Access to Argyll and Bute (A83)

Strategic Environmental Assessment & Preliminary Engineering Services

DMRB Stage 1 Assessment Report

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Contents

Glossary……iv

Abbreviations……x

1. Introduction ......1 of Chapter 1

1.1 Background ......1 of Chapter 1

1.2 Need for the Scheme ......1 of Chapter 1

1.3 Scheme Objectives ......2 of Chapter 1

1.4 Consultations ......2 of Chapter 1

1.5 Scheme Appraisal ......3 of Chapter 1

1.6 Scheme Development History ......4 of Chapter 1

1.7 Method of Assessment ......4 of Chapter 1

1.8 Report Structure ......4 of Chapter 1

2. Existing Conditions ......1 of Chapter 2

2.1 Introduction ......1 of Chapter 2

3. Description of Alternative Schemes ......1 of Chapter 3

3.1 General ......1 of Chapter 3

3.2 Preliminary Assessment ......1 of Chapter 3

3.3 Description of the Preferred Route Corridor ......2 of Chapter 3

3.4 Description of Possible Route Options within the Preferred Corridor ......3 of Chapter 3

3.5 On-going Mitigation Works in Glen Croe ......8 of Chapter 3

3.6 Preliminary Cost Estimates ......8 of Chapter 3

4. Engineering Assessment ......1 of Chapter 4

4.1 Introduction ......1 of Chapter 4

4.2 Alignment and Cross-section ......1 of Chapter 4

4.3 Junctions, Accesses and Lay-bys ......7 of Chapter 4

4.4 Geotechnics and Earthworks ......9 of Chapter 4

4.5 Hydrology, Hydrogeology and Drainage ......14 of Chapter 4

4.6 Structures ......17 of Chapter 4

4.7 Pavements ......25 of Chapter 4

4.8 Vehicle Restraint Systems ......26 of Chapter 4

4.9 Public Utilities ......26 of Chapter 4

4.10 Non-Motorised Users (NMUs) ......27 of Chapter 4

4.11 Constructability Considerations ......29 of Chapter 4

5. Environmental Assessment ... 1 of Chapter 5
5.1 Introduction ... 1 of Chapter 5
5.2 General Principles and Environmental Approach ... 2 of Chapter 5
5.3 Findings ... 4 of Chapter 5

6. Traffic and Economic Assessment ... 1 of Chapter 6
6.1 Introduction ... 1 of Chapter 6
6.2 Future Traffic Growth ... 1 of Chapter 6
6.3 Effects of Improvement Strategies ... 2 of Chapter 6
6.4 Economics ... 3 of Chapter 6
6.5 Wider Economic Impacts ... 5 of Chapter 6

7. Risk ... 1 of Chapter 7
7.1 Introduction ... 1 of Chapter 7
7.2 Challenges and Risks ... 1 of Chapter 7
7.3 Risk Management ... 2 of Chapter 7

8. Conclusions ... 1 of Chapter 8

Appendix A Figures

Appendix B Drawings

Glossary

Alluvium	A general term for clay, silt, sand and gravel deposited by a river or stream. Typically soft to firm, compressible silty clay but can contain layers (lenses) of silt, sand, peat and gravel.
Annual Exceedance Probability (AEP)	Probability that a flood event of a specified magnitude will be equalled or exceeded in any year.
At-grade Junction	A junction arrangement at which two or more roads meet at the same level.
Attenuation	Increase in duration of flow hydrograph with a consequent reduction in peak flow.
Average Annual Daily Traffic (AADT)	The total annual volume of traffic on a road divided by 365 days to give average daily traffic volumes.
Bedrock	Hard rock that lies beneath superficial deposits of soil and sediment.
Benefit-Cost Ratio (BCR)	An indicator, used in the formal discipline of cost-benefit analysis that attempts to summarise the overall value for money of a project or proposal. A BCR is the ratio of the benefits of a project or proposal, expressed in monetary terms, relative to its costs, also expressed in monetary terms.
Boulder Fall	The potential for boulders which are present on the ground surface or buried within the superficial deposits to become dislodged or otherwise disturbed and move downslope, either by falling, rolling, bouncing, sliding, or a combination thereof.
Catchment	An area defined by watersheds (e.g. hill summits and ridge lines) contributing flow to a point on a drainage system.
Channel Morphology	Physical characteristics of stream channels.
Coniferous Plantation	Managed woodland of coniferous, evergreen trees.
Core Path	Paths, waterways or any other means of crossing land to facilitate, promote and manage the exercise of access rights under the Land Reform (Scotland) Act 2003.
Culvert	A metal, wooden, plastic, or concrete conduit through which surface water can flow under or across roads.
Cut Off Drain	A longitudinal channel beyond the earthworks extent to intercept surface runoff from adjacent land.
Cutting	Typically where the ground is excavated to make way for a road or railway line (e.g. a cut into a hillside).
Debris Flow Shelter	An engineered structure forming a canopy over a section of road at risk from rock falls or landslide debris flows, often formed from reinforced concrete.

Debris Flow	Rapid moving, potentially highly destructive failures which are characterised by high proportions of air or water suspending solid material and lubricating the movement of the flow. Open hill-slope debris flows are possible, but more commonly flows are concentrated within existing channels where significant entrainment of solid material can occur due to the erosive power of the flow. [Note: The majority of the failures which have occurred on the slopes of Beinn Luibhean in Glen Croe are categorised as debris flows.]
Deflector Structures	A structure used to deviate and direct the descent or passage of debris flow material and usually positioned to protect a vulnerable asset.
Departures from Standard	Where the design requirements outlined in the DMRB are not met, a Departure from Standard application must be submitted and accepted by the Overseeing Organisation to allow the sub-standard element to be included in the design.
Design Speed	The speed used to determine geometric features using design parameters set out in the DMRB.
Desirable Minimum	The minimum value associated with a geometric design feature, without relaxations or Departures from Standard.
Detailed Assessment	An assessment in line with the Design Manual for Roads and Bridges of the corridors taken forward from the preliminary assessment.
Do Nothing Scenario	The base situation where there are no modifications to the existing road network. May also refer to the minimum modifications, which will necessarily take place in the absence of a proposed scheme.
Drainage Grip	A device to channel carriageway runoff to adjacent ditches.
Dyke	A type of intrusive igneous rock which is formed by the intrusion of magma into a fracture of a pre-existing rock body. Tabular in form and typically vertically orientated.
Embankment	Material deposition to raise ground level to required height for carriageway.
Fault	A planar fracture or discontinuity in rock across which there has been relative displacement as a result of compressional or tensional forces. The fault strike is the direction of the line of intersection between the fault plane and Earth's surface. Normal, reverse and strike slip are all types of faults, and indicate different relative movements between the rocks on either side of the fault plane.
Fill	Material deposited by man in ground depression or excavated area or to construct an embankment.
Filter Drain	Filter Drains are shallow linear trenches filled with granular filter material which convey water to outfall locations whilst providing one stage of treatment.
Flexible Construction	Pavement construction type with a bituminous surface course.
Fluvial (flood extents)	Flooding from a river or watercourse.
Fluvial Geomorphology	The study of landforms associated with river channels and the sediment processes which form them.

Freeboard	Vertical distance between water surface and the soffit of a bridge or top of embankment.
Geomorphology	The study of the structure, origin and development of landforms and their relationship with geology.
Ground Investigation	An exploratory investigation undertaken by drilling boreholes, excavating trial pits and various other techniques to determine the ground and groundwater conditions present, and the engineering properties of materials encountered.
Groundwater	Water below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.
Headroom	The height clearance from existing ground level to the underside of a bridge deck.
Heavy Goods Vehicle (HGV)	Vehicles with 3 axles (articulated) or 4 or more axles (rigid and articulated).
High friction surfacing	A pavement surface material which provides enhanced skid resistance for vehicles.
Hummocky (moundy) Glacial Deposits	Lithologically diverse and complex glacial deposits that have characteristic moundy topographic form and composed of rock debris, clayey till, and sand and gravel.
Hydrogeology	The branch of geology that deals with the occurrence, distribution, and effect of ground water.
Hydrological	The exchange of water between the atmosphere, the land and the oceans.
Hydromorphology	Physical characteristics and water content of a water body, encompassing hydrological and geomorphological characteristics.
Intrusive Igneous Rock	Rock formed when hot, molten material crystallises and solidifies below the Earth's surface.
Landslide	A general term which can be used to represent a number of different types of downslope movement of material (including Debris Flow), ranging in volume and speed of movement. The term may also be used to describe historical landscape features which indicate that movement has occurred at some time in the past. Depending on the size and nature of the landslide, and the erosion which has occurred since, the visibility of such features and the accuracy with which their age can be determined is highly variable.
Landslide hazard	The potential for a landslide to occur within a specified area and time. This takes into consideration the failure location, type, volume and velocity. Also, to be identified as a hazard, the potential instability must pose a threat to an element with perceived value, e.g. life, health, property or the environment.
Landslide risk	A measure of the probability and severity of an adverse effect (caused) to life, health, property or the environment (by landslide). [International Society of Soil Mechanics and Ground Engineering (ISSMGE), Technical Committee on Risk Assessment and Management, 2004]

Landslide susceptibility	A measure of the potential for landslide to occur, considering a range of factors including, but not limited to, the presence of pre-existing failures, material characteristics and topography (which includes slope angle). This term does not consider the proximity to any receptors, nor their vulnerability.
Made Ground	Material deposited by man, i.e. not natural.
Metamorphic Rock	Rocks which are formed as a result of the alteration of pre-existing rocks due to changes in temperature and pressure. Examples include Pelite, Semi-Pelite, Psammite and Schist.
Non-Motorised User (NMU)	Road users other than vehicular traffic, particularly cyclists, pedestrians and equestrians.
Operating Companies	Organisations, under contract with Transport Scotland, which deliver ongoing maintenance work across the trunk road network, bridges and other structures.
Optimism Bias	The proven tendency for appraisers to be over-optimistic about key project parameters, including capital costs, operating costs, project duration and benefits delivery.
Parapets	A safety barrier installed on the edge of a bridge or retaining wall or similar structure where there is a vertical drop.
Peak Rainfall	When rainfall is at its greatest during a storm event.
Peak Rainfall Intensity	An allowance for the predicted change in rainfall intensity caused by future climate change.
Peak River Flow	Flow rate within a river when discharge to the river from surface water run-off is at its greatest following a storm event.
Peat	A partially decomposed mass of semi-carbonised vegetation which has developed under waterlogged and anaerobic conditions, usually in bogs or swamps.
Preliminary Assessment	An initial assessment with the objective of identifying if route corridors can justifiably be removed from further consideration at this initial stage on the basis that they do not sufficiently meet the scheme objectives and are demonstrably less preferable than other route corridors.
Preliminary Engineering Services (PES)	A package of work which provides an overview of the project, summarising engineering, environmental and traffic and economic considerations
Relaxations	A reduction of the design of a geometric design feature, below desirable minimum, where permitted in the DMRB.
River Terrace Deposits	A series of level surfaces in a stream or river valley which were deposited when the river was flowing along a different course in the past. Sand and gravel, locally with lenses of silt, clay or peat; may include soft or loose deposits.
Rock Fall	The potential for blocks or pieces of rock to become detached from rock crags or exposures, and to move downslope, by falling, rolling, bouncing, sliding or a combination thereof. Note distinction from Boulder Fall.

