5%)	4.130	3.830	3.961
Total Scheme Cost	**94.163**	**87.325**	**90.318**

4. Engineering Assessment

4.1 Introduction

This section describes the findings of the engineering assessment of the three design options. A description of the engineering features of each option is provided covering design standards, alignment, geotechnical issues, structures, NMU provision, drainage, impact on public utilities and buildability.

4.2 Engineering Standards

4.2.1 Design Standards and Best Practice Guidance

The alignment and design of the options has been developed in accordance with current design standards and industry best practice as follows:

Design Manual for Roads and Bridges (DMRB);

- TD9 (*'Highway Link Design'*);
- TD16 ('*Geometric Design of Roundabouts'*);
- TD22 ('*Layout of Grade Separated Junctions'*);
- TD27 ('*Cross Sections and Headrooms'*);
- TD36 ('*Subways for Pedestrians and Pedal Cyclists Layout and Dimensions'*); and

Transport Scotland Design Guidance;

- Roads for All – Good Practice Guide for Roads (2013); and
- Cycling by Design (2010)

4.2.2 Road Geometry

Road geometry is designed in accordance with DMRB TD 9/93 'Highway Link Design', which details the standards for horizontal and vertical geometry dependent on the design speed of the road. Design speed is an index which links road function, traffic flow and terrain to the design parameters of stopping sight distance (SSD) and curvature to ensure that a driver is presented with a reasonably consistent speed environment, as per guidance set out in DMRB TD 9/93 'Highway Link Design'. The selected design speed should be consistent with the speeds drivers are likely to expect on a given road therefore, for the preliminary layouts, the design speed has been based on the speed limits of the existing roads, as detailed in Table 4.2.2.1.

Table 4.2.2.1 - Design Speeds

Road	Existing Speed Limit	Proposed Design Speed
A720 Edinburgh City Bypass	70mph	120kph (70mph)
A7 North	50mph	85kph (50mph)
A7 South	60mph	100kph (60mph)
A6106 Millerhill Road	60mph	100kph (60mph)
A6106 Old Dalkeith Road	40mph	70kph (40mph)
Merge/Diverge Slip Roads	N/A	70kph (40mph)

The horizontal and vertical geometry adopted for each of the design options has been provided in accordance with the standards set out in TD 9/93 'Highway Link Design', based on the proposed design speeds. The design parameters are detailed in Table 4.2.2.2.

Table 4.2.2.2 – Design Parameters

Road	Desirable Min Horizontal Radius (m)	Desirable Min Vertical Crest K	Absolute Min Vertical Sag K	Min & Max Vertical Gradient (+/-)	Desirable Min SSD (m)
A720 Edinburgh City Bypass	1020	182	37	> 0.5% & < 4%	295
A7 North	510	55	20	> 0.5% & < 6%	160
A7 South	720	100	26	> 0.5% & < 6%	215
A6106 Millerhill Road	720	100	26	> 0.5% & < 6%	215
A6106 Old Dalkeith Road	360	30	20	> 0.5% & < 6%	120
Merge/Diverge Slip Roads	360	30	20	> 0.5% & < 6%	120

Transition curves are spiral curve elements used to allow road users to adjust to the change in direction in a comfortable manner, based on accepted rates of centripetal acceleration. Over transition curves, designers typically remove camber or normal crossfall and replace it with superelevation, whereby the outer channels are lifted/lowered in an appropriate manner to provide a crossfall towards the inside of the curve.

From DMRB TD 9/93, the length of transition curve is given as $L = \frac{V^3}{46.7 \times q \times R}$ where 'q' should not exceed 0.3m/sec^3, although in difficult cases it may be necessary to increase the value up to 0.6m/sec^3. Where felt necessary, transition lengths have been designed to the higher limit as noted above to allow tie-in to the local road network, which minimises impact on the local environment. These cases have been listed as departures from standard within the geometry review and account for the majority of departures recorded.

4.2.3 Cross Section

The existing A720 is a two lane all-purpose dual carriageway, as defined in DMRB TD 27/05 'Cross Sections and Headrooms'. The cross section provided for realigned lengths of the A720 are as per the existing cross sections: typically two 7.3m wide carriageways with 1.0m nearside and offside hardstrips, 2.5m verges and 2.5m central reserve. It should be noted that although the A720 mainline includes 1.0m nearside hardstrips, the A720 bridge spans would allow for future widening of the A720.

The cross sections adopted for the side roads are based on the TD 27/05 criteria for rural all-purpose single carriageway roads and comprise a 7.3m carriageway with 1.0m hardstrips and 2.5m verges as a minimum.

The cross sections adopted for the merge and diverge slip roads are based on the TD 27/05 criteria for rural all-purpose connector roads and comprise two 3.65m lanes with 1.0m hardstrips and 2.5m verges as a minimum.

Verge and central reserve widening for SSD has been applied to the design layouts where necessary and feasible to ensure the full visibility envelope is contained within the maintained cross section. Typical cross sections are detailed in Figure 4.2.3.

4.2.4 Grade Separated Junctions

Grade separated junction layouts have been designed in accordance with standards set out in DMRB TD 22/06 'Layout of Grade Separated Junctions'. This standard includes guidance on weaving lengths, and guidance on merge and diverge layouts. Grade separated junctions are located regularly along the length of the A720 Edinburgh City Bypass, and the junctions immediately adjacent to Sheriffhall – Gilmerton Junction and Millerhill Junction – are both grade separated.

TD 22/06 sets out minimum criteria on weaving lengths provided between adjacent grade separated junctions. The weaving length is the distance between a merge and a successive diverge. The weaving length is a function of the design speed, and for the A720 Edinburgh City Bypass, the desirable minimum weaving length is 1000m.

TD 22/06 also sets out the minimum distance between successive merges (merge followed by a merge) and successive diverges (diverge followed by a diverge). The distance between successive merges/diverges is a function of the design speed and for the A720 Edinburgh City Bypass the minimum spacing is 450m.

TD 22/06 also sets out guidance for the layout of merge and diverge slips. The length of the elements which make up merges and diverges (nose, taper, auxiliary lanes if provided), are based on the design speed. The layout of the merges and diverges (provision of any auxiliary lanes to increase capacity and avoid queuing etc.) is based on the mainline traffic and merging/diverging traffic flows. Standard merge/diverge layouts have been adopted for the options.

4.2.5 Roundabouts

Roundabouts have been designed in accordance with the standards set out in DMRB TD 16/07 'Geometric Design of Roundabouts'. TD 16/07 details the criteria for the circulatory carriageway and the entry and exit layout arrangements on the roundabout arms.

The inscribed circle diameter (ICD) of the roundabout is the diameter of the largest circle that can be fitted into the junction outline. TD 16/07 does not set a maximum requirement for the ICD but recommends that designers are mindful of the potential for high circulatory speeds when the ICD exceeds 100m.

TD 16/07 stipulates that the width of the circulatory carriageway must be between 1.0 and 1.2 times the maximum entry width.

Entry width is the width of the carriageway at the point of entry, measured from the right hand end of the give way line along the normal to the nearside kerb. TD 16/07 states that the entry width must be not less than 3m or more than 4.5m, with the 4.5m value appropriate at single lane entries and values of 3 to 3.5m appropriate at multilane entries.

Entry flaring is the localised widening at the point of roundabout entry to increase capacity. The average effective flare length is the average length over which the entry widens. TD 16/07 recommends a desirable minimum average effective flare length of approximately 25m in rural areas.

TD 16/07 recommends that the entry kerb radius (nearside) should be not be less than 20m or greater than 100m to accommodate large goods vehicles and prevent inadequate entry deflection. It also recommends that the entry angle for traffic joining the circulatory carriageway should be between 20 and 60 degrees.

The entry path radius is a measure of the deflection to the left of vehicles entering a roundabout. It governs the speed of vehicles through the junction and determines whether drivers are likely to give way to circulating vehicles. TD 16/07 states that the smallest radius of the entry path from a point 50m in advance of the give way line to where it joins the circulatory carriageway must not exceed 100m.

The exit width is the width of the carriageway on the roundabout exit and is measured in a similar manner to the entry width. It is the distance, measured along the normal to the nearside kerb, between the nearside kerb and the edge of any splitter island or central reserve where it intersects with the outer edge of the circulatory carriageway. TD 16/07 recommends that the exit width should accommodate one more traffic lane than is present on the link downstream and that the width should reduce at a taper of 1:15 to 1:20.

TD 16/07 recommends that values for the exit kerb radius (nearside) should exceed the largest entry kerb radius and be between 20m and 100m.

4.2.6 Vehicle Road Restraint System

Due to the preliminary nature of the design at DMRB Stage 2, no detailed vehicle road restraint system design has been undertaken. Vehicle Road Restraint Systems (RRS) will be incorporated at hazards, such as traffic signs, high embankments and structures, in accordance with the requirements of DMRB TD 19/06 'The Requirement for Road Restraint Systems'.

A continuous RRS will be required in the central reserve throughout the A720 and has therefore been taken into account when designing the width required to achieve the necessary SSD for both scheme options, and in identifying potential Departures from Standard.

4.2.7 Non-motorised Users (NMUs)

Outline NMU routes have been developed in accordance with the standards set out in Transport Scotland's 'Roads for All – Good Practice Guide for Roads (2013)' and 'Cycling by Design (2010)' guidance documentation as well as DMRB TD 36/93 'Subways for Pedestrians and Pedal Cyclists Layout and Dimensions'.

'Roads for All – Good Practice Guide for Roads' contains Transport Scotland's requirement for inclusive design in the construction, operation and maintenance of road infrastructure. Where guidance and design standards presented within the guide conflict with the DMRB, the Roads for All document takes precedence. Roads for All sets out minimum and maximum criteria on footways and headroom. The guidance stipulates a minimum footway width of 2m and a maximum longitudinal gradient of 5%. The guidance also sets a general minimum headroom requirement of 2.6m which reduces to 2.3m for short obstructions.

'Cycling by Design' contains Transport Scotland's requirements for the design of cycleways and shared facilities. Where guidance and design standards presented within the guide conflict with the DMRB, the Cycling by Design document takes precedence. Cycling by Design sets the desirable minimum width as 3.0m for shared facilities, which should incorporate a maximum crossfall of 2.5%. Geometric design is also covered within the document and a desirable minimum radius of 15m is advised for horizontal alignment. This can be reduced to an absolute minimum radius of 4.0m at junctions where turning speeds should be low. The desirable maximum longitudinal gradient is given as 3%, with an absolute maximum of 5%.

TD 36/93 'Subways for Pedestrian and Pedal Cyclists Layout and Dimensions' outlines the geometry and cross-section standards for NMU subways, access ramps and stairs. For unsegregated shared use underpasses, less than 23m in length, TD 36/93 stipulates a 2.4m minimum headroom clearance and 4m minimum width. The guidance also recommends gradients are kept below 5%.

4.3 Engineering Description of Options

4.3.1 Option A

Option A is a grade separated dumbbell arrangement at Sheriffhall with the A720 elevated and passing over the A7 carried by a new overbridge with a span of approximately 35m. The proposed layout plan and profiles are shown on Figures 4.3.1.1 to 4.3.1.3.

4.3.1.1 Geometry

Option A aims to provide geometry appropriate for each road's design speed in accordance with DMRB TD 9/93 "Highway Link Design". However, due to the constrained nature of the study area, relaxations in both the horizontal and vertical geometry are included where necessary to minimise the impact on the local environment.

At least desirable minimum geometry standards are provided throughout the A720 mainline. A summary of the geometry standards achieved for all links associated with Option A are shown in Table 4.3.1.1.

Table 4.3.1.1 – Option A Geometry Summary

Road	Section Length (m)	Min Horizontal Radius (m)	Min Vertical Crest K	Min Vertical Sag K
A720 Edinburgh City Bypass	1600	1200	182	37
A7 North	582	510	55	20
A7 Link	173	straight	30	no sag
A7 South	375	720	55	20

Road	Section Length (m)	Min Horizontal Radius (m)	Min Vertical Crest K	Min Vertical Sag K
A6106 Millerhill Road	636	720	100	26
A6106 Old Dalkeith Road	238	720	no crest	20
A720 Eastbound Diverge Slip	550	360	30	20
A720 Eastbound Merge Slip	643	360	30	20
A720 Westbound Diverge Slip	655	360	30	20
A720 Westbound Merge Slip	635	720	30	20

A summary of the anticipated departures from standard for Option A can be found in Section 4.9

4.3.1.2 Roundabouts

Two at-grade, 5-arm, roundabouts with 80m ICD and 10.95m circulatory carriageway are provided north and south of the A720 mainline and connected by the A7 Link. Entry and exit width and kerb radius are designed to standard as required by TD 16/07 and are summarised in Tables 4.3.1.2 and 4.3.1.3.

Table 4.3.1.2 – Option A Roundabout Entry Layout Summary

Road	Min Entry Width (m)	Max Entry Width (m)	Min Entry Kerb Radius (m)	Max Entry Kerb Radius (m)
North Dumbbell Roundabout	9.0	9.1	20	35
South Dumbbell Roundabout	9.0	9.2	20	35

Table 4.3.1.3 – Option A Roundabout Exit Layout Summary

Road	Min Exit Width (m)	Max Exit Width (m)	Min Exit Kerb Radius (m)	Max Exit Kerb Radius (m)
North Dumbbell Roundabout	7.1	7.3	40	40
South Dumbbell Roundabout	7.1	7.4	40	40

Entry flaring has been applied over a standard 50m length on all arms on approach to the roundabouts at this stage. Two lane exits are provided on all roundabout arms with 1 in 15 exit tapers applied to return to single carriageway width downstream where necessary.

A preliminary assessment of the entry angle and entry path radius identified that all roundabout approaches achieved the required criteria.

4.3.1.3 Stopping Sight Distance

A review of SSD has been undertaken and verge widening has been provided where necessary. Desirable minimum SSD has been provided on the A720 mainline and on the immediate approaches to junctions with the exception of the A6106 Old Dalkeith Road tie-in which is constrained by the existing bridge structure at the junction with Melville Gate Road. Otherwise the SSD has been relaxed if necessary to minimise the impact of verge widening on the local environment. A summary of the minimum SSD achieved for Option A is contained in the Table 4.3.1.4.

Table 4.3.1.4 – Option A SSD Summary

Road	Desirable Min SSD (m)	Min SSD Provided – approach to junction (m)	Min SSD Provided – out-with approach to junction (m)
A720 Edinburgh City Bypass	295	295	295
A7 North	160	160	154.5
A7 Link	120	120	120
A7 South	215	215	215
A6106 Millerhill Road	215	215	171.2
A6106 Old Dalkeith Road	120	100.2	120
A720 Eastbound Diverge Slip	120	120	120
A720 Eastbound Merge Slip	120	120	120
A720 Westbound Diverge Slip	120	120	108.6
A720 Westbound Merge Slip	120	120	104.9

A summary of the anticipated departures from standard for Option A can be found in Section 4.9

4.3.1.4 Weaving Lengths

The weaving lengths provided on the A720 between the new Sheriffhall Junction and Millerhill Junction are 1020m on the westbound carriageway and 1080m on the eastbound carriageway. The distance between the successive eastbound diverges at Gilmerton Junction and the new Sheriffhall Junction is 820m. The distance between the successive westbound merges at the new Sheriffhall Junction and Gilmerton Junction is 790m.

4.3.1.5 Structures

A new single span structure is required to carry the A720 over the side roads at Sheriffhall. Preliminary consideration of the structural form of the A720 bridge for Option A can be found in Section 4.8.2.

The regraded A720 mainline would be raised at the Borders Railway underbridge, with approximately 5m depth of additional fill. The existing Borders Railway underbridge would require to be extended by approximately 19m to allow construction of the east facing slip roads.

4.3.1.6 NMUs

Option A provides a 3m wide shared cycleway/footway which utilises sections of the abandoned A7 North, A7 South, A6106 Old Dalkeith Road and A6106 Millerhill Road carriageway as well as the verges of the realigned links. At least minimum geometry standards in line with Transport Scotland's 'Roads for All – Good Practice Guide for Roads' and 'Cycling by Design' are provided throughout.

Option A provides an NMU route length of approximately 1290m from the Melville Gate Junction to Sheriffhall Park and Ride. Three NMU at-grade crossings would be associated with this route for Option A located on the A720 westbound diverge, A7 Link and A720 eastbound merge. There are no grade separated crossing facilities provided for Option A. NMU facilities will be considered in more detail at Stage 3 for the preferred option.

4.3.1.7 Private Accesses

Indicative access proposals are positioned outwith the area of roundabout entry flaring and exit tapering on the major carriageway and match the existing level of access as closely as possible. Indicative accesses for Option A are shown on Figure 4.3.1.1 and are as follows:

- Direct access to the properties at Summerside from the A7 North, approximately 140m north of the dumbbell roundabout.
- Direct access to Sheriffhall House, Old Sheriffhall Farm and the Network Rail maintenance access for the Borders Railway from the A6106 Old Dalkeith Road, approximately 115m south of the dumbbell roundabout.

4.3.2 Option B

Option B provides a grade separated roundabout at Sheriffhall. Vertical and horizontal realignment of the A720 would be required over an approximate length of 1600m and the A720 would be carried across the Sheriffhall Roundabout by two new bridges each with spans of approximately 40m. The proposed layout plan and profiles are shown on Figures 4.3.2.1 to 4.3.2.3.

4.3.2.1 Geometry

Option B aims to provide geometry appropriate for each road's design speed in accordance with DMRB TD 9/93 "Highway Link Design". However, due to the constrained nature of the study area, relaxations in both the horizontal and vertical geometry are included where necessary to minimise the impact on the local environment.

At least desirable minimum geometry standards are provided throughout the A720 mainline. A summary of the geometry standards achieved for all links associated with Option B are shown in Table 4.3.2.1.

Table 4.3.2.1 – Option B Geometry Summary

Road	Section Length (m)	Min Horizontal Radius (m)	Min Vertical Crest K	Min Vertical Sag K
A720 Edinburgh City Bypass	1600	1150	182	37
A7 North	286	510	55	20
A7 South	429	510	55	20
A6106 Millerhill Road	577	360	100	26
A6106 Old Dalkeith Road	126	720	30	20
A720 Eastbound Diverge Slip	482	510	30	20
A720 Eastbound Merge Slip	595	720	30	20
A720 Westbound Diverge Slip	581	510	30	20
A720 Westbound Merge Slip	568	720	30	20

A summary of the anticipated Departures from Standard for Option B can be found in Section 4.9

4.3.2.2 Roundabouts

An at-grade, 8-arm, grade separated roundabout with 150m ICD and 10.95m circulatory carriageway is provided at the existing Sheriffhall Roundabout location. Entry and exit width and kerb radius are designed to standard as required by TD 16/07 and are summarised in Tables 4.3.2.2 and 4.3.2.3.

Table 4.3.2.2 – Option B Roundabout Entry Layout Summary

Road	Min Entry Width (m)	Max Entry Width (m)	Min Entry Kerb Radius (m)	Max Entry Kerb Radius (m)
Grade Separated Roundabout	7.4	9.7	20	20

Table 4.3.2.3 – Option B Roundabout Exit Layout Summary

Road	Min Exit Width (m)	Max Exit Width (m)	Min Exit Kerb Radius (m)	Max Exit Kerb Radius (m)
Grade Separated Roundabout	6.4	7.3	30	40

Entry flaring has been applied over a standard 50m length on all arms on approach to the roundabout at this stage. Two lane exits are provided on all roundabout arms with 1 in 15 exit tapers applied to return to single carriageway width downstream where necessary.

A preliminary assessment of the entry angle and entry path radius identified that all roundabout approaches achieved the required criteria.

4.3.2.3 Stopping Sight Distance

A review of SSD has been undertaken and verge widening has been provided where necessary. Desirable minimum SSD has been provided on the immediate approaches to junctions. Otherwise the SSD has been relaxed if necessary to minimise the impact of verge widening on the local environment. A summary of the minimum SSD achieved for Option B is contained in the Table 4.3.2.4.

Table 4.3.2.4 – Option B SSD Summary

Road	Desirable Min SSD (m)	Min SSD Provided – approach to junction (m)	Min SSD Provided – out-with approach to junction (m)
A720 Edinburgh City Bypass	295	295	295
A7 North	160	160	160
A7 South	215	215	215
A6106 Millerhill Road	215	215	160.3
A6106 Old Dalkeith Road	120	120	105.4
A720 Eastbound Diverge Slip	120	120	120
A720 Eastbound Merge Slip	120	120	120
A720 Westbound Diverge Slip	120	120	117.8
A720 Westbound Merge Slip	120	120	117.3

A summary of the anticipated Departures from Standard for Option B can be found in Section 4.9

4.3.2.4 Weaving Lengths

The weaving lengths provided on the A720 between the new Sheriffhall junction and Millerhill Junction would be 1100m on the eastbound carriageway and 1040m on the westbound carriageway. The distance between the new

Sheriffhall junction and Gilmerton Junction is 808m between successive diverges on the eastbound carriageway, and 850m between successive merges on the westbound carriageway.

4.3.2.5 Structures

Two new single span structures are required to carry the A720 over the new grade separated roundabout at Sheriffhall. Preliminary consideration of the structural form of the A720 bridges for Option B can be found in Section 4.8.3.

The regraded A720 mainline would be raised at the Borders Railway underbridge, with approximately 5m depth of additional fill. The existing Borders Railway underbridge would require to be extended by approximately 47m to allow construction of the east facing slip roads.

4.3.2.6 NMUs

Option B provides a 3m wide shared cycleway/footway within the verge of A7 North, A7 South and A6106 Old Dalkeith Road. The abandoned carriageway of the A6106 Millerhill Road is used to provide a fully segregated facility in this area. At least minimum geometry standards in line with Transport Scotland's 'Roads for All – Good Practice Guide for Roads' and 'Cycling by Design' are provided throughout.

Option B provides an NMU route length of approximately 1370m from the Melville Gate Junction to Sheriffhall Park and Ride. Four NMU at-grade crossings would be associated with this route for Option B, located on the A6106 Old Dalkeith Road, A7 South, A720 westbound merge and A720 eastbound diverge. Splitter islands would be used within the crossing arrangement where available. There are no grade separated crossing facilities provided for Option B. NMU facilities will be considered in more detail at Stage 3 for the preferred option.

4.3.2.7 Private Accesses

Indicative access proposals are positioned outwith the area of roundabout entry flaring and exit tapering on the major carriageway and match the existing level of access as closely as possible. Indicative accesses for Option B are shown on Figure 4.3.2.1 and are as follows:

- Direct access to the properties at Summerside from the A7 North, approximately 90m north of the grade separated roundabout.
- Direct access to Sheriffhall House and Old Sheriffhall Farm from the A6106 Old Dalkeith Road, approximately 80m south of the grade separated roundabout.

4.3.3 Option C

Option C provides a dumbbell grade separated junction west of Sheriffhall, with the A7 carried over the A720. The A7 would be realigned and carried over the A720 by a new overbridge located approximately 250m west of the existing Sheriffhall Roundabout and with a span of approximately 40m. The proposed layout plan and profiles are shown on Figures 4.3.3.1 to 4.3.3.3.

4.3.3.1 Geometry

Option C aims to provide geometry appropriate for each road's design speed in accordance with DMRB TD 9/93 "Highway Link Design". However, due to the constrained nature of the study area, relaxations in both the horizontal and vertical geometry are included where necessary to minimise the impact on the local environment.

At least desirable minimum geometry standards are provided throughout the A720 mainline. A summary of the geometry standards achieved for all links associated with Option C are shown in Table 4.3.3.1.

Table 4.3.3.1 –Option C Geometry Summary

Road	Section Length (m)	Min Horizontal Radius (m)	Min Vertical Crest K	Min Vertical Sag K
A720 Edinburgh City Bypass	1480	1200	182	37
A7 North pt.1	163	straight	55	20
A7 North pt.2	338	360	55	20
A7 Link	158	straight	30	20
A7 South	247	255	no crest	20
A6106 Millerhill Road	756	360	100	26
A6106 Old Dalkeith Road	526	360	30	20
A720 Eastbound Diverge Slip	361	360	30	20
A720 Eastbound Merge Slip	441	360	30	20
A720 Westbound Diverge Slip	424	510	30	20
A720 Westbound Merge Slip	471	510	30	20

A summary of the anticipated Departures from Standard for Option C can be found in Section 4.9

4.3.3.2 Roundabouts

4-arm and 5-arm roundabouts, on embankment, with 80m ICD and 10.95m circulatory carriageway, are provided north and south of the A720 mainline and connected by the A7 Link. An at-grade, 3-arm roundabout, with 50m ICD and 7.3m circulatory carriageway, is also provided on the realigned A7 North to connect to the A6106 Millerhill Road.

The entry and exit width and kerb radius are designed to standard as required by TD 16/07 and are summarised in Tables 4.3.3.2 and 4.3.3.3.

Table 4.3.3.2 – Option C Roundabout Entry Layout Summary

Road	Min Entry Width (m)	Max Entry Width (m)	Min Entry Kerb Radius (m)	Max Entry Kerb Radius (m)
North Dumbbell Roundabout	8.6	9.5	30	35
South Dumbbell Roundabout	8.5	9.5	20	25
A7 North Roundabout	6.3	7.9	20	25

Table 4.3.3.3 – Option C Roundabout Exit Layout Summary

Road	Min Exit Width (m)	Max Exit Width (m)	Min Exit Kerb Radius (m)	Max Exit Kerb Radius (m)
North Dumbbell Roundabout	7.3	7.3	40	40
South Dumbbell Roundabout	7.0	7.3	30	40
A7 North Roundabout	7.0	7.3	30	40

Entry flaring has been applied over a standard 50m length on all arms on approach to the roundabouts at this stage. Two lane exits are provided on all roundabout arms with 1 in 15 exit tapers applied to return to single carriageway width downstream where necessary.

A preliminary assessment of the entry angle and entry path radius identified that all roundabout approaches achieved the required criteria.

4.3.3.3 Stopping Sight Distance

A review of SSD has been undertaken and verge widening has been provided where necessary. Desirable minimum SSD has been provided on the immediate approaches to junctions with the exception of the A6106 Old Dalkeith Road tie-in which is constrained by the existing bridge structure at the junction with Melville Gate Road. Otherwise the SSD has been relaxed if necessary to minimise the impact of verge widening on the local environment. A summary of the minimum SSD achieved for Option C is contained in the Table 4.3.3.4.

Table 4.3.3.4 – Option C SSD Summary

Road	Desirable Min SSD (m)	Min SSD Provided – approach to junction (m)	Min SSD Provided – out-with approach to junction (m)
A720 Edinburgh City Bypass	295	295	295
A7 North pt.1	160	160	160
A7 North pt.2	160	160	120.2
A7 Link	120	120	120
A7 South	215	215	215
A6106 Millerhill Road	215	215	161.1
A6106 Old Dalkeith Road	120	76.1	90.8
A720 Eastbound Diverge Slip	120	120	120
A720 Eastbound Merge Slip	120	120	120
A720 Westbound Diverge Slip	120	120	120
A720 Westbound Merge Slip	120	120	120

A summary of the anticipated Departures from Standard for Option C can be found in Section 4.9

4.3.3.4 Weaving Lengths

The weaving lengths provided between the new Sheriffhall junction and Millerhill Junction would be 1540m on the eastbound carriageway and 1510m on the westbound carriageway. The distance between the new Sheriffhall junction and Gilmerton Junction is 720m between successive diverges on the eastbound carriageway, and 720m between successive merges on the westbound carriageway.