Rock Permeability	A measure of the ability of water or other fluids to pass through a rock (dependent on the connection of pore space).
Scottish Transport Appraisal Guidance	A guide for transport practitioners working on Scottish based transport projects, or any other interested party, with access to the latest information and guidance that they will need when developing and assessing transport schemes and strategies.
Sequential Drill and Blast	A method of excavating a tunnel in rock, where holes are drilled in a designed pattern in the tunnel face, charged with explosive and fired, resulting in the advancement of the tunnel face at each stage.
STATS19	A collection of data for all road traffic accidents that resulted in a personal injury and were reported to the police within 30 days of the accident.
Statutory Undertaker	Statutory undertakers are bodies that have been given statutory powers in relation to functions that are of a 'public' character.
Strategic Environmental Assessment (SEA)	The process by which information about the environmental effects of proposed plans, policies and programmes are evaluated.
Strategic Transport Projects Review 2 (STPR2)	STPR2 is a Scotland-wide review of the strategic transport network across all transport modes, including walking, wheeling, cycling, bus, rail and car, as well as reviewing wider island and rural connectivity.
Superelevation	Superelevation is where the carriageway crossfall is increased beyond standard camber to reduce the tendency of vehicles to overturn and skid laterally outwards.
Superficial deposits	The youngest, unlithified soils and sediments of the most recent period of geological time, the Quaternary, deposited during the last 2.6 million years and which overlie bedrock.
Surface Course	The top layer of pavement construction, typically flexible asphaltic material to provide durability, safety and resilience.
Sustainable Drainage System (SuDS)	A sequence of management practices and control structures designed to drain surface water in a more sustainable fashion than some conventional techniques.
Till (Diamicton)	A generally over consolidated material deposited directly by and underneath a glacier without subsequent reworking by water from the glacier. It consists of a heterogeneous mixture of clay, sand, gravel and boulders varying widely in size and shape (diamicton).
Trunk Road	Part of the road network connecting major cities, towns, airports and ports for which the Scottish Government is responsible.
Tunnel Boring Machine	A large electrically-powered machine, generally with a rotating circular face, fitted with soil/rock-cutting tools which advance the tunnel face. The resulting spoil is transported away from the face on a conveyor and transported out of the tunnel. The machine would normally incorporate actuators for installing a segmental tunnel lining immediately behind the excavating section of the machine, and it pushes forward off the completed lining to provide a face pressure to facilitate soil/rock cutting.
Tunnel Portal	Basically the beginning and end of the tunnel, typically characterised by a facing or hood structure, depending on the ground conditions.

Vehicle Restraint Systems (VRS)	Roadside barrier features which contain and redirect errant vehicles, typically described as either Open Box Beam or Tension Corrugated Beam construction. Terminals are located at the start and end to provide a gradual introduction of barrier.
Viaduct	A long elevated bridge that consists of a series of arches, piers, or columns supporting a road or railway. Typically a viaduct connects two points over a valley, road, river, or other low-lying feature or obstruction.
Weathered zone (bedrock)	Bedrock that has been weathered in situ by exposure to water or atmospheric processes resulting in its degradation or disintegration. Typically occurs across a zone at the top of the rock mass but can also occur at greater depth in association with variations in rock structure and the presence of groundwater.

Abbreviations

Abbreviation	Definition
AADT	Average Annual Daily Traffic
AEP	Annual Exceedance Probability
ATC	Automatic Traffic Counters
BCR	Benefit-Cost Ratio
BGS	British Geological Survey
BT	British Telecom
CA10	Counter Type
CAGR	Compound Annual Growth Rate
CAR	The Water Environment (Controlled Activities) (Scotland) Regulations
CEH	UK Centre for Ecology & Hydrology
CIRIA	Construction Industry Research and Information Association
CSRGT	Continuing Survey of Road Goods Transport
DMRB	Design Manual for Roads and Bridges
DVLA	Driving and Vehicle Licensing Agency
GIS	Geographic Information Systems
HEWRAT	Highways England Water Risk Assessment Too
HGV	Heavy Goods Vehicle
IRIS	Integrated Road Information System
KSI	Killed and Seriously Injured
LGV	Light Goods Vehicle
LLTNP	Loch Lomond and The Trossachs National Park
MBNL	Mobile Broadband Network Limited
MND	Mobile Network Data
MSE	Mechanically Stabilised Earth
NMU	Non-motorised User

NTDS	National Traffic Data System
OBB	Open Box Beam
OMR	Old Military Road
OS	Ordnance Survey
PES	Preliminary Engineering Services
PIA	Personal Injury Accidents
PPS	Plans, Policies and Strategies
PVB	Present Value of Benefits
PVC	Present Value of Costs
RABT	Rest and Be Thankful
RAG	Red Amber Green Screening
RC	Reinforced Concrete
RSI	Roadside Interviews
SCL	Sprayed Concrete Lining
SEA	Strategic Environmental Assessment
SEPA	Scottish Environmental Protection Agency
SMS	Structures Management System
SSSI	Site of Special Scientific Interest
STAG	Scottish Transport Appraisal Guidance
STPR2	Strategic Transport Projects Review 2
SuDS	Sustainable Drainage System
TAG	Transport Analysis Guidance
TBM	Tunnel Boring Machine
TCB	Tension Corrugated Beam
TMfS18	Transport Model for Scotland
VAT	Value-Added Tax
VRS	Vehicle Restraint System

1. Introduction

1.1 Background

1.1.1 The A83 Trunk Road is a 98-mile (158km) road in the Argyll and Bute council area providing a strategic link to Central Scotland. The road originates at Tarbet, at its junction with the A82 Trunk Road on the western side of Loch Lomond, and terminates in Campbeltown at the southern tip of the Kintyre peninsula. The section of the A83 Trunk Road through Glen Croe, between Ardgartan and the Rest and Be Thankful viewpoint at the A83 Trunk Road/B828 junction includes the highest point along the A83 Trunk Road at approximately 265m above ordnance datum and the adjacent hillsides have a history of instability leading to frequent road closures. The location of the length of the A83 Trunk Road which passes through Glen Croe is shown in Figure 1, included in Appendix A of this Report.

1.1.2 In May 2020, Jacobs and Aecom were commissioned as part of the second Strategic Transport Projects Review (STPR2) to provide Transport Scotland with early advice on the merit of different corridor options to address the problems associated with the existing A83 Trunk Road, taking particular cognisance of the constraints at the Rest and Be Thankful. The scope involved carrying out an initial appraisal of options with consideration given to the wider opportunities that these may afford. Eleven route corridor options were identified, and work commenced to assess the options.

1.1.3 Following a large landslide event on 4th August 2020 at the Rest and Be Thankful, Jacobs and Aecom were subsequently commissioned by Transport Scotland to undertake a Strategic Environmental Assessment (SEA) and provide Preliminary Engineering Services (PES) to resolve the ongoing resilience issues on the A83 Trunk Road at the Rest and Be Thankful. A Preliminary Assessment was undertaken on the eleven route corridor options identified as part of STPR2 as well as four additional route corridor options proposed by the public during the consultation held in September and October 2020. A recommend preferred route corridor for the Access to Argyll and Bute (A83) project was announced on 18th March 2021. The announcement can be found on the Transport Scotland website at the following location.

https://www.transport.gov.scot/news/a83-access-to-argyle-bute-preferred-route-corridor-identified/

1.1.4 This report, the Design Manual for Roads and Bridges (DMRB) Stage 1 Assessment Report, follows on from the Preliminary Assessment and describes the detailed assessment of the preferred route corridor. It also describes and assesses the possible route options within the preferred route corridor that are also considered in the SEA. The SEA Environmental Report sets out any significant positive or negative effects that developing this project may have on the environment. It also details the potential reasonable alternatives that have been considered, as well as the measures that could be taken to mitigate or offset any adverse impacts. Chapter 5 (Environmental Assessment) of this report refers to the outcome of the SEA.

1.2 Need for the Scheme

1.2.1 The Rest and Be Thankful was identified in the Scottish Road Network Landslide Study (2008) as one of the places in Scotland with the highest risk of landslides and debris flow hazards. While there is a long history of hillside instability, these have increased in frequency and severity in recent years due to the frequency of heavy, intense and prolonged periods of rainfall and often result in closures of the A83 Trunk Road through Glen Croe. Consequently, drivers may be required to use the Old Military Road (OMR), a single track road along the floor of the glen which tightly winds its way to the existing Rest and Be Thankful car park, or in certain instances, a longer diversion via the A819 local road, A85 Trunk Road and A82 Trunk Road. This diversionary route for A83 Trunk Road traffic between Tarbet and Inveraray is approximately 25 miles longer in length than if using the A83 Trunk Road. Depending on journey origin and destination, the longest diversion length experienced by travellers is over 60 miles.

1.2.2 The landslide in August 2020 was the largest in recent history, with a failure in the order of 10,000 tonnes of material impacting both the A83 Trunk Road and the OMR, resulting in a three-week closure of the A83 Trunk Road, and use of the diversion route to the north. Subsequent landslides in September 2020 (5000 tonnes) and October 2020 (less than 2,500 tonnes) were also recorded, and with ongoing concerns regarding the stability of the hillside this has resulted in the A83 Trunk Road being closed frequently and the OMR diversion being in use.

1.2.3 Anecdotal evidence suggests that these closures and restrictions cost the local economy £50,000 - £60,000 per day and hamper the potential for future business investment. Despite on-going maintenance and improvement schemes which have helped mitigate the impact of landslides, they have not provided a permanent solution as demonstrated in the most recent incidents.

1.2.4 Within the '*STPR2: Initial Appraisal: Case for Change – Argyll & Bute Region Report*', it is identified that the key problems within the region relate to connectivity, travel times and reliability, resilience and road safety issues. There is a lack of good standard transport infrastructure and public transport provision which is considered by stakeholders to be constraining growth within the region. When the transport connections are severed or disrupted as a consequence of accidents, incidents related to weather or operational issues, it can severely impact the residents, visitors and businesses of the Argyll and Bute region due to the lack of competitive alternative routes. This lack of good standard transport infrastructure coupled with the region's geography results in long and unreliable journey times.