4.3.3.5 Structures

A new single span structure is required to carry the A7 Link over the A720 west of Sheriffhall. Preliminary consideration of the structural form of the A720 overbridge for Option C can be found in section 4.8.4.

The proposed A720 and east facing slips tie-in to the existing A720 mainline in advance of the Borders Railway, therefore no extension would be required of the Borders Railway underbridge.

Dedicated NMU structures are proposed for the grade separated crossing of the A720 mainline and A6106 Old Dalkeith Road. A single span NMU overbridge would be provided over the A720 and east facing slips and an NMU underpass would be provided below the A6106 Old Dalkeith Road. The NMU overbridge would have an approximate span of 70m and the underpass an approximate length of 20m

4.3.3.6 NMUs

Option C utilises the abandoned carriageway of the A7 North, A7 South, A6106 Millerhill Road and A6106 Old Dalkeith Road to create a 3m wide, fully segregated shared cycleway/footway. At least minimum geometry standards in line with Transport Scotland's 'Roads for All – Good Practice Guide for Roads' and 'Cycling by Design' are provided throughout.

Option C provides an NMU route length of approximately 1280m from the Melville Gate Junction to Sheriffhall Park and Ride. One NMU at-grade crossings would be associated with this route for Option C located on the A6106 Millerhill Road and a dedicated NMU overbridge would provide a grade separated crossing over the A720 mainline and east facing slips. The approximate route length from the Melville Gate Junction to Sheriffhall Park and Ride does not consider the length of ramps required for access onto the NMU overbridge.

4.3.3.7 Private Accesses

Indicative access proposals are positioned outwith the area of roundabout entry flaring and exit tapering on the major carriageway and match the existing level of access as closely as possible. Indicative accesses for Option C are shown on Figure 4.3.3.1 and are as follows:

- Direct access to the properties east of the existing A7 North from the realigned A7 North, approximately 100m north of the A7 North Roundabout.
- Direct access to the properties at Summerside from the A6106 Millerhill Road, approximately 100m east of the A7 North Roundabout.
- Direct access to Sheriffhall House, Old Sheriffhall Farm and the Network Rail maintenance access for the Borders Railway from the A6106 Old Dalkeith Road, approximately 310m south-east of the dumbbell roundabout.

4.4 Geology, Geomorphology and Ground Conditions

4.4.1 Cuttings

Earthworks will be required that include forming new cuttings for all three options. Cuttings generally will be less than 5m deep, but locally could increase to 8m deep. Based on the available ground investigation information most cuttings are expected to be formed in cohesive deposits of glacial till or more granular deposits of glaciofluvial silty sand with gravel, or both. The deepest cutting for all options is in glacial sand and gravel to the north of the existing roundabout.

Based on experience of working with mixed Scottish glacial deposits, the potential for shallow groundwater, and taking into account the guidance provided in CIRIA Report C504 'Engineering in Glacial Tills' (CIRIA, 1999), it is considered that, for preliminary assessment a slope profile of 1v in 3h is adopted for all cuttings in glacial deposits. A 1v in 3h slope profile is also recommended for cuttings formed in the other types of deposits that the PSSR indicates may be present in all of the options being considered. Glaciofluvial and alluvial deposits may be very silty and may become potentially unstable in cuttings without drainage measures. Detailed design informed by site specific ground investigation and appropriate drainage measures may permit steeper profiles, especially for smaller heights of cutting slopes.

The eventual slope profile in cuttings may be dictated by the groundwater level. A high ground water level may necessitate a slacker slope in conjunction with pre-drainage, deep interceptor drainage and slope drainage. Also, potential water-bearing horizons in the glacial till can have a significant impact on slope stability if not recognised and allowed for in the design and during construction. Slope face treatment measures (such as slope drainage, granular blankets or toe support) may need to be employed to ensure the stability of the cutting slopes.

Temporary excavations in glacial till and glaciofluvial sands and gravels are likely to remain stable in the short-term providing groundwater levels are lower than the excavation level and water-bearing granular horizons are absent in the cohesive glacial till.

Difficult temporary conditions were encountered in excavations into water bearing glaciofluvial deposits (sometimes known as 'running sands') on the Borders Railway construction works to the south of the city bypass in the Sheriffhall Mains area. Any excavation into these 'running sands' will require special advance dewatering and other construction measures to ensure base and side stability is maintained in trenches and other excavations during construction. Advance deep drainage or staged excavation together with temporary and permanent slope face drainage measures will be necessary for stability of the cutting slopes in the short-term and long-term. Parts of Option A and Option B run through the area on embankment which will reduce the potential exposure to these circumstances. However, any temporary excavation, drainage trenches or foundation excavations required beneath the earthworks footprint may be made more challenging by such conditions. Temporary stability of completed fills or road pavements adjacent to excavations would require special consideration.

Excavation into the existing A720 embankments will be required where new proposed slip roads merge with the existing road alignments, mainly in Option A and Option B. The existing embankments are constructed with engineered fill materials predominantly sourced from mining waste or waste industrial by-products. These comprise red blaes (well burnt colliery spoil or spent oil-shale waste) at the base of embankments beneath black/grey unburnt colliery spoil, which is occasionally interbedded with thinner layers of sand fill and cohesive fill derived from natural soil deposits.

Both burnt and unburnt colliery spoil (also known as "red blaes" and "black blaes" respectively) and spent oil-shale may contain high levels of heavy metals and sulphates (including pyrite minerals). The metals content also makes them potentially phytotoxic (toxic to plants). The high sulphate content increases their aggressivity to concrete. Contaminants may leach where water infiltrates the fill materials which could result in higher levels of contaminants occurring in underlying and surrounding ground or watercourses. The materials are also frost susceptible which makes them prone to frost heave if not suitably modified or protected.

Unburnt colliery spoil could contain high levels of carbonaceous material and can be combustible if they are not fully compacted to reduce access to oxygen in conjunction with other precaution. There is therefore some potential for combustion in limited circumstances during excavation. Specialist laboratory testing carried out as part of ground investigations can assist to assess the potential for combustion.

A comprehensive suite of contamination testing and resulting assessments should be carried out at ground investigation stages to determine the characteristics of the existing embankment fill and to inform the risk assessment, both for design of permanent works and for construction works that will disturb or interface with the existing artificial materials and made ground present on the site.

The geotechnical features anticipated in the cuttings for each option are summarised in Table 4.4.1 below:

Table 4.4.1 - Cutting Considerations

	Option A	Option B	Option C
Deep cuttings > 5m	Yes	No	No
Strengthened/reinforced cutting slopes	No	No	No
Possible high groundwater	Yes	Maybe	Yes
Extensive or thick soft soils	No	No	Yes
Extensive or thick loose soils	Yes	No	Yes
Excavation of A720 fill	Yes	Yes	No
Potentially contaminated arisings and groundwater	Yes	Yes	Less than A or B
Total Score	**5**	**2.5**	**3.5**

Notes: A higher score indicates a greater number of geotechnical features so potentially a less favourable option.

From the above summary it is apparent that Option A appears least favourable in terms of cuttings. Option C appears most favourable.

None of the features anticipated would be expected to cause insurmountable engineering difficulties with regards to the proposed scheme but they will have an impact on the cost of construction and may cause localised environmental impacts. The potential challenges identified are not necessarily unique for a scheme of this type and recognised methods could be employed to overcome them.

4.4.2 Embankments

Embankments are proposed, up to a maximum of 8.5m high. The predominant founding stratum is expected to be Glacial Till which is a good founding stratum for embankments depending on the extent of near surface weathering and associated softening. Based on the BGS historic boreholes large thicknesses of soft low strength (undrained shear strength below 50kPa) weathered glacial till material are not anticipated, however this will be confirmed by a detailed ground investigation. If encountered soft weathered Glacial Till is likely to require excavation or other design measures prior to construction of the main embankment. Beyond a certain depth excavation and backfilling with selected fill material may cease being cost effective and ground improvement measures could be more economic and in some circumstances will be necessary because of limitations on the land available or other constraints.

Glaciofluvial sands and gravels, as recorded around the Sheriffhall roundabout extending north to Campend and south to Sheriffhall Mains, are expected to provide an adequate founding material for embankments as the SPT N values in these deposits indicate they have a medium dense to dense relative density. Any loose granular soils with high silt or clay contents occurring beneath high embankments may require replacement or in-situ improvement (such as compaction) if present at ground level.

Alluvial deposits are expected east and southeast of Sheriffhall, possibly underlying the westbound off-slips of Option A and Option B. The alluvial deposits are indicated to comprise between 1m and 6m of loose fine clayey sands and soft clays which will not provide an adequate founding material for embankment construction. Where the deposits are of limited depth it is recommended that these soils are replaced prior to placing embankment fill. Replacement will not be practical where there are large thicknesses of soft/loose material, and in these cases ground improvement techniques or staged construction will be considered (depending on feasibility of staged construction in time restricted online widening conditions).

The cutting excavations may yield some site-won fill which could be re-used for embankment construction. Embankments constructed from cohesive fill material derived from Glacial Till or glacio-fluvial materials are expected to provide adequate stability with side slopes at between 1v:2.5h and 1v:3h, depending on

embankment height and underlying ground conditions. However, the amount of acceptable site won fill generated by cutting excavation is anticipated to be much less than the required fill volume. As such much of the embankment will be formed of imported fill, which can be placed to form side slopes of 1v in 2h, again depending on embankment height and underlying ground conditions. This has the benefit of reducing the footprint of the earthworks, which in turn reduces the area of mine workings stabilisation.

To maximise re-use of site won material zoned fills may be considered for construction of new embankments.

The two main issues, which are common to all three options to a varying degree, are excessive settlements of embankments associated with consolidation of thick drift deposits of cohesive soils, particularly alluvial deposits, soft glacial deposits and non-engineered made ground and differential settlement, in particular between approach embankments and their structures.

Compressible soils under the embankments will consolidate during construction of the embankment, and post-construction will experience a degree of consolidation under the full embankment load. In particular at the high approach embankments to the A720 structures staged construction (if feasible in online widening construction conditions) or surcharging or other design measures may be required to ensure consolidation settlements are within acceptable limits.

Differential settlements may occur associated with changing drift deposits at Sheriffhall Roundabout, with cohesive Glacial Till to the west and granular glaciofluvial deposits to the east. Additionally, differential settlement between existing fills and new/widened embankment fills may occur, in particular in Option A and B where the new fill east of Sheriffhall roundabout is to be placed over potentially loose/soft soils.

Cross-sections prepared at the construction stage (circa 1983) of the A720 city bypass embankments east of Sheriffhall Roundabout show 2.0m of soft to firm clayey silty sand/sandy silt over a hard sandy silty clay underlying the embankment. Transverse differential settlement between the new widened portion of embankment and original embankment fill could be moderated by excavation of all soft and loose soils before deposition of the new fills. The embankment side slope also provides a degree of transition that could make the transverse differential settlement tolerable to the in-service road pavement. If none of these solutions are possible or cannot achieve the required performance then engineering measures such as surcharging, staged construction or ground improvement can be employed. Sufficient land should be acquired for the works to permit safe temporary excavations to be constructed for removal of soft/loose soils

Further differential settlements could affect Option A and Option B where new fill is to be placed over and around an existing box tunnel structure at Borders Railway. Drawings of the structure show granular fill placed below existing underpass sections. Similar treatment would be required beneath any new fill to limit differential settlements or assist to reduce the time for settlement of the new fills to take place.

The fill elements in Option C are considered likely to be affected most by watercourses and associated poor ground conditions as the Dean Burn and other watercourses or drainage ditches cross the alignments and the westbound merge slip fill is shown to be placed over an existing pond. This pond will need to be dewatered prior to construction.

Embankment construction on soft cohesive or compressible deposits and water-bearing sand and gravel may require a granular starter layer or drainage blanket. A granular starter layer and/or a drainage layer enclosed by a geotextile separator fabric was observed beneath the existing A720 embankment fill where it was exposed by the Borders Railway construction works. A 0.5m thick granular starter layer is shown on design drawings for the bypass earthworks.

A ‘reinforced earth foundation raft’ 16.0m wide, 100m long and approximately 1.0m deep is shown on the A720 design drawings beneath the southeast and northwest approaches/limbs of the Sheriffhall roundabout. It spans across the line of the Sheriffhall fault and its purpose was to mitigate differential ground movement across the fault line [Note – Atkins/Amey correspondence in 2007 suggests a concrete raft was constructed]. Unless the raft (concrete or reinforced earth) it is removed it will be present beneath the proposed embankment footprint of Option A, and Option B to a lesser degree. Differential settlement may occur between fill placed above the ‘raft’ and fill placed onto the surrounding un-reinforced natural ground.

The geotechnical issues anticipated in the embankments for each option are summarised in Table 4.4.2.

Table 4.4.2 - Embankment Considerations

	Option A	Option B	Option C
High embankments >5m	Yes	Yes	Yes
Consolidation Settlement	Yes	Yes	Yes
Differential Settlement	Yes	Yes	Yes
Extensive or thick soft soils	Yes	Yes	Yes
Extensive or thick loose soils	Yes	Yes	Yes
Construction over unconsolidated man-made fill	Yes	Yes	Yes
Possible high groundwater	Maybe	Maybe	Yes
Possible shallow mine workings	Yes	Yes	Yes
Water courses and ponds	Maybe	Maybe	Yes
Strengthened/reinforced earthfill slopes where fill clashes with OHTL pylons	Yes	Yes	No
Online embankment widening	Yes	Yes	Less than A or B
Temporary stability adjacent to running lanes	Yes	Yes	Less than A or B
Interface with operational Borders Rail line	Yes	Yes	Less than A or B
Total Score	**12**	**12**	**10.5**

Notes: A higher score indicates a greater number of geotechnical issues so potentially a less favourable option.