1.2.5 The A83 Trunk Road is a vital lifeline for communities in Argyll and Bute, being essential for transport, regional and national economic trade, and their social, health and overall wellbeing. The increase in the frequency of incidents, means there is a need for a long-term solution to be developed to allow the area to prosper.

1.3 Scheme Objectives

1.3.1 The objectives for Access to Argyll and Bute (A83) project were developed based on the problems and opportunities relating to the strategic road network through an extensive review of existing studies. Additionally, cognisance was taken of public and stakeholder feedback obtained through consultation in September and October 2020.

1.3.2 The resulting scheme specific transport planning objectives are:

- Resilience - Reduce the impact of disruption for travel to, from and between key towns within Argyll & Bute, and for communities accessed via the strategic road network;
- Safety - Positively contribute towards the Scottish Government's Vision Zero road safety target by reducing accidents on the road network and their severity;
- Economy - Reduce geographic and economic inequalities within Argyll & Bute through improved connectivity and resilience;
- Sustainable travel - Encourage sustainable travel to, from and within Argyll & Bute through facilitating bus, active travel and sustainable travel choices; and
- Environment - Protect the environment, including the benefits local communities and visitors obtain from the natural environment, by enhancing natural capital assets and ecosystem service provision through delivery of sustainable transport infrastructure.

1.4 Consultations

1.4.1 To ensure successful delivery of the Access to Argyll and Bute (A83) project, comprehensive, early consultation with invested parties on a continual basis is essential.

1.4.2 For this reason, stakeholder engagement has been undertaken from the outset and played a crucial role at this early stage by influencing the scheme objectives as well as feedback being considered throughout the assessment. To date, this has included:

- Launch of an updated A83 website in September 2020;
- Initial email engagement with 250 key stakeholders inviting feedback in September and October 2020;
- Launch of a 'Storymap' site providing regular updates of the ongoing A83 work and progress to date in March 2021; and
- Continuing to undertake updates to the website and 'Storymap' as the scheme develops.

1.4.3 The following key stakeholders, statutory consultees and parties interested in the project have been identified, but are not limited to:

- Argyll and Bute Council;
- Highlands and Islands Enterprise;
- NatureScot;
- Scottish Environment Protection Agency (SEPA);
- Historic Environment Scotland (HES);
- Loch Lomond and The Trossachs National Park Authority;
- Forestry and Land Scotland;
- The Trunk Road Operating Company, currently BEAR Scotland;
- Highlands and Islands Transport Partnership (HITRANS);
- Elected Representatives;
- Local landowners and residents;
- Community Councils; and
- Numerous local interest, environmental, business, non-motorised user, accessibility and transport groups.

1.5 Scheme Appraisal

1.5.1 The '*STPR2: Initial Appraisal: Case for Change – Argyll & Bute Region Report'* sets out an approach to assessing options as part of that study and explains that the resulting short list of interventions will be appraised in line with the Scottish Transport Appraisal Guidance (STAG) based Appraisal Framework developed for STPR2. Transport Scotland's web site indicates that:

- during the appraisal stage, the sifted options are combined into packages and appraised against the Transport Planning Objectives, against wider STAG criteria and deliverability. This includes feasibility, affordability and public acceptability.
- further detailed assessment is undertaken to produce a final short list of proposed interventions. A scenario-based approach is proposed within this appraisal stage to help ensure that the future outcomes envisaged in National Transport Strategy 2 and other relevant policy commitments can be achieved. This is underpinned by the use of robust modelling and data analysis tools appropriate for the overall review and the diverse regions.

1.5.2 As the assessment for the Access to Argyll and Bute (A83) project is being undertaken in parallel to the wider STPR2 it will align with the approach set out in the '*STPR2: Initial Appraisal: Case for Change – Argyll & Bute Region Report'* and extend that work to recommend a preferred route corridor for the scheme.

1.5.3 This will take a two-stage assessment approach:

- Preliminary Assessment – an initial assessment with the objective of identifying if route corridors can justifiably be removed from further consideration at this initial stage on the basis that they do not sufficiently meet the scheme objectives and are demonstrably less preferable than other route corridors; and
- Detailed Assessment (this report) – an assessment in line with the Design Manual for Roads and Bridges of the corridors taken forward from the preliminary assessment.

1.5.4 The Preliminary Assessment Report was completed and published on the Transport Scotland website on 18th March 2021, and can be found via the following link:

https://www.transport.gov.scot/publication/preliminary-assessment-report-march-2021-a83-access-to-argyll-and-bute/

1.6 Scheme Development History

1.6.1 Relevant previous studies carried out include the following:

- Scottish Road Network Landslide Study: Implementation, Transport Scotland, 2008;
- A83 Trunk Road Route Study, Jacobs, 2013;
- A83 Glen Kinglas Options Report – 2019 Update, Jacobs, 2019; (This report was prepared for BEAR Scotland by Jacobs to assess the risk due to debris flow landslide hazards along the A83 Trunk Road in Glen Kinglas and identify areas where future work could be focussed. This was an update to a report prepared in 2014 to assess the impact associated with changes to the hillside during the intervening period including remedial measures implemented and deforestation.)
- STPR2: Initial Appraisal: Case for Change – Argyll and & Bute Region Report; and,
- STPR2: Update and Phase 1 recommendations Report.

1.7 Method of Assessment

1.7.1 The DMRB Stage 1 Scheme Assessment Report and method of assessment for the Access to Argyll and Bute (A83) project has been prepared in accordance with DMRB, TD 37/93 ‘*Scheme Assessment Reporting’*.

1.7.2 The Stage 1 report looks to identify, broadly define and compare improvement strategies for the area in question, Argyll and Bute. It initially examines the existing conditions within Glen Croe. Subsequently, the engineering, environmental and traffic and economic aspects for the recommended preferred corridor are assessed identifying associated advantages, disadvantages, and constraints which may influence the route option development and assessment at DMRB Stage 2.

1.8 Report Structure

1.8.1 This report has been structured as per DMRB, TD 37/93 ‘*Scheme Assessment Reporting’* and broadly follows the structure in Annex A of TD37/93 as set out below. These chapters are written in a factual, unbiased manner using clear and non-technical wording, where possible, so as it can be easily read and understood.

- Chapter 2 – Existing Conditions: provides an outline of the existing engineering conditions within the preferred route corridor, and a description of accident and traffic data along the A83 trunk road as a whole;
- Chapter 3 – Description of Alternative Schemes: describes the approach to the initial Preliminary Assessment and possible route options under consideration within the preferred route corridor, and provides a summary of the estimated construction costs;
- Chapter 4 – Engineering Assessment: details the engineering assessment of the possible route options under consideration within the preferred route corridor, identifying advantages, disadvantages, and constraints from a highways, structures, geotechnical and hydrology perspective;
- Chapter 5 – Environmental Assessment: provides a summary of the findings from the SEA;
- Chapter 6 – Traffic and Economic Assessment: provides a summary of the traffic and economic findings for the possible route options under consideration within the preferred route corridor;
- Chapter 7 – Risks: provides a summary of the risks present; and
- Chapter 8 – Conclusions: provides an overall summary and discussion of Chapters 4, 5, 6 and 7.

2. Existing Conditions

2.1 Introduction

2.1.1 This chapter describes the existing engineering conditions within the preferred route corridor (Route Corridor 1). Baseline accident data and traffic conditions for the A83 Trunk Road as a whole is also provided in this chapter.

2.1.2 The Preliminary Assessment carried out for the route corridor options considered for the project noted that there was potential for some internal connectivity benefits to be achieved through minor upgrades of the wider trunk road network in the region. As part of the Access to Argyll and Bute project, a review of the existing conditions has also therefore been undertaken for the A82, A85 and A828 Trunk Roads which make up the strategic transport network connecting Argyll and Bute to wider Scotland. These descriptions are contained in a separate Technical Note and will be used to inform further work to consider minor upgrades of the wider trunk road network in the region.

2.1.3 The existing conditions have been established from a desktop study and are set out as follows:

- Scheme Location and Environment;
- Topography;
- Climate;
- Land Use;
- Accident Data;
- Alignment and Cross-section;
- Junctions and Accesses;
- Lay-bys;
- Speed Limits;
- Signage;
- Traffic Signals and Road Lighting;
- Road Pavement;
- Drainage;
- Active Travel/Non-motorised User Provision;
- Resilience;
- Diversion Routes;
- Vehicle Restraint Systems;
- Utilities;
- Public Transport Provision;
- Structures;
- Geotechnical;
- Hydrology; and,
- Baseline Traffic Conditions.

Scheme Location and Environment

2.1.4 The scheme location is shown in Figure 1 included in Appendix A. The A83 Trunk Road travels generally north-west through Glen Croe, a V-shaped valley, where it increases in elevation to the Rest and Be Thankful car park and viewpoint, passing Loch Restil and dropping again as it approaches Glen Kinglas. Through this glen, it is flanked on both sides by the steep side slopes of The Cobbler, Cruach Fhiarach, the Brack, Ben Donich, Beinn Luibhean and Beinn an Lochain. The preferred route corridor is approximately 6km in length, and the A83 Trunk Road through the preferred route corridor is signed at the national speed limit. The preferred route corridor lies entirely within the local authority area of Argyll and Bute.

Topography

2.1.5 Ground levels along the preferred route corridor centre generally rise from the south-east extents of the corridor, where the A83 Trunk Road is approximately 90m above ordnance datum, to a height of approximately 265m above ordnance datum, near the Rest and Be Thankful car park. Ground levels to the north-east of the route corridor rise steeply towards the summits of The Cobbler and Beinn Luibhean and ground levels to the south-west of the corridor fall steeply towards the valley floor which is elevated between approximately 100m and 130m above ordnance datum. On the south-west side of Glen Croe, ground levels rise steeply again towards the summit of Coire Culach which is elevated approximately 660m above ordnance datum. As the route corridor passes Loch Restil, ground levels along the corridor centre gradually fall, down to a height of approximately 180m above ordnance datum where the corridor ends at Glen Kinglas. On the west side of the route corridor here, ground levels rise steeply towards the summit of Bein an Lochain which is elevated in excess of 900m above ordnance datum. On the east side of the preferred route corridor, ground levels also rise steeply towards the summit of Beinn Luibhean which is elevated approximately 860m above ordnance datum.

2.1.6 The study area is lined by a number of hills and mountains, including:

- The Cobbler (Ben Arthur) at approximately 884 metres above ordnance datum;
- The Brack at approximately 787 metres above ordnance datum;
- Ben Donich at approximately 847 metres above ordnance datum;
- Beinn Luibhean at approximately 858 metres above ordnance datum; and
- Beinn an Lochain at approximately 900 metres above ordnance datum.

Climate

2.1.7 Overall, the climate in the preferred route corridor can be described as cold and wet. The annual average temperature for the period between 1981 and 2010 for the West of Scotland is 11.3^{o}C (Met Office 2021) and the average annual rainfall at Glen Falloch (approximately 11km north-east of the preferred route corridor), between 1987 and 2017 is approximately 3145 millimetres (mm) (CEH, 2021). The average annual rainfall nationally for Scotland for the years between 1981-2010 is 1570.9 millimetres (mm) (Met Office 2021).

2.1.8 Climate change is likely to result in a range of impacts that would have implications on the existing road network. Scottish Environmental Protection Agency (SEPA) guidance (SEPA, 2019) provides allowances for peak rainfall, peak river flow and sea levels. Peak rainfall allowances account for increases in rainfall intensity, for the west of Scotland this equates to a 55% potential change in peak rainfall intensity for the year 2100. Peak river flow allowances vary depending on the River Basin Region with the predicted total change to the year 2100 is 56% for Argyll region and 44% for Clyde region, with the A83 Trunk Road crossing both regions.

<u>Land Use</u>

2.1.9 Land use within the preferred route corridor is generally agricultural with commercial interests in the form of coniferous plantation woodland on the surrounding hillsides, including parts of The Brack, Ben Dornich on the south-western side and The Cobbler to the north-east. There are six properties within the preferred route corridor which consist of two residential properties, one situated at the northern end of the corridor on the valley floor below the Rest and Be Thankful car park and the other to the south adjacent to the A83 Trunk Road, south of the bridge crossing the Croe Water. Along the valley floor there are four outbuildings/ livestock sheds which are located next to the Old Military Road (OMR).

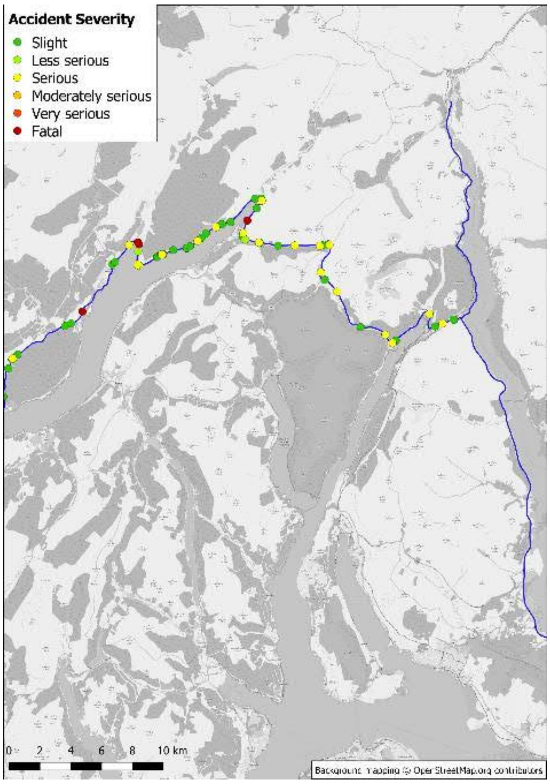
<u>Accident Data</u>

2.1.10 STATS19 data is collected by the police and contains information on all accidents attended by the police, which result in death or personal injury. Stats19 records for the A83 Trunk Road between its junction with the A82 Trunk Road at Tarbet and its end in Campbeltown were provided by Transport Scotland, for the five year period of 2015-2019. This data was used to derive the most up to date accident statistics and provide an understanding of road safety trends in the corridor

<u>Accident Locations</u>

2.1.11 Figure 2.1 shows the location of accidents recorded in the five-year period by severity.

2.1.12 It should be noted that the recording of accident severities changed in 2019. Prior to this date accidents were recorded as slight, serious or fatal. 2019 saw the introduction of the following additional severity categories: less serious, moderately serious and very serious. Accident statistics by severity for years prior to 2019 are therefore not directly comparable with severity statistics from 2019 onwards.



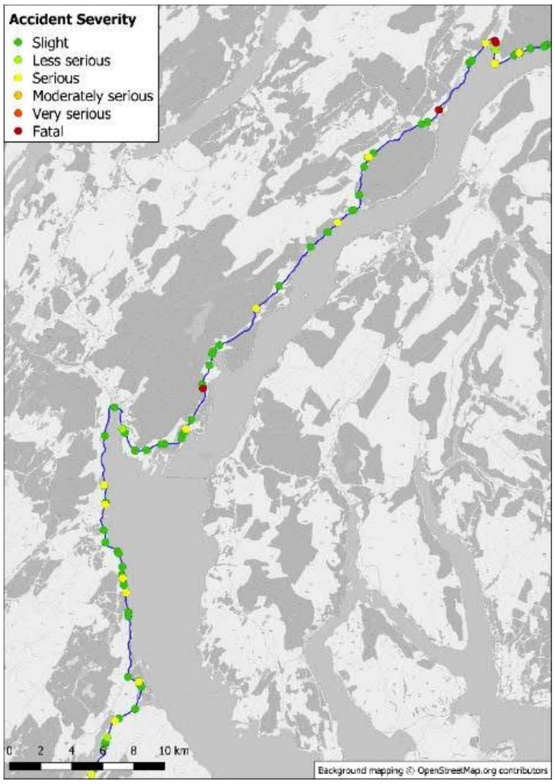


Figure 2.1: A83 Tarbet to Campbeltown - Accidents by Severity, Source: STATS19, 2015-2019

2.1.13 Higher frequencies of accidents were observed in some locations along the sections between the A815 junction and Inveraray, Lochgair and Lochgilphead, including to the south of Port Ann, and in some locations along the sections of the A83 Trunk Road between its junctions with the B8024 north and the B8001. Annual average traffic volumes in these locations are relatively low and so these accidents are likely to be attributable to other factors.

2.1.14 Table 2-1 shows the locations of fatal accidents recorded along the A83 Trunk Road during the years between 2015 and 2019.

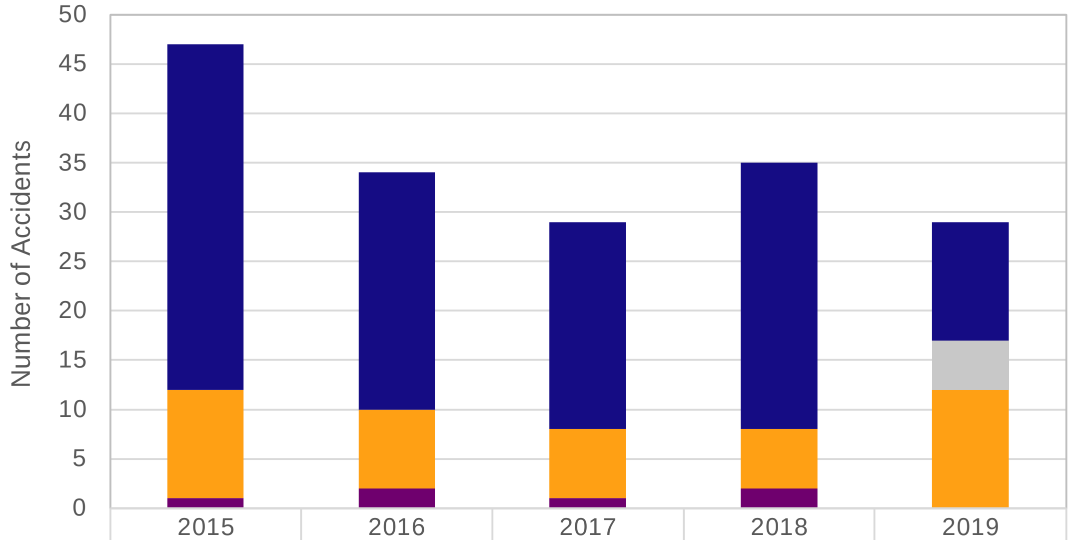
Table 2-1: A83 Tarbet to Campbeltown - Fatal Accidents, Source: Stats19 2015-2019

Location	Date	Number of Vehicles	Vehicle Types
Cairndow War Memorial	Nov 2016	2	Car
Gearr Abhain Crossing	May 2017	1	LGV
Approx 160 m north of Gearr Abhain Crossing	Jun 2016	1	Motorcycle
Approx 600m north of access to Argyll Caravan Park	Nov 2015	2	Car
Approx 2.7 km north of Part Anne	Apr 2018	2	Motorcycle, Other Vehicle
South of Muasdale	Nov 2018	1	Car

2.1.15 Six fatal accidents were recorded between 2015 and 2019. On the A83 Rest and Be Thankful section, no fatal accidents were recorded during this period. However, three fatal accidents were observed between Cairndow and Inveraray. Two of these accidents were located on the section to the north of Inveraray, near the Gearr Abhain Crossing.

Accident Trends

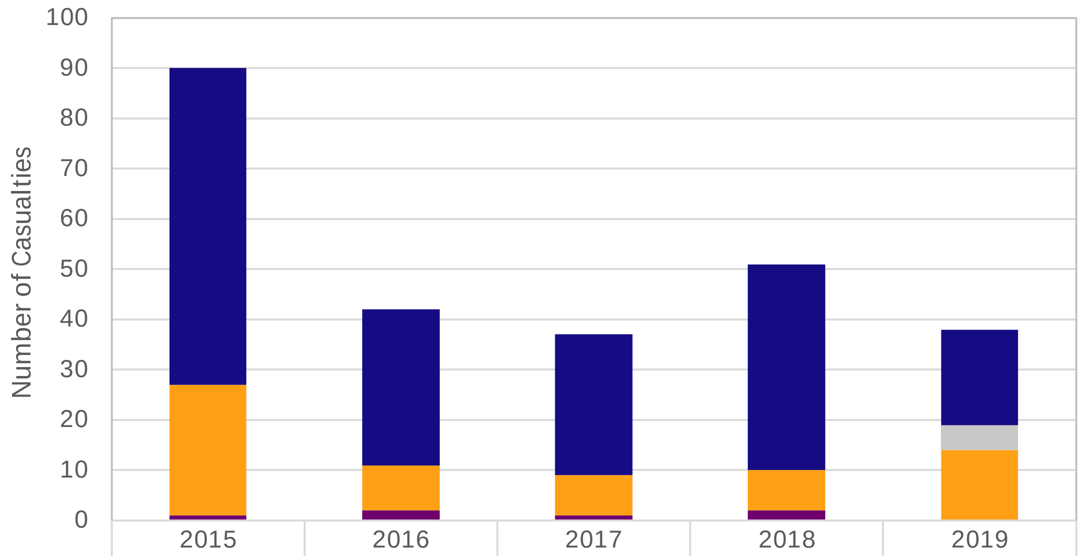
2.1.16 Figure 2.2 shows the number of accidents by year and severity. Figure 2.3 provides similar information with respect to casualties. The highest frequencies of accidents (47) and casualties (90) were recorded in 2015. Accident numbers can be subject to substantial year on year fluctuation and it is therefore not clear whether this suggests safety has improved since 2015, or just represents a single year outlier. In subsequent years up to 2019, the number of accidents fluctuated between 29 and 35. The number of casualties varied between 37 and 51. Data for the period analysed therefore does not provide evidence of consistent changes in the number of accidents over the period.