The summary table shows that the embankment works on all three options encounter similar issues to varying degrees. Option A and B are very similar in that a large amount of the embankment work comprises on-line widening and raising the existing A720. Option C involves more off-line embankment construction and so is slightly more favourable in terms of embankments.

None of the issues anticipated would be expected to cause insurmountable engineering difficulties with regards to the proposed scheme. However, they will have an impact on the cost of construction and may cause localised environmental impacts. The potential difficulties identified are not necessarily unique for a scheme of this type and recognised methods could be employed to overcome them.

4.4.3 Structures

Despite seismic activity in the future being considered as a low risk, given the faulted structure of the geology beneath the site and the historic mining activity, even if all appropriate measures are taken to treat shallow coal workings, it is recommended that consideration is given to the use of highly flexible structures incorporating high degrees of redundancy designed specifically to cater for significant differential ground movements. This could include greater use of earthworks embankments and cuttings to minimise the lengths of structures, box underpasses rather than discrete end supports, in addition to structures that are capable of taking-up movement by systems of bearings and jacking.

Weak and fractured rock caused by geological age movements could underlie the site around the Sheriffhall fault. Fractured rock may be weathered and weakened at considerable depth in fault zones and it should not be assumed that the weathered zone is confined to a zone near rockhead. Improving the rock mass by pressure grouting with high strength grouts in combination with spread footings may be an economic alternative to deep piles into fresh un-weathered bedrock.

As a founding material for smaller principal structures, high to very high strength very stiff Glacial Till material can be expected to perform adequately when spread foundations are adopted. However there is a potential that piled foundations may be required for larger structures or structural types that are more sensitive to differential

settlement (eg structures with integral bridge decks). Weathered Glacial Till will not provide an adequate bearing stratum for principal structures (including retaining walls)., and approach embankments containing the end supports of bridges. Where end supports are located in approach fills designs are required which remove the weathered till or transmit the loadings to a deeper adequate bearing stratum because of additional settlement caused directly by the embankment loading.

In comparison, soft low to medium strength weathered Glacial Till material with an undrained shear strength below 50kPa will not be suitable as a founding material for spread foundations and is therefore likely to require excavation and replacement by selected granular fill or ground improvement if present at founding level. If thick deposits of soft material are encountered, consideration will need to be given to the use of a piled foundation solution. Based on the BGS historic borehole records thick deposits of soft low strength highly compressible material are not anticipated across much of the site

Differential settlement of structures associated with different foundation strata at Sheriffhall Roundabout with Glacial Till to the west and Glaciofluvial Deposits to the east will have to be considered in detailed design, as will differential settlement between structures and the high approach embankments. The position of the settlement mitigation raft at the fault relative to the proposed foundations also needs considered. Monitoring will be required to verify that the magnitude and rate of settlement of structural elements and associated earthworks are consistent with design estimates and requirements at different stages of construction.

The above considerations affect the principal highway structures of all options to some degree. The structures of Option A and Option B lie on the downthrow side of the fault and in the ‘shatter zone’ as indicated on the A720 design drawings. As such the structures for these options may be underlain by more disturbed, less competent bedrock. The structure for Option C is to the south of the fault so may be underlain by more competent bedrock. However, the Option C structure is in an area likely to be affected by shallow mine workings and in close proximity to possible mine entry locations.

4.4.4 Mineral Extraction – Coal Mine Workings

Shallow underground mine workings are anticipated to occur beneath a large proportion of the study area and these may pose a risk to surface stability in the form of both localised surface subsidence (‘crown holes’) or more widespread (‘aerial’) subsidence. Targetted ground investigation is required to determine the full extent of former mining activity, the corresponding risks of future surface instability affecting the completed infrastructure and extents of mine working treatment.

It is currently unclear whether any mine workings treatment was undertaken below the existing A720 city bypass prior to its construction. Certainly mine abandonment plans suggest that workings in the Splint coal (dated 1832 – 1835) extend from Summerside to Lugton Bogs, thus underlying the present line of the A720 city bypass. Given the age of the working and their proximity to the seam outcrop it is likely that these would be shallow workings undertaken by the stoop and room method.

Additionally the Environmental Geology maps for the South East Wedge (dated 1981) show the same area from Summerside to Lugton Bogs to be an area of ‘Recorded workings within 50m of the surface’, whereas the surrounding area is noted as ‘Workable coals within 50m of the surface’.

Historic boreholes in the area record seams of coal and other associated minerals occur at shallow depth.

Each of the three options is underlain in part by the coal measures strata and potential shallow mine workings. If further ground investigation identifies that the underlying coal seams have been worked then mine workings treatment will possibly be required. Figures 4.4.4.1 to 4.4.4.3 show potential areas of shallow mine workings treatment required beneath each of the three options.

The indicative range of anticipated treatment areas is presented in Table 4.4.4. Cost estimates are presented in Section 3.7 of this report.

Table 4.4.4 - Mine Workings Treatment

	Area (m^2)		Area Difference (m^2)	Comments
	Min	Max		
Option A	71,676	104,525	32,849	-
Option B	41,263	70,717	29,454	Least potential mine workings treatment in both geology cases.
Option C	110,747	214,952	104,205	Greatest potential mine workings treatment in both geology cases. Most affected by geology change.

The estimates in Table 4.4.4 are preliminary only and are based on various assumptions. The main assumptions are:

- Known shallow worked seams beneath the alignment are assumed to require treatment until they are overlain by rock cover greater than 10 times the seam thickness.
- Minimum estimate assumes geology is as shown on BGS geology Sheet 32E (Bedrock), dated 2003 which amended the geology previously shown on older 1:10,560 scale County Series maps, dated 1966.
- Maximum estimate assumes geology is as shown on the 1:10,560 scale County Series map, which has four additional coal seams shown beneath the earthworks to the south of the Sheriffhall Fault.
- Strata are displaced downwards by at least 15m east of a fault which trends northwest-southeast near the A7 northern leg of the Sheriffhall roundabout. As a result the Splint and Rough seams are 15m deeper to the east of the A7 (north) and therefore will not require treatment.
- Any shallow mine workings beneath the existing A720 were treated prior to the construction of the road. So, mine working treatment is not required beneath the existing A720.

Mine entry treatment is covered in Section 4.4.5.

4.4.5 Mineral Extraction – Coal Mine Entries

Associated with the historic mining activity in the area there are a number of mine entries, which comprise features such as mine shafts and adits. Table 4.4.5 shows the number of mine entries within influencing distance (taken to be 30m) of the earthworks outline. A 30m offset allows for drift deposit thickness to be deeper than anticipated and allows for earthworks slopes to become slacker from 1v in 2h to 1v in 3h. Figures 4.4.4.1 to 4.4.4.3 show the mine entries within influencing distance of the earthworks outline for each of the three options.

Mine entry positions revealed by the different desk study sources may include duplicates of the same mine entry due to lack of consistency or accuracy between the different information sources. For instance, there are six possible mine entry locations at Ch 1600m all of which may represent a single entry. These particular mine entries are likely to have been treated as part of the A720 works. The 'corrected' numbers in Table 4.4.5 attempts to eliminate this duplication, where possible, in order to give a better estimate of the number of potential mine entries that need to be considered for each of the options.

Table 4.4.5 - Mine Entries Summary

Option	Mine entries ('corrected')	Mine entries already treated	Untreated mine entries ('corrected')
Option A	19	4	15
Option B	16	4	12
Option C	17	4	13

Four mine entries directly beneath the A720 city bypass earthworks footprint are likely to have been treated prior to construction of the city bypass and this has been assumed in this estimate. Four entries are shown on the

A720 Tender Drawings to be either capped or grouted (no as-built data has been seen). Details of all other mine entries are not available, so it is assumed they are not treated and, if within influencing distance of the earthworks or structures would require treatment.

Mine entries with shallow overburden could be treated by infill grouting and construction of a reinforced concrete cap or cover , however it may become impractical to excavate more than 5m overburden to install a cap. Mine entries with deeper overburden (greater than 10m deep) would be treated by infill grouting, with a cap constructed at a higher level within the superficial deposits if required

All options may encounter a number of mine entries which will require investigation and thereafter possibly treatment (capping and infill grouting). Options B and C will potentially encounter the fewest number of mine entries and Option A will potentially encounter the most number of mine entries.

4.4.6 Re-Use of Excavated Materials

The cutting excavations may yield some site-won fill which could be re-used for embankment construction and as landscape fill. In addition where the vertical road alignments are close to existing ground level the road box may yield site-won fill.

The Glacial Till encountered across the site is anticipated to be a Class 2C (stony cohesive) fill. Glaciofluvial sands and gravel may generate some Class 1 fill. Closer to the existing Sheriffhall Roundabout boreholes show a mix of sands, gravels and clays. As such the excavated site-won fill is likely to be on the boundaries of Class 1/Class 2 material. To the east of the existing Sheriffhall Roundabout more soft/loose deposits are recorded in historic boreholes which are not likely to be suitable for re-use without treatment to reduce moisture content and render them acceptable for use as general fill.

Further ground investigation is required to delineate and characterise the materials likely to be excavated from a selected scheme option.

There is expected to be very little rock excavation. Limited rock excavation may be necessary for Option C where the new A6106 cutting crosses an area of shallow bedrock, with rockhead potentially occurring at around 5m below ground level.

Excavation into the existing A720 embankments will be required where new proposed slip roads merge with the existing earthworks, mainly in Options A and B. As discussed elsewhere the existing embankments are formed of engineered fill comprising red blaes at the base of the embankment under black/grey colliery spoil (possibly unburnt) occasionally interbedded with thinner layers of sand fill and cohesive fill derived from re-worked Glacial Till. These fill materials may contain chemical contaminants and may contain small proportions of combustible materials that require to be assessed and managed during ground investigation and during construction works. These types of materials are permitted for use in the Specification for Highway Works, subject to compliance with various provisions. The design and construction of the Works should take this into account when considering the use of fill materials and zoning of fill materials.

A full suite of contamination testing should be completed at GI stage and as compliance testing during the construction phase to determine the characteristics of the existing embankment fill and thereafter establish its potential for re-use or the requirements for disposal to landfill, and its classification for landfill tax.

Option B is expected to yield the least site-won fill, and Option A is expected to yield most site-won fill. However, as Option A requires a greater volume of fill the net import for Option A and Option B could be almost equal. Option A and Option B will involve most excavation of the A720 fill. Precautions may be required when the fill material is disturbed to manage the risk of combustion. As noted previously colliery spoil may contain contaminants. All three options may encounter soft and loose soils in the excavations which could be unsuitable for re-use in their as-dug condition. Such materials would have to be rendered acceptable by modification of moisture content before they could be used as general fill.

From initial assessment Option C is favourable in terms of cut / fill balance and re-use of excavated materials as it has least disposal volume, and least imported fill volume. Table 4.4.6 summarises the option comparison.

Table 4.4.6 - Cut/Fill/ Balance and Material Re-use

	Option A	Option B	Option C
Cut volume	High (3)	Medium (2)	Low (1)
Fill Volume	High (3)	Medium (2)	Low (1)
Net imported fill	Medium (2)	High (3)	Low (1)
Total Score	**8**	**7**	**3**

Notes: A higher score indicates a potentially less favourable option.

 # - for this purpose it is assumed that most materials will be acceptable for re-use within the scheme, albeit after treatment to render them acceptable.

4.4.7 Pavement and Capping

With the exception of soft weathered material the Glacial Till can be expected to perform adequately as a sub-grade material, although a CBR of 4% would be the upper bound CBR value suitable for use in preliminary assessment. Where weathered soft Glacial Till material is present as the subgrade a capping layer may be required, and depending on the thickness and stiffness of the in-situ subgrade improvement may also be necessary to allow a design CBR of 2.5% to be used in the pavement design.

Glaciofluvial sands and gravels are a predominantly granular material and would be expected to perform adequately as a subgrade, with CBR between 5% and 10% at least, providing the fines content is low and the subgrade is drained and protected from inundation.

In areas of high groundwater dewatering during the works and prior to completion of formation would be required to prevent deterioration of the subgrade.

Option A and Option C are less favourable as they involve greater lengths of cut and at-grade earthworks, where the in-situ subgrade strength and stiffness may be poor for various reasons, including more instances of loose and/or soft soils and potentially high groundwater. Option B is more favourable for pavement foundation design as it is mostly on fill where the subgrade strength and stiffness can be dictated by design and construction choices in the zoning and selection of the new embankment fill forming the subgrade.

4.4.8 Contamination

In summary there are no significant risks to the Scheme from contaminated land.

The site contains made ground associated with a number of roads, including the existing A720 City Bypass, as well as the Borders Railway. In addition due to the underlying Coal Measures strata, the site has a history of underground coal mining. As such potentially contaminated areas noted across the site may include colliery spoil, backfilled clay pits and sand pits and/or abandoned mine entries.

The land surrounding the existing road and railway infrastructure is predominantly used for arable farmland and has been since early historical mapping. Potential contaminants associated with pesticides/ fertilisers may be present on site resulting from farming activities.

Other features which may be a potential source of contamination are bunds of made ground/re-worked soils formed during construction of the A720 (in the 1980's) and Borders Railway (in 2010's), disused sewage works, disused water works, disused railway, former landfill, fuel dealers and a nursery. These areas may have associated contamination and they require targeted ground investigation.

Option A and Option B, and to a much lesser extent Option C, involve excavation into the existing A720 embankment east of Sheriffhall roundabout. The embankment is likely to comprise colliery spoil and red blaes which have been used as embankment fill material. Ground investigation and testing is required to determine whether these fill materials present a contamination source.

If excavations are undertaken within areas of historical landfills/pits or areas where significant thickness of made ground is present there is a potential for contaminated groundwater to be encountered in these areas. Locally dewatering measures and treatment or special disposal of the water discharges may be required to deal with the presence of potentially contaminated groundwater.