	2015	2016	2017	2018	2019
Slight	35	24	21	27	12
Less Serious	0	0	0	0	5
Serious	11	8	7	6	12
Very Serious	0	0	0	0	0
Fatal	1	2	1	2	0

Fatal Very Serious Serious Less Serious Slight

Figure 2.2: A83 Number of Accidents by Severity and Year, Source: Stats19 2015-19



	2015	2016	2017	2018	2019
Slight	63	31	28	41	19
Less Serious	0	0	0	0	5
Serious	26	9	8	8	14
Very Serious	0	0	0	0	0
Fatal	1	2	1	2	0

Figure 2.3: A83 Number of Casualties by Severity and Year, Source: Stats19 2015-19

Accident Rates

2.1.17 Accident rates, expressed as the number of accidents per million vehicle km, take into account traffic flows, therefore providing a better measure for comparison between locations where traffic flows differ. Comparisons with national statistics in this section have therefore been expressed in terms of accident rates.

2.1.18 Accident rates for the above routes have been calculated and compared with observed national statistics as published in Reported Road Casualties Scotland[1].

2.1.19 For the purposes of calculating rates, a distinction was made between non-built up sections and built-up section to account for differences in safety performance where the roads run through settlements, and to facilitate comparison with observed values.

2.1.20 Figure 2.4 shows the accident rate along rural sections of the A83 Trunk Road, compared with the five year average for similar roads in Scotland[2].

2.1.21 Accident rates on rural sections of the A83 Trunk Road were 0.230 accidents per million vehicle km to the north of Lochgilphead and 0.184 accidents per million vehicle km to the south of the town. Based on statistical analysis at 95% confidence level, accident rates on both sections were higher than for similar roads nationally (0.085 accidents per million vehicle km).

[1] Source: Reported Road Casualties Scotland 2019, A National Statistics Publication, Table 5b
[2] Source: Based on 2015-2019 Average Rate for Rural Trunk A-Roads in Scotland from Reported Road Casualties Scotland 2019, A National Statistics Publication, Table 5b

2.1.22 Whilst the numbers suggest that the rates may be higher to the north than to the south of Lochgilphead, this is not confirmed conclusively by statistical analysis at 95% level.

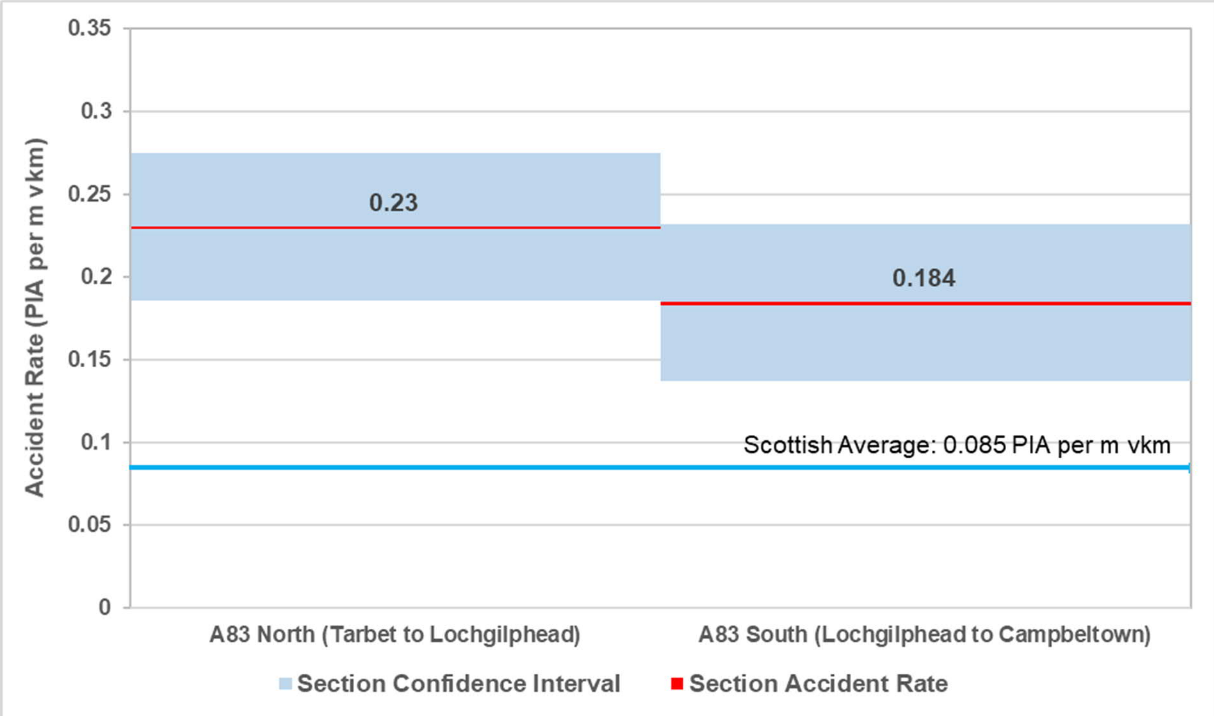


Figure 2.4: A83 Accident Rates (Personal Injury Accidents (PIA) per million vehicle km)-Comparison with National Statistics, Source: Stats19 2015-2019

Severity Splits

2.1.23 Figure 2.5 shows a comparison of severity splits along rural sections of the route with national statistics. Due to the changes in the way severities were recorded from 2019 onwards, the comparison with national statistic has been based on data for the years between 2015 and 2018 only.

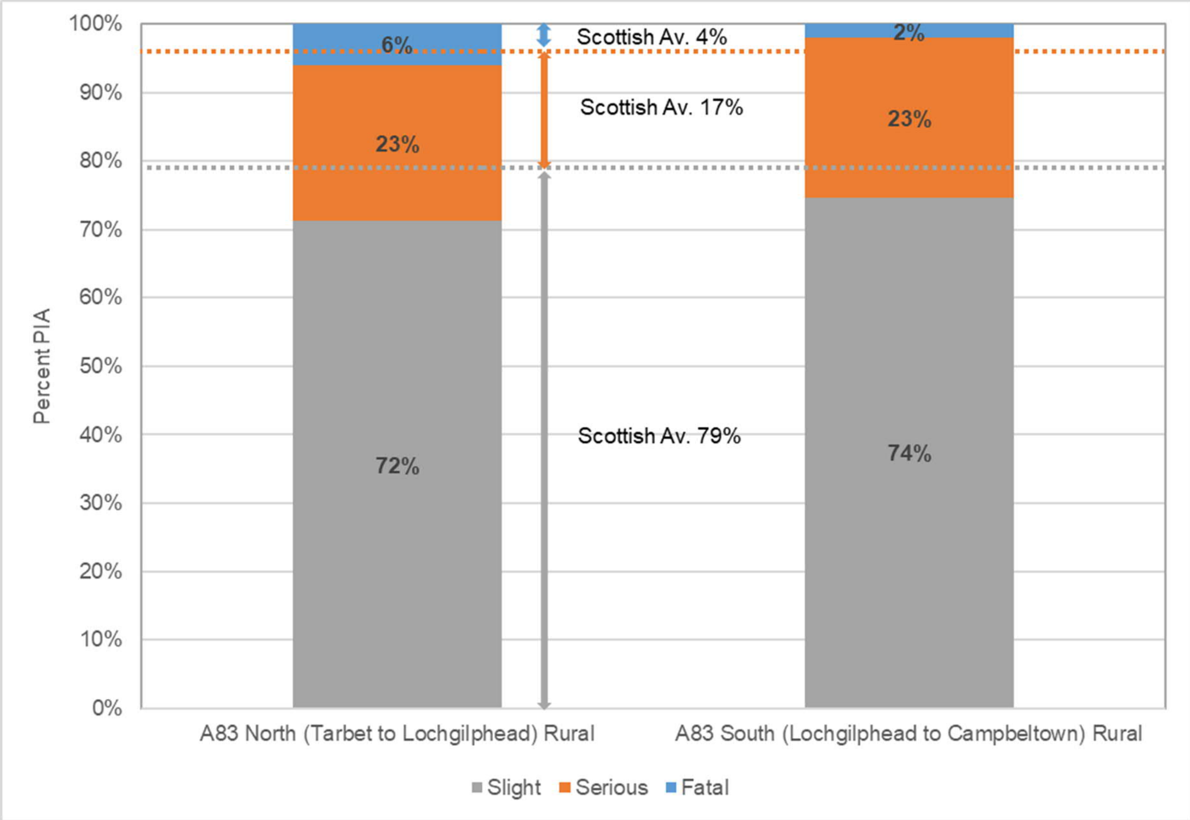


Figure 2.5: A83 Severity Splits - Comparison with National Statistics, Source: Stats19 2015-2018 [3]

2.1.24 In 2015-18 Killed and Seriously Injured (KSI) accidents accounted for a higher proportion of all personal injury accidents than on Scottish trunk A-roads, overall. The proportions of KSI accidents were 28% and 26% on the rural sections of the A83 Trunk Road to the north and to the south of Lochgilphead, respectively, slightly above the national average for similar roads (21%).

Seasonal Variation

2.1.25 Figure 2.6 shows the seasonal variations of accidents and casualties recorded during the period between 2015-2019, both in absolute terms and as a percentage of the five year total.

2.1.26 The highest monthly proportion of accidents (16%) was recorded in May. The analysis generally indicates that a higher number of accidents take place during the late spring and summer months when the total traffic volumes are typically higher. An increase in accidents was also observed in January, which may be attributable to the weather conditions leading to impaired visibility and more hazardous driving conditions.

2.1.27 The number of casualties generally follows the seasonal increases in accidents. The outlier in the month of March was caused by a multi casualty accident involving a bus/coach.

[3] Source: Scottish averages based on accidents by severity for non-built up trunk A-roads reported in Reported Road Casualties Scotland 2019, A National Statistics Publication, Table 5a

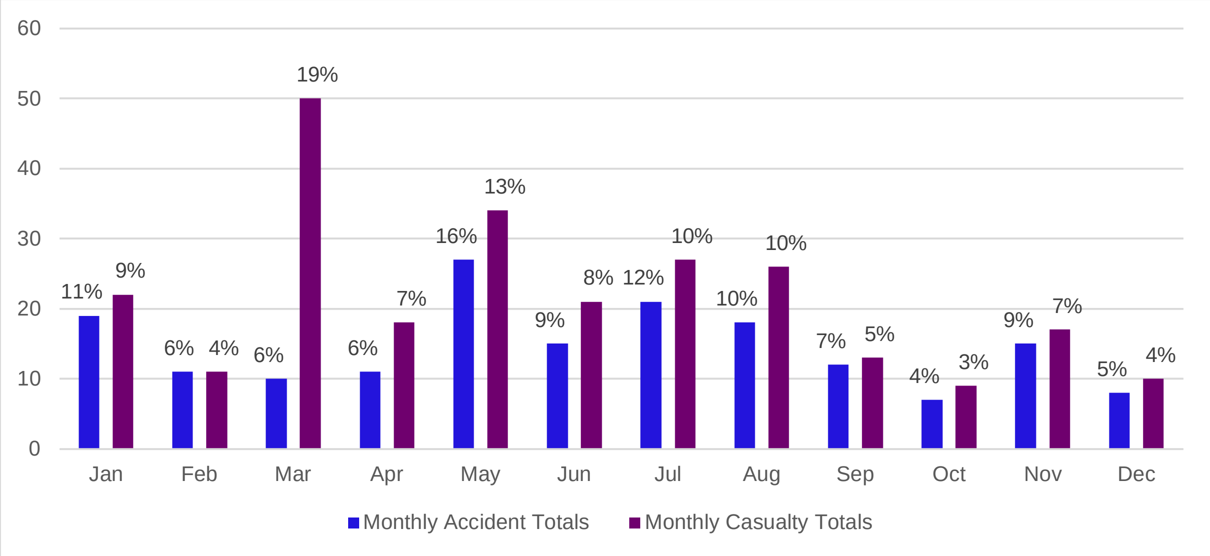


Figure 2.6: A83 Seasonal Variation of Accidents and Casualties, Source: Stats19, 2015-19

Accidents by Vehicle Type

2.1.28 Figure 2.7 illustrates accidents recorded in the corridor by vehicle type involved, including breakdown for the sections of the A83 Trunk Road to the north and south of Lochgilphead.

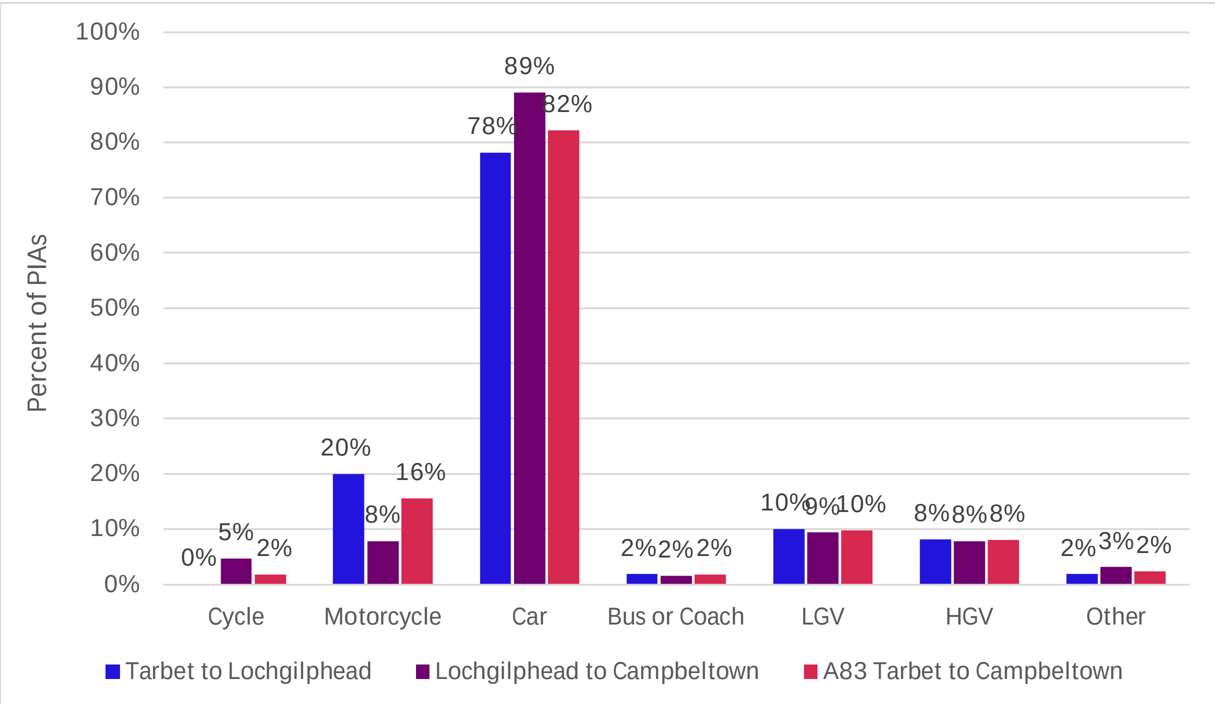


Figure 2.7: A83 Tarbet to Campbeltown -Accidents by Vehicle Type, Source: Stats19 2015-2019

2.1.29 82% of accidents recorded on the A83 Trunk Road between 2015 and 2019 involved at least one car, 10% of accidents involved an LGV and 8% and HGV. It is noteworthy that a relatively high proportion of accidents in the corridor (16%) involved a motorbike. The proportion of accidents involving a motorbike was particularly high (20%) on the northern section of the A83 Trunk Road, between Tarbet and

Lochgilphead. 5% of accidents recorded on the A83 Trunk Road between Lochgilphead and Campbeltown involved a bicycle.

Accidents Summary

2.1.30 The analysis of Stats19 for the period 2015 to 2019 indicates that:

- Annual accident numbers fluctuated, with no evidence of consistent change;
- Accident rates are significantly above national average values, with some evidence that the Tarbet to Lochgilphead section has higher accident rates than the Lochgilphead to Campbeltown section;
- Severity rates are slightly above the national average for similar roads;
- A higher number of accidents take place in the late spring and summer months, associated with the higher traffic volumes; and
- 20% of accidents on the Tarbet to Lochgilphead section involved a motorbike.

Alignment and Cross-section

Alignment

2.1.31 The A83 Trunk Road is generally an evolution of military roads and tracks from the 18th century and earlier, which have gradually been developed and integrated to form part of the current trunk road network. Within the preferred route corridor, the alignment of the A83 Trunk Road was constructed in the 1930s to replace the OMR at the base of the valley between the lower and upper parts of the glen. From this point, it generally follows the OMR. As such, much of the route pre-dates modern day design standards which is reflected in the alignment geometry across much of the route. However, with the introduction and implementation of uniform road design standards through the latter 20th century and into the 21st, local improvements have been carried out along the route as identified by the Operating Companies.

2.1.32 Based on a design speed of 100kph, approximately 12.7% (768m) of the horizontal alignment geometry through the preferred route corridor was found to be greater than three steps below the desirable minimum design standard and is therefore not in accordance with current road design standards. A total of 4 horizontal curves were noted to be Departures from Standards. The location of horizontal curves that are below the desirable minimum design standard are shown on Figure 3A to Figure 3H included in Appendix A.

2.1.33 While a detailed check on vertical geometry has not been undertaken, BEAR Scotland confirmed that the maximum gradient through the preferred route corridor is approximately 5%. As such, the vertical gradient is generally compliant with road design standards. A visual assessment of the route have shown that rock cuttings and limited provision of a verge, in combination with tight bend radii will likely impede driver visibility over localised lengths.

Cross-section

2.1.34 The cross-section of the A83 Trunk Road through the preferred route corridor is predominately that of a rural, un-kerbed two-lane single carriageway road, with no hard strip provision, constantly varying verge widths and at some locations, no verge provision. Kerbed sections are present along its length; however, these are typically limited to junction bell mouths and some lay-bys.

2.1.35 While exact widths for carriageway features are unknown across the entire length, it has been concluded that the cross-section is generally non-compliant with current design standards for a rural single all-purpose carriageway, attributable to the historic nature of the A83 and to the variability of the of the cross section, described above.

Junctions and Accesses

2.1.36 From a desktop review, a total of 8 junctions and accesses connecting directly to the A83 Trunk Road were recorded. These are shown on Figure 3A to Figure 3H included in Appendix A and are summarised below.

- B-road junction: 1
- OMR access: 1
- Residential access: 1
- Access Tracks / Field Access: 5

2.1.37 The junction between the A83 Trunk Road and B828 local road is an at-grade priority junction.

Lay-bys

2.1.38 From the desktop review, a total of 10 parking and bus lay-bys were recorded within the preferred route corridor. These are shown on Figure 3A to Figure 3H included in Appendix A and are summarised below.

- 1 lay-by which exhibits a small kerbed segregation island;
- 5 lay-bys similar in layout to a Type B arrangement but with variations; and
- 4 informal lay-bys.

2.1.39 While no detailed survey work has been carried out to date, it was noted from the desktop review that all existing lay-bys, appeared not to be in accordance with current design standards.

2.1.40 Use of lay-by signage was also noted to be mixed and dependent on the type of lay-by provided.

Speed Limits

2.1.41 As a rural trunk road, the national speed limit for single carriageway roads applies to the length of the A83 Trunk Road throughout the preferred route corridor.

Signage

2.1.42 From the desktop review and with reference to the traffic sign information provided by BEAR Scotland, signage through the preferred route corridor includes warning, advance directional, directional, route confirmation, tourist and information signs. Signs are positioned at expected locations in the verge and do not impact on any footways. As far as could be assessed, signs appeared to generally be at sufficient mounting heights.

2.1.43 No signs within the preferred route corridor are illuminated and no regulatory signs were noted.

2.1.44 Directional signs are noted to include locations in Gaelic, in addition to English.

Traffic Signals and Road Lighting

2.1.45 In keeping with its rural nature, no traffic signals or road lighting is present within the preferred route corridor.

Road Pavement

2.1.46 As far as could be assessed, the A83 Trunk Road appears to be of flexible construction with a bituminous/asphaltic surface course. It is assumed that recent improvement schemes have applied TS 2010 surface course in line with other Scottish trunk roads.