All three options are in the vicinity of potential sources of contamination as is illustrated by Table 4.4.8. No single option appears better or worse than the others in terms of contamination based on the information available at this stage.

Table 4.4.8 - Potential Sources of Contamination

Option	Potential Sources of Contamination
Option A	Works would be undertaken in the close proximity of potential contamination sources including a registered waste transfer site at Sheriffhall Farm, former fuel dealers and railway land. Excavation into A720 embankments which contain potentially contaminated fill.
Option B	Route does not intersect any potential contamination sources except made ground known to be present on site. Works would be undertaken in close proximity to earth bund south of A720 and a registered waste transfer site at Sheriffhall Farm. Excavation into A720 embankments which contain potentially contaminated fill.
Option C	Route intersects earth bund (unknown composition) south of A720. Works are undertaken in close proximity to potential contamination sources including former fuel dealers, disused sewage works and former railway land.

4.4.9 Conclusion

The three options have been assessed against a number of geotechnical considerations such as embankments, cuttings, mine workings, pavement conditions re-use potential of material and contaminated land.

The assessment has found that all three options encounter similar issues to varying degrees. None of the issues anticipated would be expected to cause insurmountable engineering difficulties with regards to the proposed scheme. However, they will have an impact on the cost and manner of construction and may cause localised environmental impacts. The potential challenges identified are not necessarily unique for a scheme of this type and recognised methods could be employed to overcome them. The major challenge is to deal with these aspects in a satisfactory manner while having to construct the earthworks in a fragmented sequence and phasing that is dictated by the constraints of the existing A720 City Bypass operations.

4.5 Hydrology, Hydrogeology and Drainage

4.5.1 Consultation

Consultation was undertaken with SEPA during Stage 1 of the study. General comments only were returned due to the high level nature of the proposals at time of consultation. Further contact was made at the beginning of the Stage 2 study but SEPA noted the initial comments would be applicable until the proposals were developed further.

At Stage 1, SEPA requested investigation into the scope for installing Sustainable Urban Drainage Systems (SuDS) for any new hard-standing areas or retro-fitting SuDS for larger areas of existing road. SEPA recommended that reference be made to the ‘SuDS Manual’ and ‘SuDS for Roads’ documents for guidance on the appropriate drainage method and level of provision for a scheme of this nature.

SEPA guidance in line with the Water Environment (Controlled Activities) (Scotland) Regulations 2011 states that Sheriffhall will require a Simple License as the surface water discharge will be from motorways/trunk roads which are new or enlarged. Further consultation will be undertaken with SEPA in the development of the Stage 3 drainage design.

4.5.2 Basis of Design

‘SuDS for Roads’ outlines the requirement for two levels of treatment in general cases. In addition to the SuDS guidance, all new road drainage design shall be in accordance with HD 33 – Surface and Sub-surface Drainage Systems for Highways. The drainage design seeks to replicate natural runoff conveyance and minimise impact on the natural environment.

The proposed Sheriffhall drainage strategy is to provide an edge of carriageway or over the edge drainage system which feeds into filter drains or swales and then attenuation ponds. All new components will be lined to

ensure no infiltration of carriageway runoff into protected groundwater. Consideration will be given to utilising the existing drainage systems. This can potentially be achieved for online sections where the profile is similar to existing.

The profiles of the proposed junction layout options, localised topography, watercourse locations and catchment areas influence the location and size of each attenuation pond.

4.5.3 Stage 2 Outline Drainage Design

4.5.3.1 Drainage Strategy

A review of Stage 2 junction layouts was undertaken to determine the primary catchment areas and an outline drainage strategy. The A720 is elevated on embankment over the at-grade side roads for Options A and B, while the A720 remains at-grade for Option C. Design high and low points and existing topography were considered as part of this exercise. The future direction of flow towards discharge points will remain broadly similar to existing for the junction layouts, however each catchment area will be required to incorporate SuDS components close to the source of runoff to provide the two levels of treatment required prior to outfall.

4.5.3.2 Option A

Option A can be divided into three primary catchment areas. Catchment area one includes the A720 and slip roads from the western tie-in to the Borders Railway underpass, the dumbbell roundabouts, A7 Link, A7 South and A6106 Old Dalkeith Road. Flow from the A720 would be distributed along the slip roads and towards the existing outfall location at the A6106 Old Dalkeith Road joining the other sources of runoff from the catchment area.

Catchment area two includes runoff flow from the A7 North and A6106 Millerhill Road. The A7 North generally falls towards the northern dumbbell roundabout. From here, A7 North runoff flow would be conveyed into the A6106 Millerhill Road drainage system and to an outfall location north.

Catchment area three would carry runoff from the sections of the A720 and east facing slips east of the Borders Railway underpass. The rest of the catchment area falls to the east towards an unconfirmed outfall.

4.5.3.3 Option B

Catchment areas are similar to option A. The design is divided into three catchment areas which drain to outfalls at the A6106 Old Dalkeith Road, A6106 Millerhill Road and the A720 east.

4.5.3.4 Option C

Option C can be divided into three general catchment areas which broadly cover similar sections as Options A and B. For Option C, the side roads are elevated on embankment over the at-grade A720 and this results in some variations in the intermediate flow direction of runoff.

Catchment area one includes the A720 from its western tie-in to approximately 100m east of Sheriffhall, the A7 Link, dumbbell roundabouts, slip roads, A7 South and A6106 Old Dalkeith Road. The runoff principally flows towards the low point at the existing Sheriffhall Roundabout via the A720 and then southwards to join runoff from the realigned A7 South and A6106 Old Dalkeith Road for treatment and discharge.

Catchment area two includes the A7 North and A6106 Millerhill Road, similar to Options A and B. The A7 North falls to a low point approximately 150m north of the A6106 Millerhill Road roundabout. Flow would be transferred back towards the roundabout from this point to connect into the A6106 Millerhill Road drainage system for treatment and discharge to the north.

Catchment area three includes the area of A720 from the high point approximately 100m east of Sheriffhall to the eastern tie-in. The outfall for flow from this section would be located to the east.

4.5.3.5 SuDS

Indicative runoff storage volume requirements were calculated taking account of the catchment areas, soil types and rainfall volumes. The catchment areas consist of the impermeable pavement area as well as that of any

adjacent cut slopes. Based on an attenuation pond depth of 2m, the approximate footprint areas of the ponds were developed. Table 4.5.4 outlines the catchment areas and approximate attenuation pond footprint sizes.

Table 4.5.4 – Catchment Areas and Initial Sizing of Attenuation Ponds

	Option A			Option B			Option C		
	Positively Drained Catchment Area (Ha)	Impermeable Area (Ha)	Approx SuDS footprint (m^2)	Positively Drained Catchment Area (Ha)	Impermeable Area (Ha)	Approx SuDS footprint (m^2)	Positively Drained Catchment Area (Ha)	Impermeable Area (Ha)	Approx SuDS footprint (m^2)
Catchment 1	8.93	5.66	1,320	9.99	5.39	1,130	7.66	5.64	1,410
Catchment 2	2.33	1.20	240	1.97	0.88	170	2.89	1.54	320
Catchment 3	1.65	1.57	430	1.81	1.58	420	1.21	1.21	340

The SuDS footprint is generally proportionate with the overall scheme footprint. An allowance has been made for SuDS provision within the construction and land cost estimates presented in Section 3.7 of this report.

4.6 Public Utilities

Preliminary inquiries were made to the major utility operators, in accordance with Appendix C2 of the Code of Practice to the New Roads and Streetworks Act 1991, to establish the presence of their apparatus and assess the impact on each of the junction improvement options.

Responses were received from Vodafone, BT Openreach, Scottish Gas Networks, Scottish Water, Scottish & Southern Energy, and Scottish Power Energy Networks, who all have equipment within the study area. Responses were also received from Virgin Media, National Grid and Mobile Broadband Network, who all indicated no equipment within the study area.

Information provided by the major utility providers has been used to assess any impact that their apparatus may have upon each of the options. Details of the utilities information received are described in Section 2.2.8 and reproduced on Figures 2.2.8.1 to 2.2.8.4

4.6.1 Electricity

The impact of electricity apparatus on each option is summarised in Table 4.6.1. Diversion of low voltage distribution lines are unlikely to add significantly to the cost of the junction options, therefore only the medium and high voltage transmission network has been considered at this stage.

Table 4.6.1 – Impact of Electricity Apparatus

Option	SPEN 275kV O/H Crossings	SPEN 33kV O/H Crossings	SPEN 33kV U/G Crossings	SPEN 11kV O/H Crossings	SPEN 11kV U/G Crossings	SSE U/G Crossings
Option A	6	13	9	7	0	0
Option B	3	10	4	6	0	0
Option C	6	8	7	10	0	0

There is a substantial amount of electricity apparatus within the study area. Of particular note is the presence of Scottish Power 33kV overhead cables, which cross A7 South, A720 and A7 North. The overhead cables have a

significant impact on all options as they run north-south through the study area and further investigation would be required.

Scottish Power 275kV overhead cables also run parallel to the A720 to the north of the study area. Option B would have a minimal impact in terms of the 275kV lines. Generally, Option A and Option C have more impact on Electricity apparatus although all options would require diversions.

4.6.2 Scottish Water

The impact of Scottish Water apparatus on each of the junction options is summarised in Table 4.6.2.

Table 4.6.2 – Impact of Scottish Water Apparatus

Option	Water Main Conflict
Option A	3
Option B	3
Option C	6

Option A would require approximately 480m of water main diversions; Option B would require approximately 210m of water main diversions and Option C would require approximately 580m. Although all options would require diversions, Option B would have the least impact on Scottish Water apparatus.

4.6.3 Scotland Gas Networks

The impact of Scotland Gas Networks apparatus on each of the junction options is summarised in Table 4.6.3.

Table 4.6.3 – Impact of Scotland Gas Networks Apparatus

Option	MP Mains Conflicts
Option A	7
Option B	5
Option C	9

There is a significant presence of medium pressure gas mains in the vicinity of the existing Sheriffhall Roundabout and these would affect all options. Diversions would be required on the A720 mainline, A7 North and A7 South. Option A would require approximately 535m of gas network diversions; Option B would require approximately 350m of network diversions and Option C would require approximately 520m. Although all options would require diversions, Option B would have the least impact on Scottish Gas Networks.

4.6.4 Telecommunications

The impact of the telecommunications apparatus on each of the junction options is summarised in Table 4.6.4.

Table 4.6.4 – Impact of Telecommunication Apparatus

Option	No. of BT Crossings	Mobile Phone Mast
Option A	15	1
Option B	13	1
Option C	16	1

All options would interface with BT apparatus, either through Sheriffhall Roundabout, at Gilmerton Junction, at A772 Gilmerton Road, at A7 North and South, at A6106 Millerhill Road or at A6106 Old Dalkeith Road. Option A would require approximately 1635m of diversions; Option B would require approximately 1080m of diversions and Option C would require 1760m. Although all options require significant diversions to BT apparatus, Option B would have the lowest impact.

All options would impact on the T-Mobile/3 mast west of Sheriffhall and would therefore require diversions. The Vodafone mast at Gilmerton Junction is not affected by any of the options.

4.6.5 Summary

Option B has the least impact on utility apparatus, followed by Options A and C with little to separate them. Further consultation and C3 budget estimates for the anticipated diversionary work for the preferred scheme will be required at Stage 3. Whilst there is a substantial amount of statutory undertaker plant in and around the study area, at this stage it is not considered that any of the interfaces are significant enough to justify the elimination of any of the options.

4.7 Buildabitlity

4.7.1 Introduction

All options have been assessed in terms of buildability. The main issues for consideration are the likely impacts of the construction activity on the existing A720 trunk road, the local road network and the Borders Railway.

Options A and B occupy a predominantly online footprint and raise the A720 mainline above its current vertical alignment over side roads which remain approximately at-grade. By contrast, Option C provides a new offline junction, west of Sheriffhall and raises the side roads above their current vertical alignment over the at-grade A720 mainline.

The Borders Railway underbridge is located approximately 250m east of the existing Sheriffhall Roundabout and currently is not wide enough to accommodate the A720 east facing slip roads for Options A and B. Widening the bridge presents a significant challenge with the operational railway. The proposed A720 and east facing slips tie-in to the existing A720 mainline in advance of the Borders Railway with Option C, therefore no extension would be required of the Borders Railway underbridge for this option.

Indicative construction sequences are illustrated on Figures 4.7.2.1 to 4.7.4.5 and outlined in the sections below. It should be noted that the outline construction sequence is subject to change following further design development of the preferred option.

4.7.2 Option A

An initial construction phasing proposal has been developed which minimises restrictions on existing traffic movements. Six main phases are proposed as described below and shown in Figures 4.7.2.1 to 4.7.2.6.

4.7.2.1 Phase 1

Offline works would be undertaken in this phase, including construction of the dumbbell roundabouts, large sections of the A6106 Old Dalkeith Road, A6106 Millerhill Road, A7 North and A7 South and part of the A7 Link within the central island of the existing roundabout. The Borders Railway underbridge would be extended to accommodate the partial construction of the east facing slips. The slip roads would be partially constructed, tying

in at-grade to the A720 mainline at the extents of the scheme. Traffic management on the A720 mainline would be required to construct the slip road tie-ins but traffic would continue to occupy the existing carriageway with no vehicle movement restrictions.

4.7.2.2 Phase 2

Traffic would be diverted off the A720 mainline onto the partially constructed slip roads with temporary carriageway linking back into the existing Sheriffhall Roundabout to maintain all vehicle movements. Construction of the raised A720 on embankment would commence between the east and west scheme extents and the areas occupied by the temporary carriageway. Traffic management would be required on the slip roads to maintain safe clearance between the construction activity and the live traffic.