2.1.47 Horizontal curves towards the northern end of the corridor appear to have worn high friction surfacing.

Drainage

2.1.48 Through the preferred route corridor, surface water is generally removed from the carriageway through over edge drainage.

2.1.49 Typically, this is through informal verge runoff, ditches, grips and filter drains. It is assumed that surface water is discharged to adjacent land or watercourses, depending on location, either directly or conveyed through ditches. There are no obvious signs of attenuation further to assumed capacity provided by pipes or ditches prior to discharge.

2.1.50 Within the extents of the preferred route corridor, no positive drainage through kerb and gullies was identified.

2.1.51 No obvious SuDS provision was noted within the preferred route corridor. This is not unexpected as construction of the A83 is likely to have pre-dated the introduction of modern SuDS techniques and given the challenging and constrained topography within the preferred route corridor.

2.1.52 Ditches and Filter drains are also used as cut off drains to protect the road formation.

2.1.53 A significant number of tributaries and watercourses cross the A83 Trunk Road via culverts and piped crossings along its length. The total number is unknown for this assessment; however, culverts with a diameter greater than 900mm are discussed in the Structures section later in this chapter.

Active Travel/NMUs

2.1.54 Within the preferred route corridor, there are no existing formal NMU facilities within the cross-section of the A83 Trunk Road. A Core Path located on the western side of the glen does provide a connection from Ardgartan to Lochgoilhead with a link to the B828 local road just west of the Rest and Be Thankful car park.

Resilience

2.1.55 Route resilience across the A83 Trunk Road is important to ensure continuation of local and strategic travel between Tarbet and Campbeltown. The A83 Trunk Road has well documented road resilience issues, particularly within Glen Croe.

2.1.56 In recent years, rainfall intensity and frequency have increased resulting in severe, ongoing landslide events within Glen Croe, affecting the A83 Trunk Road and to a lesser degree, the OMR which acts as a diversion route, under convoy control when the A83 Trunk Road is closed. This causes considerable delay and disruption to traffic to and from Argyll and Bute and between communities within. Considerable works have been undertaken to mitigate the landslide risk, however the increased frequency and magnitude of the recent landslides has overwhelmed these measures causing further and ongoing, traffic disruption. Ongoing improvement works to the OMR continue to be progressed.

2.1.57 Flooding is also an issue in Glen Croe, with the Croe Water classified by SEPA's flood mapping as having a high likelihood of flooding both in its hillside tributary and in the valley floor.

2.1.58 BEAR Scotland's Winter Service Plan for the North West Unit (2018 – 2019) identifies snow pole provision between the Rest and Be Thankful and Glen Kinglas adjacent to the A83 Trunk Road carriageway and classifies the route between the Rest and Be Thankful and Campbeltown as a precautionary salting and plough route. This indicates that snow accumulation or surface frost/ice in this area is possible, with implications for route resilience during snowstorms.

2.1.59 The completion of routine cyclical maintenance is a resilience challenge along the route which, on a two-lane carriageway is likely to require the closure of at least one lane and the placing of the remaining lane under some form of traffic management, e.g. 'stop-go' boards or temporary traffic signals.

2.1.60 Road Traffic Accidents are also likely to impact route resilience with full closure possibly implemented until such accidents are cleared. A diversion route in the event of a route closure is outlined later in this chapter of the report.

2.1.61 Given the strategic link of the A83 Trunk Road to Kennacraig Ferry Terminal, issues on the trunk road could cause wider impact to the islands due to disruption and delays potentially resulting in missed ferries.

<u>Diversion Routes</u>

2.1.62 As noted in the Resilience section above, the OMR is used as a convoy controlled single lane diversion route when the A83 Trunk Road is closed within Glen Croe. In instances when the OMR cannot be used, a longer diversion route via the A819 local road, A85 Trunk Road and A82 Trunk Road is required. A diversion distance and journey time has been estimated from the junction between the A83 Trunk Road/A815 local road to Tarbet, this is outlined in Table 2-2 below and Figure 4 included in Appendix A. Without a diversion, the travel distance between these two points is approximately 12.5 miles, therefore in this particular instance, the additional journey length created by the diversion is approximately 47 miles.

Table 2-2: Diversion Route

Closure of A83 Between	Diversion Route	Diversion Distance	Diversion Journey Time	Journey Time Difference
Rest and be Thankful car Park and Ardgartan	From the A83 Trunk Road/A815 local road junction, head west on A83 Trunk Road to Inveraray, then north on the A819 local road to Dalmally. Turn east on to A85 Trunk Road to Tyndrum, and then follow the A82 Trunk Road south to Tarbet.	59.5 miles	80 mins	+59mins

2.1.63 Depending on journey origin and destination, the longest diversion length experienced by travellers would be over 60 miles.

<u>Vehicle Restraint Systems</u>

2.1.64 Vehicle Restraint Systems, more commonly known as safety barriers are used extensively along the length of the A83 Trunk Road through the preferred route corridor as it rises through Glen Croe to the Rest and Be Thankful car park, predominately in the northbound verge. Generally, these barriers consist of tension corrugated beam (TCB) south of the car park and open box beam (OBB) north of the car park.

2.1.65 From the desktop review, sections of barrier have been identified as using ramp style terminals which are usually performance class P2. A total of 24 ramp style terminals were noted. For a two-way single carriageway road, these are non-complaint as current design standards require a performance class of P4 and be energy absorbing i.e. not ramped.

2.1.66 Bridge parapets appear to be masonry wall construction.

Utilities

2.1.67 A C2 notification was issued to Statutory Undertakers in line with the New Roads and Street Works Act 1991. At present, responses have been received from two Statutory Undertakers confirming they had apparatus within the preferred route corridor. These include:

- BT Openreach currently has existing apparatus in the form of underground cables and chambers which run parallel and in close proximity to both the A83 Trunk Road and the OMR for the extents of the preferred route corridor; and
- Mobile Broadband Network Limited (MBNL) currently has existing apparatus in the form of a mast which is located on the B828 local road, approximately 200m south-west of the Rest and Be Thankful car park.

2.1.68 Additionally, there is an overhead line running parallel to the B828 between Lochgoilhead and the Rest and Be Thankful car park. The owner of the apparatus is unknown.

Public Transport Provision

2.1.69 Within the preferred route corridor, the A83 Trunk Road forms part of the route of three bus services, two services providing links to strategic and regional destinations, and one a regional service. Figure 5 included in Appendix A shows the route of these services.

2.1.70 Bus operators in the preferred route corridor are West Coast Motors (on behalf of Scottish Citylink) and Garelochhead Coaches. Frequencies for key regional and strategic routes are listed in Table 2-3.

Table 2-3: A83 Key Bus Routes and Frequencies, Source: Traveline FTP data, September 2018 [16]

Service	Origin	Destination	Typical Frequency
302	Helensburgh	Carrick Castle	3x daily
926	Glasgow	Campbeltown	5-6x daily per direction
976	Glasgow	Oban	5x daily

2.1.71 Refer to the Lay-bys section of this report for bus lay-by locations.

Structures

2.1.72 The information relating to existing structures within the preferred route corridor has been extracted from Transport Scotland's Integrated Road Information System (IRIS) within the Structures Management System (SMS).

[16] Since current timetables varied from normal service provision due to the impact of the COVID-19 pandemic, bus frequencies have been extracted from historic Traveline data. Since the Traveline FTP site does not retain historic data, this was taken from FTP data for September 2018, which was available from the development of Transport Model for Scotland. Journey time data is taken from travelinescotland.com and traveline.info.

Bridge Structures

2.1.73 There are two bridge structures present along the preferred route corridor. The Cobbler bridge is a water crossing carrying the A83 Trunk road over Croe Water. The Kinglas bridge is a water crossing carrying the A83 Trunk Road over Kinglas Water.

2.1.74 Table 2-4 contains summary information for existing Route Corridor 1.

Table 2-4: Existing Bridge Structures

Bridge Code	Bridge Name	Bridge Type	Chainage	Year Of Completion	Deck Width (m)	Deck Length (m)	Form of Structure
A83 60	Cobbler	Water Crossing	11+385	1940	7.5	14.6	Composite beam and slab
A83 70	Kinglas	Water Crossing	15+755	1932	7.5	14.6	RC Slab

2.1.75 The West Highland Line railway overbridge crosses the A83 Trunk Road between Tarbet and Arrochar. The structure is maintained by Network Rail. Although this structure is not directly within the geographic extents of the preferred route corridor, the bridge has a signed height restriction of 16 feet (4.877m) and the measured minimum headroom clearance of 16 ft 4 inches (4.978m).

2.1.76 Within the preferred route corridor, there are bridge structures where the width between the parapets causes a width restriction. Those where the width between parapets is 8.5m or less are highlighted in Table 2-5.

Table 2-5: Bridge structures with width restriction to Route Corridor 1 of 8.5m or less

Bridge Code	Bridge Name	Form of structure	Width available on bridge (m)
A83 60	Cobbler	In-situ reinforced concrete beams with reinforced concrete slab (composite)	8.23
A83 70	Kinglas	Reinforced concrete slab	6.4

Culverts

2.1.77 There are 12 existing highway related culverts present within the preferred route corridor.

2.1.78 Table 2-6 contains summary information for the existing culverts within the preferred route corridor.

Table 2-6: Existing Culverts

Culvert Code	Bridge Number	Structure Type Number	Chainage	Year Of Completion	Diameter (m)	Span Length (m)	Form of Structure
A83 50 C18	50	18	9+535	1938	0.9	14	Pipe
A83 50 C60	50	60	10+440	1937	1.8	15	Box
A83 50 C73	50	73	10+730	1938	0.9	10	Box
A83 50 C87	50	87	11+040	1938	0.9	18	Box
A83 50 C91	50	91	11+140	1938	0.9	17	Box
A83 60 C8	60	8	11+685	1938	0.9	15	Box

Culvert Code	Bridge Number	Structure Type Number	Chainage	Year Of Completion	Diameter (m)	Span Length (m)	Form of Structure
A83 60 C23	60	23	12+330	1938	1.2	26	Box
A83 60 C26	60	26	12+480	1938	0.9	24	Pipe
A83 60 C30	60	30	12+805	2003	1.8	14	Box
A83 60 C38	60	38	13+010	1939	1.2	12	Solid Slab
A83 60 C40	60	40	13+100	1938	0.9	12	Pipe
A83 60 C89	60	89	15+290	1939	1.8	15	Box

2.1.79 The culverts comprise:

- 8 box culverts of 0.9 to 1.8 metres maximum span;
- 3 piped culverts of 0.9 metres in diameter; and
- 1 reinforced concrete slab of 1.2 metre span.