4.7.2.3 Phase 3

The at-grade tie-ins at the extents of the A7 North, A7 South, A6106 Millerhill Road and A6106 Old Dalkeith Road would be completed under traffic management. The remaining sections of the slip roads over the existing carriageway would be constructed. Vehicle movements would change considerably throughout this phase with an evolving traffic management layout required. At the conclusion of the phase, north-south vehicle movements across the A720 would be temporarily restricted due to the A7 Link being incomplete and removal of access onto the existing Sheriffhall Roundabout.

4.7.2.4 Phase 4

The remaining sections of the at-grade A7 Link would be constructed over the abandoned Sheriffhall Roundabout circulatory carriageway and the temporary carriageway utilised in earlier phases removed. As the existing side roads are redundant in this phase, work would also commence on the offline NMU routes. Full north-south vehicle movements would be returned on completion of the A7 Link.

4.7.2.5 Phase 5

The remaining sections of the raised A720 mainline and the abutments of the A7 underbridge would be constructed. Traffic would continue to be directed via the slips roads and through the dumbbell roundabouts with no vehicle movement restrictions.

4.7.2.6 Phase 6

The A7 underbridge would be installed to complete the new A720 carriageway. Closure of the A7 link road and restrictions in north-south vehicle movements would be temporarily required for the completion of the works.

4.7.3 Option B

An initial construction phasing proposal has been developed which minimises restrictions on existing traffic movements. The construction sequencing for Option B is similar to that proposed for Option A. Five main phases are proposed as described below and shown in Figures 4.7.3.1 to 4.7.3.5.

4.7.3.1 Phase 1

Offline works would be undertaken in this phase, including large sections of the new roundabout, the A6106 Old Dalkeith Road, A6106 Millerhill Road, A7 North and A7 South. The Borders Railway underbridge would be extended initially to accommodate the partial construction of the east facing slips. The slip roads would be partially constructed, tying in at-grade to the A720 mainline at the extents of the scheme. Traffic management on the A720 mainline would be required to construct the slip road tie-ins however traffic would continue to occupy the existing carriageway with no vehicle movement restrictions.

4.7.3.2 Phase 2

Traffic would be diverted off the A720 mainline onto the partially constructed slip roads with temporary carriageway linking back into the existing Sheriffhall Roundabout to maintain all vehicle movements. Construction of the raised A720 on embankment would commence between the east and west scheme extents and the areas occupied by the temporary carriageway. Traffic management would be required on the slip roads to maintain safe clearance between the construction activity and the live traffic.

4.7.3.3 Phase 3

The at-grade tie-ins at the extents of the A7 North, A7 South, A6106 Millerhill Road and A6106 Old Dalkeith Road would be completed under traffic management. The remaining sections of the new circulatory carriageway and slip roads over the existing carriageway would be constructed. Vehicle movements would change considerably throughout this phase with an evolving traffic management layout required. At the conclusion of the phase, traffic would occupy the new roundabout, slip roads and side roads.

4.7.3.4 Phase 4

The retained earthworks and bridge abutments in the centre island of the new roundabout would be formed. Traffic management would be required to provide access to the work area and maintain safe clearance between the works and the live traffic.

4.7.3.5 Phase 5

The Sheriffhall Roundabout underbridges would be installed to complete the new A720 carriageway. Closure of the roundabout and restrictions in north-south vehicle movements would be temporarily required for the completion of the works.

4.7.4 Option C

An initial construction phasing proposal has been developed which minimises restrictions on existing traffic movements. The construction sequencing for Option C benefits from it having a predominantly offline footprint however challenges are presented with the construction activity in the vicinity of the existing Sheriffhall Roundabout. Five main phases are proposed as described below and shown in Figures 4.7.4.1 to 4.7.4.5.

4.7.4.1 Phase 1

Offline works would be undertaken in this phase, including construction of the dumbbell roundabouts, A7 North roundabout and west facing slips. Large sections of the A6106 Old Dalkeith Road, A6106 Millerhill Road, A7 North, A7 South and east facing slips would also be constructed. Traffic management on the A720 mainline would be required to construct the slip road tie-ins and undertake verge widening works however traffic would continue to occupy the existing carriageway with no vehicle movement restrictions.

4.7.4.2 Phase 2

Traffic would be diverted off the A720 mainline, through the dumbbell roundabouts and onto the partially constructed slip roads which would link back into the existing Sheriffhall Roundabout to maintain all vehicle movements. Construction off the A7 overbridge would be undertaken to complete the link between the dumbbell roundabouts. Improvement works to the central reserve and verge of the at-grade A720 on the east and west approach to Sheriffhall Roundabout would also be undertaken during this phase.

4.7.4.3 Phase 3

The at-grade tie-ins at the extents of the A7 North and A7 South would be completed under traffic management. The closure of the existing A7 North and A7 South carriageways would also enable further development of the A6106 Old Dalkeith Road and A6106 Millerhill Road. Vehicle movements would change considerably throughout this phase with an evolving traffic management layout required. At the conclusion of the phase, A720 through traffic would use the west facing slips, dumbbell roundabouts, partially constructed east facing slips, the existing Sheriffhall Roundabout and A720 mainline to the east. The north-south link on the A7 would be provided via the new A7 overbridge and the north-south link on the A6106 provided via the existing Sheriffhall Roundabout.

4.7.4.4 Phase 4

The tie-ins on the A6106 Old Dalkeith Road and A6106 Millerhill Road would be completed under traffic management enabling traffic to fully occupy the new side roads and removing north-south flow through the existing Sheriffhall Roundabout. Construction of the new A720 mainline and completion of the east facing slips through Sheriffhall Roundabout would be undertaken during this phase. A720 through traffic would be continue to use the west and east facing slips but be re-directed onto temporary carriageway to the outside of the existing Sheriffhall Roundabout.

4.7.4.5 Phase 5

The proposed NMU provision would be constructed on the redundant carriageway. Temporary closure of the A720 and east facing slips would be required for the installation of the new NMU overbridge at Sheriffhall.

4.7.5 Summary

All options can be constructed whilst maintaining traffic flows, albeit all options would require extensive traffic management. Due to its off-line location, Option C offers buildability advantages compared to the other two options. Options A and B were assessed to have similar buildability characteristics.

4.8 Preliminary Engineering - Structures

4.8.1 Introduction

The following is a summary of the structural features of the three proposed Options for upgrading the junction at the Sheriffhall Roundabout.

In each case, a simply supported steel/concrete composite structure with bearings, gallery abutment and expansion joints has been proposed at this stage in order to provide structures that are reasonably tolerant of the differential settlement that may occur in difficult ground conditions. It should be noted that the structures shown here have large spread foundations, although ground improvement or piling may be required. When further ground investigation data is available it may be possible to consider different types of structure and foundations.

General arrangement drawings are presented in Figures 4.8.2.1 to 4.8.4.2.

4.8.2 Option A

The proposed bridge for Option A would support the A720 mainline over the A7 Link road. The bridge would be almost square to the road below (30 degree skew) and would be required to span a clear distance of approximately 35m between abutment faces.

The bridge would comprise a composite steel beam and concrete slab deck design. This provides an efficient way of supporting the structure over the large required span length whilst keeping the bridge depth profile shallow enough to provide the required headroom for the link road below.

The structural steel beams would be arranged in pairs, connected by diagonal cross-bracing. The cross-bracing would provide lateral stability both during the service of the bridge and during lifting operations and when the concrete slab is cast on top of the beams. The concrete slab would be connected to the steel beams by shear studs at the top flange of the beams, allowing the steel and concrete to act as one composite load bearing element.

The width of the bridge deck, carrying a dual carriageway with two lanes on both sides, and with an allowance for parapets and future A720 widening to accommodate another lane of traffic would be 37.2m. 14 structural beams (approximately 1400mm in depth) would span the length of the bridge at approximately 2600mm centres and be arranged into 7 pairs using steel cross bracing. The reinforced concrete deck would be approximately 250mm thick, with spray applied waterproofing, 20mm protective layer and 100mm road surfacing.

The bridge parapet (Type N2) would be located approximately 1400mm from the outermost structural steel beam on each side. The parapets would extend for a short distance beyond the deck, supported on separate parapet ground beams and would be connected to the vehicle restraint system on the approaches to the bridge.

The bridge would be supported on pot type bearings on either side. The bridge would be “fixed” at the East abutment and “guided” at the West abutment. The bearings sit upon reinforced concrete abutments either side. It is envisaged that the abutment wall would be 1200mm thick with the same depth of base.

Reinforced concrete wingwalls would be cut into the side of the slope to retain the embankment between the A720 and the link road at a slope of 1 in 2.

4.8.3 Option B

Option B would consist of two bridges, supporting the A720 mainline over two sections of a new roundabout that would pass under the A720. Both bridges would be square to the road below (00 degree skew) and would be required to span a clear distance of approximately 40m between abutment faces.

Both bridges would be of composite steel beam and concrete slab deck design. This would provide an efficient way of supporting the structure over the large span length whilst keeping the bridge depth profile shallow enough to provide the required headroom for the roundabout below.

In both cases, the structural steel beams would be arranged in pairs, connected by diagonal cross-bracing. The cross-bracing would provide lateral stability both during the service of the bridge and during lifting operations and when the concrete slab is cast on top of the beams. The concrete slab would be connected to the steel beams by shear studs at the top flange of the beams, allowing the steel and concrete to act as one composite load bearing element.

The width of the bridge deck, carrying a dual carriageway with two lanes on both sides, and with an allowance for parapets and future A720 widening to accommodate another lane of traffic would be 39.2m. 14 structural beams (approximately 1400mm in depth) would span the length of the bridge at approximately 2800mm centres and be arranged into 7 pairs using steel cross bracing. The reinforced concrete deck would be approximately 250mm thick, with spray applied waterproofing, 20mm protective layer and 100mm road surfacing.

The bridge parapet (Type N2) would be located approximately 1400mm from the outermost structural steel beam on each side. The parapets would extend for a short distance beyond the deck, supported on separate parapet ground beams and connected to the vehicle restraint system on the approaches to the bridge.

Each bridge would be supported on pot type bearings on either side. Both bridges would be “fixed” at the East abutment and “guided” at the West abutment. The bearings would sit upon reinforced concrete abutments either side. It is envisaged that the abutment wall would be 1200mm thick with the same depth of base.

Reinforced concrete wingwalls would be cut into the side of the slope to retain the soil between the A720 and the roundabout below at a slope of 1 in 2.

4.8.4 Option C

The proposed bridge for Option C would support a new link road over the existing A720 mainline. The link bridge would be at a skew of 150 degrees to the A720 road below and would be required to span a clear (skew) distance of approximately 40m between abutment faces.

The bridge would be a composite steel beam and concrete slab deck design. This would provide an efficient way of supporting the structure over the large span length whilst keeping the bridge depth profile shallow enough to provide the required headroom for the A720 mainline below.

The structural steel beams would be arranged in pairs, connected by diagonal cross-bracing. The cross-bracing would provide lateral stability both during the service of the bridge and during lifting operations and when the concrete slab is cast on top of the beams. The concrete slab would be connected to the steel beams by shear studs at the top flange of the beams, allowing the steel and concrete to act as one composite load bearing element.

The bridge deck would carry a dual carriageway with two lanes on each side, hard verges and parapets, and allow for future A720 widening. The maximum overall width of the deck would be approximately 27.2m. The 10 structural beams (approximately 1600mm in depth) would span the length of the bridge at approximately 2800mm centres and be arranged into 5 pairs using steel cross bracing. The reinforced concrete deck would be approximately 250mm thick, with spray applied waterproofing, 20mm protective layer and 100mm road surfacing.

The bridge parapet (Type N2) would be located between 1450-2050mm from the outermost structural steel beam on each side. This distance would vary along the length as a consequence of the skew. The parapets would extend for a short distance beyond the deck, supported on separate parapet ground beams and would be connected to the vehicle restraint system on the approaches to the bridge.

The bridge would be supported on pot type bearings on either side. The bridge would be “fixed” at the South abutment and “guided” at the North abutment. The bearings would sit upon reinforced concrete abutments either side. It is envisaged that the abutment wall would be 1200mm thick with the same depth of base.

At three out of the four corners, the reinforced concrete wingwalls would be cut into the side of the slope to retain the soil between the link road and roundabout and the A720 at a slope of 1 in 2.

The north west wingwall would run parallel to the A720 mainline due to the curvature of the slope and top of the banking where a new roundabout would be created on the same level as the link road. The wingwall running parallel to the A720 would be shorter than one cut into the slope at this corner.

4.8.5 General Construction Sequence

The construction sequence is considered generally similar for each of the structures and is outlined below:

- Excavation and any ground improvement or piling work.
- Cast reinforced concrete abutments and wingwall foundations
- Cast abutment walls to bearing level
- Cast reinforced concrete wingwalls
- Backfill abutments and wingwalls to underside of abutment gallery
- Lift structural beams in pairs into place by crane, resting upon the bearings on each abutment
- Construct formwork for end diaphragms and permanent formwork for the deck slab
- Cast the reinforced concrete diaphragm beams, slab and coping
- Cast inspection gallery behind each abutment
- Construct parapet ground beams
- Complete backfill (6N fill) to road formation level
- Construct parapets, surfacing and other finishes.

4.9 Anticipated Departures from Standard

4.9.1 Introduction

During the development of the DMRB Stage 2 design options, meetings were held with Transport Scotland’s Standards Branch to discuss geometry parameters and to identify areas where potential Departures and Relaxations from the applicable DMRB standards may be required. Consideration was given to the impact of compliant and non-compliant design in terms of the effect on existing properties, land, earthworks extents and environmental designations.

Where possible, mitigation such as verge widening has been introduced to maximise the standard provided. Where adequate mitigation cannot be identified, Departures and Relaxations from standard have been introduced. In principle it was accepted that Departures from standard would be required, due to the constraints of the side road tie-in points, although these should be minimised as much as possible.

Junctions for private accesses have not been considered as part of this review.

4.9.2 Option A

Option A contains one Departure from standard for a relaxation in SSD occurring in approach to a junction. This is detailed in Table 4.9.2. A further sixteen Departures from standard have been recorded for Option A relating to transition lengths designed using a centripetal acceleration of 0.6m/sec^3.

Table 4.9.2 - Option A Anticipated Departures Summary

Reference	Description	Location	Standard Required	Minimum Provided	Comments
A/DEP/01	1 design speed step below desirable minimum in stopping sight distance and on approach to roundabout junction	A6106 Old Dalkeith Road SB Lane	120.0m	100.2m	Visibility restricted by existing masonry wall over railway and existing 120mR (4DSS) curve immediately beyond tie-in

4.9.3 Option B

Option B contains two Departures from standard for relaxations in SSD occurring in combination with relaxations in horizontal geometry. These are detailed in Table 4.9.3. A further twenty-two Departures from standard have been recorded for Option B relating to transition lengths designed using a centripetal acceleration of 0.6m/sec^3.

Table 4.9.3 - Option B Anticipated Departures Summary

Reference	Description	Location	Standard Required	Minimum Provided	Comments
B/DEP/01	1 design speed step relaxation in stopping sight distance in combination with a 2 design speed step relaxation in horizontal geometry	A6106 Millerhill Road NB Lane	215m SSD 720mR	160.10m SSD 360mR	Horizontal geometry constrained by limited space at roundabout tie-in and attempt to achieve deflection standards as well as tying into existing A6106 at earliest point. Existing alignment has 360mR curve. Visibility restricted by 360mR (2DSS) RH curve followed by 360mR (2DSS) LH curve in plan.
B/DEP/02	1 design speed step relaxation in stopping sight distance in combination with a 2 design speed step relaxation in horizontal geometry	A6106 Millerhill Road SB Lane	215m SSD 720mR	204.60m SSD 360mR	As above.

4.9.4 Option C

Option C contains two Departures from standard for relaxations in SSD occurring in combination with relaxations in horizontal geometry. Option C also contains three Departures from standard for relaxations in SSD occurring in approach to a junction. These are detailed in Table 4.9.4.

A further twenty-one Departures from standard have been recorded for Option C relating to transition lengths designed using a centripetal acceleration of 0.6m/sec^3.

Table 4.9.4 - Option C Anticipated Departures Summary

Reference	Description	Location	Standard Required	Minimum Provided	Comments
C/DEP/01	1 design speed step relaxation in stopping sight distance in combination with a 2 design speed step relaxation in horizontal geometry	A6106 Millerhill Road NB Lane	215m SSD 720mR	153.80m SSD 360mR	Horizontal geometry constrained by properties east of A7 and tie-in to existing A6106. Visibility restricted by 360mR (2DSS) LH curve in plan.
C/DEP/02	1 design speed step relaxation in stopping sight distance in combination with a 2 design speed step relaxation in horizontal geometry	A6106 Millerhill Road SB Lane	215m SSD 720mR	197.70 SSD 360mR	As above.

Reference	Description	Location	Standard Required	Minimum Provided	Comments
C/DEP/03	1 design speed step below desirable minimum in stopping sight distance and on approach to roundabout junction	A6106 Old Dalkeith Road NB Lane	120.0m	113.60m	Visibility restricted by existing masonry wall over railway and 127mR (3DSS) LH curve at tie-in.
C/DEP/04	1 design speed step below desirable minimum in stopping sight distance and on approach to junction	A6106 Old Dalkeith Road SB Lane	120.0m	91.50m	Visibility restricted by existing masonry wall over railway and 127mR (3DSS) LH curve at tie-in.
C/DEP/05	2 design speed steps below desirable minimum in stopping sight distance and on approach to junction	A6106 Old Dalkeith Road SB Lane	120.0m	76.10m	Visibility restricted by existing masonry wall over railway and 127mR (3DSS) LH curve at tie-in.

5. Traffic and Economic Assessment

5.1 Introduction

This section outlines the indicative costs associated with the proposed improvement options and describes the work undertaken to develop the various computer models. It also considers future traffic conditions over the economic life of the scheme and presents the results of an operational and economic assessment of the proposed improvement options.

The operational and economic assessment of proposed road improvement schemes requires the development and application of various computer models. In the case of the A720 Sheriffhall Roundabout, this has involved the development of a Paramics micro-simulation model due to interaction between adjacent junctions and the likely effects of high traffic demand in a congested network.

In addition, the Sestran Regional Model (SRM) and the Traffic Model for Scotland (TMfS) have been used to assist in forecasting future traffic levels, and industry-standard software packages Program for the Economic Assessment of Road Schemes (PEARS) and Network Evaluation from Surveys and Assignments (NESA) have been used for the purposes of the Economic Assessment.

Further details can be found in the separate A720 Sheriffhall Roundabout DMRB Stage 2 Traffic and Economic Assessment Report.

5.2 Indicative Costs

5.2.1 Cost Estimates

A breakdown of the estimated costs of the proposed improvement options, including optimism bias, is shown in Table 5.2.1. Full details of the derivation of the cost estimates are set out in Section 3.7 of this report.

Table 5.2.1 – Estimated Scheme Cost Summary, Including Optimism Bias

	Option A	Option B	Option C
Total Construction Cost (£m)	£70,478,242	£69,494,636	£70,514,999
Total Land Cost (£m)	£12,120,847	£7,106,351	£8,711,476
Preparation (9% of Total Construction and Land Costs)	£7,433,918	£6,894,089	£7,130,383
Supervision (5% of Total Construction and Land Costs)	£4,129,954	£3,830,049	£3,961,324
Total Scheme Cost (£m)	£94,162,961	£87,325,125	£90,318,182

Note: All costs are in Quarter 4, 2016 prices and exclude VAT.

5.2.2 Cost Profile

For the purpose of the economic appraisal, the overall cost profiles which have been adopted are shown in Table 5.2.2.

Table 5.2.2 – Scheme Cost Profiles

	2020	2021	2022	2023	2024
Option A	6.0%	15.0%	23.0%	54.0%	2.0%
Option B	6.0%	10.0%	24.0%	57.0%	3.0%
Option C	6.0%	11.0%	24.0%	56.0%	3.0%

A 2 year construction programme has been used commencing in 2022 with the scheme opening in 2024.

5.3 Development of Computer Models

5.3.1 Introduction

The operational and economic assessment of proposed road improvement schemes requires the development and application of various computer models. In the case of the A720 Sheriffhall Roundabout, this has involved the development of a Paramics Micro-Simulation Model.

5.3.2 Paramics Base Network

The Paramics Base network has been developed to represent existing conditions observed during the programme of traffic surveys undertaken in October 2013 and October 2014. The limits of the modelled base network were defined to include road sections that are likely to experience a change in operating conditions as a result of the proposed improvement options.

A network plot indicating the extent of the modelled network is shown in Figure 5.3.2.

5.3.3 Zoning System

A zoning system was developed to represent the main origins and destinations of trips in the modelled area. A total of 12 zones were defined to model trip patterns in the area.

The zones used to define traffic movements in the modelled network are as follows:

- Zone 1 – A720 West of Sheriffhall Roundabout;
- Zone 2 – A720 East of Sheriffhall Roundabout;
- Zone 3 – A68 Dalkieth Northern Bypass;
- Zone 4 – A6106 Old Dalkieth Road South of Sheriffhall Roundabout;
- Zone 5 – B6392;
- Zone 6 – A7 South of Sheriffhall Roundabout;
- Zone 7 – Dobbies Garden Centre South of the A772 Gilmerton Road;
- Zone 8 – A772 Gilmerton Road North of Gilmerton Junction;
- Zone 9 – A7 North of Sheriffhall Roundabout;
- Zone 10 – Sheriffhall Park and Ride;
- Zone 11 – A7 to A6106 Link Road; and
- Zone 12 – A6106 Millerhill Road North of Sheriffhall Roundabout.

It should be noted that Zone 10 and Zone 11 were defined to allow modelling of conditions when more detailed information is available on trip patterns.

A network plot indicating the locations of these zones is shown in Figure 5.3.3.

5.3.4 Vehicle Composition

Based on the manual classified counts (MCC) information collected within the study area, the 2014 12-hour weekday vehicle proportions defined in the Paramics Base model are as follows:

- 80.4% Cars;
- 12.6% Light Goods Vehicles (LGV);
- 3.2% Other Goods Vehicles 1 (OGV1);

- 2.5% Other Goods Vehicles 2 (OGV2); and
- 1.3% Buses and Coaches (PSV).

Trip patterns around the Paramics Base model network have been based on two matrices, namely:

- Demand Matrix 1 – Light Vehicles (Cars and LGVs); and
- Demand Matrix 2 – Heavy Vehicles (OGV1s, OGV2s and PSVs).

Of the 93% of Cars and LGVs in Demand Matrix 1, 86.4% are Cars and 13.6% are LGVs.

Of the 7% of OGV1s, OGV2s and PSVs in Demand Matrix 2, 46% are OGV1, 35.6% are OGV2 and 18.4% are PSVs.

5.3.5 Demand Profile

The total traffic flow observed passing through Sheriffhall Roundabout during each 30-minute period throughout the 12-hour MCC survey was used to derive a representative Demand Profile for the release of traffic onto the Paramics Base model network.

The MCC traffic survey undertaken at each junction entry records the volume of traffic which actually passes through each junction during any given time period. However, in congested operating conditions, the actual volume may not necessarily be the total traffic demand that wishes to pass through the junction during the same time period.

To provide a more reasonable representation of the volume of traffic demand, the total number of vehicles recorded in a queue at the end of each 30 minute period was added to the vehicle count passing through the junction during the corresponding 30 minute period, and subtracted from the subsequent 30 minute period.

The observed traffic demand profile derived from the October 2014 MCC and queue surveys is shown in Figure 5.3.5.

Examination of the demand flow profile indicates that the AM Peak demand occurs between 07:30 and 08:00 hours and the PM Peak demand occurs between 16:30 and 17:00 hours.

5.4 Forecasting

5.4.1 Introduction

The Paramics model was developed to provide a reasonable representation of traffic conditions observed during the 12-hour traffic surveys undertaken in October 2014, as described previously in the report.

For the purposes of the traffic and economic assessment, it is necessary to further develop the model to represent the 24-hour annual average daily traffic flows and to incorporate the forecasted growth in traffic volumes from the day of survey to the proposed Scheme Opening Year and beyond.

Details of the forecasting procedures are described below.

5.4.2 Traffic Growth

5.4.2.1 2014 Base Traffic from SRM12

Although the 2014 traffic surveys provide detailed information to assist in building the Paramics model, further information is required to define future traffic demand up to the 2024 Scheme Opening Year and beyond.

The SEStran Regional Model (SRM12), which has been developed separately by Transport Scotland and covers the South East Scotland area, has been used to derive an estimate of future growth based on the traffic related effects of proposed changes in land use over both the local and the wider regional area.

5.4.2.2 2024 Future Base Traffic from SRM12 Reference Case

As an integral part of the development of the SRM12 model, the effects of the proposed changes in land use up to 2024 were used to define the SRM12 Reference Case.

To provide an estimate of future traffic conditions in the area and to maintain consistency with other Transport Scotland models, the predicted changes in traffic flows between the 2014 Base Year and the proposed 2024 Scheme Opening Year were derived from the SRM12 model.

SRM12 indicates that traffic flows through Sheriffhall Roundabout could increase by approximately 12% between 2012 and 2024, i.e. approximately 1% pa. This is based on the SRM12 'actual' traffic flows. The SRM12 'demand' traffic flows indicate an increase of 16%, which exceeds the 'actual' flows and the capacity of the junction.

Due to wider area network characteristics in SRM12 constraining some of the 'demand' traffic from reaching Sheriffhall Roundabout within the modelled time period, it is considered that the 'actual' traffic flows from SRM12 are more appropriate to use for the comparative assessment of improvement options.

To develop trip matrices for the Paramics model which represent traffic flows in the 2024 Scheme Opening year, the change in traffic movements between the SRM12 2012 base and the SRM12 2024 Reference Case models were added to the existing 2014 traffic matrix defined in the Paramics Base model.

5.4.2.3 2024 Future Design Traffic from SRM12 Reference Case with Grade-Separation at Sheriffhall

The Design models have been developed to incorporate the SRM12 2024 predicted traffic including the effects of releasing suppressed demand/induced traffic following grade-separation.

In addition to the 12% increase in traffic flows described above, the SRM12 model indicates that traffic flows through Sheriffhall could increase by a further 18% approximately in 2024 as a result of the proposed grade-separated junction at Sheriffhall. This is based on the SRM12 'actual' traffic flows and is an indication on the potential for suppressed demand/induced traffic in the area.

5.4.2.4 Traffic Growth Beyond 2024 from TMfS12

Although traffic volumes are expected to increase beyond 2024, this information is not available from the SRM12 model.

For the purpose of the assessment of the improvement options, and in discussion with Transport Scotland Technical Analysis Branch, the Transport Model for Scotland (TMfS12) forecasts of traffic growth for the SESplan area have been applied to define the increase in traffic beyond 2024.

The TMfS12 traffic growth factors applied to future years are as follows:

- 2024 to 2027 - 1.34% p.a.
- 2027 to 2032 - 1.05% p.a.
- 2032 to 2037 - 0.83% p.a.

5.4.2.5 Traffic Growth Limits

Examination of the Base model, taking into account the effects of annualisation in traffic flows, indicates that the base network can accommodate the full SRM12 demand in 2024, but beyond 2024 significant congestion occurs which extends to the limits of the model, indicating that the network is unable to accommodate any further growth beyond 2024.

The Base model is therefore based on zero growth beyond 2024 to establish the level of demand that could be accommodated on the base network to provide a reasonable basis for the 60-year assessment of the improvement options.

Examination of the Design models indicates that beyond 2030, significant congestion occurs on Improvement Option C which extends to the limits of the model, indicating that the network is unable to accommodate any further growth beyond 2030.

The Design models for Improvement Options A, B and C are therefore based on zero growth beyond 2030 to establish the level of demand that could be accommodated on the design networks to provide a reasonable basis for the comparative 60-year assessment of all improvement options. However it should be noted that Improvement Options A and B can accommodate growth beyond 2030.

5.4.2.6 Forecasting Summary

A chart illustrating the future traffic growth forecasts used for the assessment is shown in Figure 5.4.2.

A summary of the 12-hour 2-way traffic flows at the entry/exit links on each of the 6 key routes in the Paramics model and for each scenario described above is shown in Table 5.4.2.

Table 5.4.2 – 2-way Entry/Exit Traffic Flows (07:00 – 19:00)

Scenario	A720 West	A720 East	A7 North	A7 South	A6106 North	A6106 South
2014 Day of Survey	49,314	36,926	12,156	18,019	7,314	8,624
2014 Average Annual Weekday	46,360	34,713	11,427	16,947	6,878	8,110
2024 Existing Junction	53,745	40,238	11,333	17,327	7,608	8,853
2024 Grade-Separated Junction	58,612	44,740	12,166	21,846	12,439	9,064
2030 Existing Junction	*53,745	*40,238	*11,333	*17,327	*7,608	*8,853
2030 Grade-Separated Junction	62,940	48,041	13,066	23,456	13,354	9,732

*Zero traffic growth has been applied in the Base model beyond the 2024 Opening Year

5.5 Operational Assessment

For the purpose of the assessment of the proposed improvements it has been assumed that the scheme would open in 2024. The operational assessment is based on the examination of the results from the various 2024 and 2030 Paramics models.

Paramics includes the function to simulate the effects of the random variations in vehicle behaviour that occur naturally on the road network throughout the day, which can result in variability in the modelled results. To minimise the effects of any abnormal results, the economic assessment is based on the aggregation of multiple runs. The average of 20 separate model runs has therefore been examined to provide a reasonable basis to compare the operational effects of each modelled improvement option relative to the Base network model.

5.5.1 Traffic Flows

Details of the results of the Paramics model can be found in the A720 Sheriffhall Roundabout DMRB Stage 2 Traffic and Economic Assessment Report. Comparison of Improvement Options

The 12-hour Journey Speeds and Times for the Base network and each of the three Design networks in 2030, along with corresponding savings in Journey Times, are summarised in Table 5.5.1.

Table 5.5.1 – 12-hour Journey Speeds and Times Summary – 2030

		A720 E/b	A720 W/b	A7 N/b	A7 S/b	A6106 N/b	A6106 S/b
Journey Speeds (mph)	Base*	30.8	32.3	13.9	12.3	9.6	7.7
	Option A	62.9	64.2	36.3	33.6	28.8	28.9
	Option B	62.9	63.9	39.7	35.5	30.3	29.9
	Option C	59.5	50.4	33.4	24.2	22.0	23.1
Journey Times (mm:ss)	Base*	07:08	06:46	05:48	07:04	06:04	07:12
	Option A	03:29	03:23	02:18	02:41	02:08	01:59
	Option B	03:28	03:24	02:03	02:30	01:58	01:52
	Option C	03:41	04:19	02:21	03:22	03:52	03:25

		A720 E/b	A720 W/b	A7 N/b	A7 S/b	A6106 N/b	A6106 S/b
Journey Time Savings (mm:ss)	Base*	-	-	-	-	-	-
	Option A	03:40	03:23	03:30	04:23	03:56	05:13
	Option B	03:40	03:22	03:45	04:34	04:07	05:20
	Option C	03:28	02:28	03:27	03:42	02:13	03:47
Journey Time Savings (%)	Base*	-	-	-	-	-	-
	Option A	51%	50%	60%	62%	65%	72%
	Option B	51%	50%	65%	65%	68%	74%
	Option C	49%	36%	59%	52%	37%	53%

*Journey Speeds and Times from the Base model are the same in 2024 and 2030 due to the application of zero traffic growth beyond 2024

Examination of the above journey speed and time information indicates that Improvement Option C is operating less efficiently than Improvement Option A and Improvement Option B.

Improvement Option C is located to the west of the existing Sheriffhall Roundabout, and as such is closer in proximity to Gilmerton Roundabout on the A7.

This has the effect that there is a shorter distance on the A7 to accommodate vehicles queueing on the southbound approach to Gilmerton Roundabout, before queues extend back onto the southern dumb-bell of the Improvement Option C grade-separated junction layout. This causes blocked access to traffic trying to use this roundabout from the A720 westbound off-slip, which then causes queuing down the off-slip and back onto the A720 itself.

5.6 Economic Assessment

5.6.1 Introduction

PEARS (Program for the Economic Assessment of Road Schemes) is an economic assessment package that has been specifically designed for use with the output from traffic microsimulation models and has therefore been used to quantify the operational benefits of the improvement options relative to the Base network in monetary terms.

Paramics includes the function to simulate the effects of the random variations in vehicle behaviour that occur naturally on the road network throughout the day, which can result in variability in the modelled results. To minimise the effects of any abnormal results, the economic assessment is based on the aggregation of multiple runs. The results from 20 separate model runs have therefore been extracted from the Paramics models and input into PEARS to provide a reasonable basis to compare the economic impact of each modelled improvement option relative to the Base network model over the 60 year assessment period.

5.6.2 PEARS Appraisal

A detailed breakdown of the PEARS results is contained in Table 5.6.2.1 and indicates the transport economic efficiency, public accounts and monetised costs and benefits as defined in PEARS Tables 15A to 15C.

In accordance with current government guidelines on the reporting of transport economic efficiency, the results of the economic assessment are presented in the market prices unit of account.

Table 5.6.2.1 – PEARS Assessment Summary

	Option A	Option B	Option C
Non-Business User Benefits			
Travel Time	347.09	335.20	186.00
Vehicle Operating Costs	-27.45	-27.41	-34.99
Travel Time and VOC during Construction (QUADRO)	-	-	-
Travel Time and VOC during Maintenance (QUADRO)	-	-	-
Net Non-Business User Benefits	**319.64**	**307.79**	**151.01**
Business User Benefits			
Travel Time	287.47	277.73	160.21
Vehicle Operating Costs	-2.34	-2.53	-12.94
Travel Time and VOC during Construction (QUADRO)	-	-	-
Travel Time and VOC during Maintenance (QUADRO)	-	-	-
Subtotal	285.13	275.20	147.27
Private Sector Provider Impacts (Operating Costs)	2.86	2.86	0.58
Net Business Impact	**287.99**	**278.06**	**147.85**
Total Present Value of TEE Benefits	**607.63**	**585.85**	**298.86**
Government Funding			
Investment Costs	64.75	59.85	61.94
Operating Costs	0.00	0.00	0.00
Present Value of Costs	**64.75**	**59.85**	**61.94**
TEE Benefits			
Emissions	-3.79	-3.87	-6.74
Accident Benefits	-	-	-
Non Business User Benefits	319.64	307.79	151.01
Business User Benefits	287.99	278.06	147.85
Indirect Tax Revenues	9.17	9.37	16.18
Present Value of Benefits (PVB)	**613.01**	**591.35**	**308.30**
Present Value of Costs (PVC)	**64.75**	**59.85**	**61.94**
OVERALL IMPACT			
Net Present Value (NPV)	**548.26**	**531.49**	**246.36**
Benefit to Cost Ratio (BCR)	**9.47**	**9.88**	**4.98**

Based on the estimated scheme costs and the application of the SRM12 and TMfS12 traffic growth projections, as described previously in the report, the economic assessment (excluding Accident Benefits) of the improvement options defined using PEARS is summarised in Table 5.6.2.2.

Table 5.6.2.2 – PEARS Assessment Summary (Excluding Accident Benefits)

	Option A	Option B	Option C
Present Value of Benefits (£m)	613.01	591.35	308.30
Present Value of Costs (£m)	64.75	59.85	61.94
Net Present Value (£m)	548.26	531.49	246.36
Benefit to Cost Ratio	9.47	9.88	4.98

5.6.3 Road Safety

The PEARS assessment software does not consider any aspect of changes in road traffic accidents as part of the scheme assessment. To provide a standard assessment of the effects of the proposed improvement options, separate accident models have been created using industry standard software.

NESA (Network Evaluation from Surveys and Assignments) is the standard computer program introduced in the 1970s to examine proposed investments in the trunk road network in Scotland by comparing the costs of the road scheme with the associated road user benefits. The procedures for developing and applying the NESA model are set out in DMRB Volume 15.

A series of simplified “accident only” NESA models has therefore been developed to quantify the changes in accident numbers and costs due to the provision of the proposed improvement options.

The number of total personal injury accidents over the 60-year assessment period and corresponding Present Values of Benefit associated with each of the three improvement options, based on the application of national accident values, are shown in Tables 5.6.3.1 to 5.6.3.3.

It should be noted that the NESA accident only model indicates that the proposed improvement options would increase the number of accidents on the road network. This is due primarily to the additional traffic on the network following the release of suppressed demand associated with the proposed grade-separated junction.

Table 5.6.3.1 – Road Safety Benefits – Option A

	No. of Acc. In 2024	No. of Acc. In 2030	No. of Acc. 60-year Total	Acc. Total Cost (£m)
Base Network	36.2	35.2	2119.7	114.538
Option A Network	39.2	41.3	2470.3	135.44
Benefits	-3.0	-6.1	-350.6	-20.902

The results from the NESA model, based on the application of default accident rates for a link and junction analysis, indicates that the provision of Improvement Option A would generate 351 accidents over the 60-year economic life of the scheme which equates to an accident cost disbenefit of £20.9m.

Table 5.6.3.2 – Road Safety Benefits – Option B

	No. of Acc. In 2024	No. of Acc. In 2030	No. of Acc. 60-year Total	Acc. Total Cost (£m)
Base Network	36.2	35.2	2119.7	114.538
Option B Network	39.6	41.9	2505.1	137.746
Benefits	-3.4	-6.7	-385.4	-23.208

The results from the NESA model, based on the application of default accident rates for a link and junction analysis, indicates that the provision of the Improvement Option B would generate 385 accidents over the 60-year economic life of the scheme which equates to an accident cost disbenefit of £23.2m.

Table 5.6.3.3 – Road Safety Benefits – Option C

	No. of Acc. In 2024	No. of Acc. In 2030	No. of Acc. 60-year Total	Acc. Total Cost (£m)
Base Network	36.2	35.2	2119.7	114.538
Option C Network	39.8	42	2512.1	136.762
Benefits	-3.6	-6.8	-392.4	-22.224

The results from the NESA model, based on the application of default accident rates for a link and junction analysis, indicates that the provision of the Improvement Option C would generate 392 accidents over the 60-year economic life of the scheme which equates to an accident cost disbenefit of £22.2m.

5.6.3.1 Common Base and Design Traffic Demand

In addition to the main “accident only” assessment, a further assessment has been undertaken to examine the effects of adopting the same level of traffic demand in both the Base and Design Networks. This assessment removes the effects of releasing suppressed demand in 2024 and the predicted TMfS12 growth in traffic between 2024 and 2030. Separate models have been created where both the Base and Design models are based on the same 2024 traffic flows derived from SRM12 Reference Case, with zero growth beyond 2024.

The results from this assessment are shown in Tables 5.6.3.4 to 5.6.3.6.

Table 5.6.3.4 – Road Safety Benefits – Option A (Common Traffic Demand)

	No. of Acc. In 2024	No. of Acc. In 2030	No. of Acc. 60-year Total	Acc. Total Cost (£m)
Base Network	36.9	35.8	2155.1	115.703
Option A Network	35.9	34.9	2099.8	115.093
Benefits	1.0	0.9	55.3	0.610

The results of the NESA analysis, based on the application of default accident rates for a link and junction analysis, indicates that the provision of Option A would save 55 accidents over the 60-year economic life of the scheme which equates to an accident cost benefit of £0.61m.

Table 5.6.3.5 – Road Safety Benefits – Option B (Common Traffic Demand)

	No. of Acc. In 2024	No. of Acc. In 2030	No. of Acc. 60-year Total	Acc. Total Cost (£m)
Base Network	36.9	35.8	2155.1	115.703
Option B Network	35.6	34.6	2080.5	114.426
Benefits	1.3	1.2	74.6	1.277

The results of the NESA analysis, based on the application of default accident rates for a link and junction analysis, indicates that the provision of Option B would save 75 accidents over the 60-year economic life of the scheme which equates to an accident cost benefit of £1.28m.

Table 5.6.3.6 – Road Safety Benefits – Option C (Common Traffic Demand)

	No. of Acc. In 2024	No. of Acc. In 2030	No. of Acc. 60-year Total	Acc. Total Cost (£m)
Base Network	36.9	35.8	2155.1	115.703
Option C Network	36.4	35.4	2127.9	115.641
Benefits	0.5	0.4	27.2	0.062

The results of the NESA analysis, based on the application of default accident rates for a link and junction analysis, indicates that the provision of Option C would save 27 accidents over the 60-year economic life of the scheme which equates to an accident cost benefit of £0.06m.

5.6.4 Overall Economic Appraisal

Based on the estimated scheme costs and the application of the SRM12 and TMfS12 traffic growth projections, as described previously in the report, the economic assessment (including Accident Benefits) of the Improvement Options defined using PEARS is summarised in Table 5.6.4.

Table 5.6.4 – Overall Economic Appraisal Summary

	Option A	Option B	Option C
PVB – PEARS only (£m)	613.01	591.35	308.30
PVB – Accidents only (£m)	-20.90	-23.21	-22.22
Present Value of Benefits (£m)	592.11	568.14	286.08
Present Value of Costs (£m)	64.75	59.85	61.94
Net Present Value (£m)	527.36	508.29	224.14
Benefit to Cost Ratio	9.14	9.49	4.62

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