__Retaining Walls__

2.1.80 There are 6 retaining wall structures present along the preferred route corridor.

2.1.81 Table 2-7 contains summary information for the existing retaining walls along the preferred route corridor.

Table 2-7: Existing Retaining Walls

Retaining Wall Code	Chainages	Year Of Completion	Length Of Wall (m)	Maximum Height (m)	Minimum Height (m)	Form of structure
A83 50 W61	10+940	1938	35	2.1	1.1	Masonry
A83 60 W17	12+210	2020	No information			
A83 60 W22	12+295	1938	82	6	0.6	Masonry
A83 60 W76	14+690	1940	18	2.5	0.9	Masonry
A83 60 W79	14+955	1800	38	5.5	1	Insitu Reinforced Concrete
A83 60 W83	15+000	1940	17	2.6	1	Mass Concrete

2.1.82 The retaining walls comprise:

- 3 masonry stone wall;
- 1 in-situ reinforced concrete wall;
- 1 mass concrete wall; and
- 1 unknown (no information available).

2.1.83 The walls vary in height up to approximately 6.0 metres and are of lengths up to 82 metres.

Geotechnical

2.1.84 The existing conditions within the preferred route corridor are influenced by the topography which in general terms is characterised by the traversing of mountainous terrain. The main areas of concern are associated with hillside instability and susceptibility to landslide, and poor drainage with potential for wash-out affecting earthworks and structures along the route.

2.1.85 The preferred route corridor is highly susceptible to landslide and debris flow events. The National Landslide Database records historic events to have occurred throughout but with a particular concentration on the south-west facing slopes of Beinn Luibhean on approach to the Rest and Be Thankful. An assessment of the geotechnical hazards and key constraints within Glen Croe is summarised in Chapter 4 of this report. The Scottish Road Network Landslides Study (2005, 2008)[18] provides a categorisation of landslide susceptibility on the hillsides above the trunk road along the route and the Implementation report dated 2008 assigned hazard ranking scores to sections of the existing A83 Trunk Road. The section between Ardgartan and the Rest and Be Thankful received the highest hazard ranking along the A83 Trunk Road (joint highest with Glen Kinglas).

2.1.86 Poor drainage, both up-slope and at roadside, has potential to affect the earthworks, structures and slope stability within the route corridor. These can often be linked to locations particularly susceptible to landslide and debris flow. There may also be associated issues with blockage of culverts due to debris and carriageway flooding.

2.1.87 Rock slopes are present locally within the route corridor with potential for instability and rock-fall landing on the road, particularly on the final approach to the Rest and Be Thankful through Glen Croe.

2.1.88 At the time of writing, various works have been completed, are under construction or planned in the future by the Operating Company, BEAR Scotland, to address some of the issues at locations noted above. At the Rest and Be Thankful on the southwest-facing slopes of Beinn Luibhean, mitigation measures have comprised mainly the installation of debris fences and construction of catch pits, as well as measures to improve the resilience of the diversion route along the OMR. These works are summarised in Table 2-8.

Table 2-8 : Summary of mitigation measures completed, under construction and future planned

Phase	Completed	Under construction	Future planned
1	1 No. Geobrugg SL-150 landslide barrier [REMOVED]	Catch pit 1 No. RXE-2000 rockfall barrier (modified to be open at the bottom)	-
2A	1 No. Geobrugg UX120 H6 barrier 1 No. Geobrugg VX 060L barrier	-	-
2B	1 No. Geobrugg SL-150 shallow landslide barrier	-	-
3A	Catch pit	-	-
3B	1 No. Geobrugg UX180-H6 barrier (modified to be open at the bottom) HESCO barrier along OMR	-	Catch pit
4	2 No. tiers of Isofer Debris STOP 200-HM	-	Catch pit [1]
5	2 No. Maccaferri debris flow channel barriers - DF30 Type	-	Catch pit

[18] Scottish Executive, Scottish Road Network Landslides Study, 2005
Transport Scotland, Scottish Road Network Landslides Study: Implementation Report, 2008

Phase	Completed	Under construction	Future planned
6	1 No. Maccaferri debris flow channel barriers - DF30 Type	-	Catch pit
7	2 No. Maccaferri DF30 Type 3 landslide barrier Catch pit	-	-
8	1 No. Maccaferri DF30 Type 3 landslide barrier Catch pit	-	-
9	1 No. Maccaferri DF30 Type 3 landslide barrier Catch pit	-	-
10	1 No. 66 m long Maccaferri DF50 Type 3 barrier 1 No. 26 m long Maccaferri DF50 Type 2 barrier	-	Catch pit [1]
11A	2 No. Maccaferri DF50 Composite Type 3 and Type 1 landslide barriers	-	-
11B	1 No. Maccaferri DF50 Type 3 landslide barrier	-	-
12	1 No. Maccaferri DF50 Type 3 shallow landslide barrier 1 No. Maccaferri DF50 Type 1 debris flow channel barrier	-	-

2.1.89 There is potential for river and loch erosion within the route corridor at locations identified but not limited to those outlined in Table 2-9. Erosion can manifest in the following ways:

- At locations where the road crosses rivers or other watercourses and where water flows may result in scour affecting structures or undermine the carriageway.
- At locations where the road runs parallel to rivers or other watercourses and where erosion may occur along the outside bends of meanders with potential to undermine the carriageway and associated earthworks.
- At locations where the road runs parallel to the shoreline of lochs or the coast and where wave action, often increased by high winds, may result in erosion along the shoreline with potential to undermine the carriageway, and associated earthworks and structures.

Table 2-9: Summary of locations with potential to be affected by erosion along A83 Trunk Road

Cause of Erosion	Location
River	Multiple unnamed and named rivers and watercourses including Croe Water (including three crossings) and Kinglas Water.
Loch	Loch Restil

<u>Hydrology</u>

<u>Surface Waters</u>

2.1.90 A number of surface waters exist within the preferred route corridor, including water bodies classified by SEPA under the Water Framework Directive (river, lake, coastal and transitional water bodies), minor watercourses, lochans and lochs.

2.1.91 The following are the most notable water features within and in close proximity to the preferred route corridor.

Loch Long

2.1.92 Loch Long is a coastal water body, covering an area of approximately 10.km^2 The water body was classified by SEPA in 2018 as having ‘Good’ overall status and has known pressures relating to water quality (SEPA, 2018). Assessments carried out by SEPA in 2014 indicating that nutrient levels in the Loch were “worse than good”, although the causes of these issues are not known (SEPA, 2015a). The A83 Trunk Road lies within the 0.5% Annual Exceedance Probability (AEP) (200-year) coastal flood extents for Loch Long, generally at Succoth and east of Ardgartan where the carriageway is adjacent to the loch (SEPA, 2020).

Croe Water

2.1.93 Croe Water is one of the main tributaries of Loch Long within the A83 Trunk Road corridor and has a catchment of approximately 18 km^2. The catchment is rural and includes a number of minor watercourses. The water body was classified by SEPA in 2018 as having ‘Moderate’ overall status and the water body has no known pressures (SEPA, 2018). The southern section of the A83 Trunk Road and Old Military Road, up to the A83 Croe Water crossing, referred to as the ‘Cobbler’ structure, lies within the fluvial 0.5% AEP (200-year) flood extents of Croe Water according to indicative flood maps published by SEPA (SEPA, 2020).

Kinglas Water

2.1.94 Kinglas Water is one of the main tributaries of Loch Fyne, and has a catchment of approximately 30 km^2 (CEH, 2021). The catchment is rural and includes a number of minor watercourses and Loch Restil. The watercourse was classified by SEPA in 2018 as having ‘Bad ecological potential’ (SEPA, 2018) and is designated by SEPA as a ‘heavily modified water body’ due to physical alterations as a result of hydroelectric power generation. The A83 Trunk Road lies within the 0.5% AEP (200-year) fluvial flood extents for Kinglas Water at multiple locations between the crossing of the A83 north of Loch Restil and Cairndow, particularly surrounding the confluence of numerous minor watercourses (SEPA, 2020).

Groundwater

2.1.95 The characteristic rock, within the area of the existing A83 Trunk Road, has a low permeability and contains only small volumes of groundwater in near surface weathered zone and secondary fractures, in addition to the potential for springs in localised areas (BGS, 2021).

Baseline Traffic Conditions

2.1.96 The following section of this chapter describes the baseline traffic conditions for the A83 Trunk Road.

Average Annual Daily Traffic (AADT)

2.1.97 Traffic data recorded at the National Traffic Data System (NTDS) permanent count sites in the A83 Trunk Road corridor in the period between 01/01/2015 and 31/12/2019 was provided by Transport Scotland. In total there were eight operating Automatic Traffic Counters (ATCs) along the A83 Trunk Road between Tarbet and Campbeltown which recorded sufficient data to permit calculation of Annual Average Daily Traffic (AADT) for at least some years in the period, estimation of AADT for the full period was possible at seven of these sites. Data from each ATC was analysed to understand traffic conditions at each location and allow the assessment of trends in traffic demand along the corridor. The locations of the counters are listed in Table 2-10.

Table 2-10: A83 Tarbet to Campbeltown - Location of NTDS ATC Counters

ATC	LOCATION
A83 North – Tarbet to Lochgilphead	
ATC08104	A83 West of Tarbet
ATC08090	A83 at Succoth
JTC08338	A83 Rest And Be Thankful
ATC08063	A83 East of Inveraray
ATC08055	A83 at Inveraray
ATC08075	A83 at Lochgilphead
A83 South – Lochgilphead to Campbeltown	
JTC08339	A83 South of Ardrishaig
ATC08058	A83 South of Tarbert

2.1.98 Figure 2.8 provides a map showing the AADT values for the latest year available in each location. Heavy Goods Vehicle (HGV) proportions are also indicated in brackets at locations where this information was available.

2.1.99 Based on AADT for the most recent year available, traffic levels between Tarbet and Lochgilphead were between 3,100 and 5,300 vehicles. Along the A83 Trunk Road at the Rest and Be Thankful, the AADT value from the latest available year was observed to be 4,400 vehicles, with an HGV proportion of 9.8%.

2.1.100 South of Lochgilphead travelling along the A83 Trunk Road towards Campbeltown, AADT levels of 2,800 and 2,300 vehicles per day were recorded. Higher traffic levels were observed around Lochgilphead (5,900). The ATC counter immediately south of Ardrishaig indicated an HGV proportion of 19.7%. However, it should be noted that the proportion of HGVs recorded at the site may be impacted by the counter type (CA10). A review of count sites in the wider area indicated that other CA10 also produced higher HGV proportion than Euro 6 sites in the area.

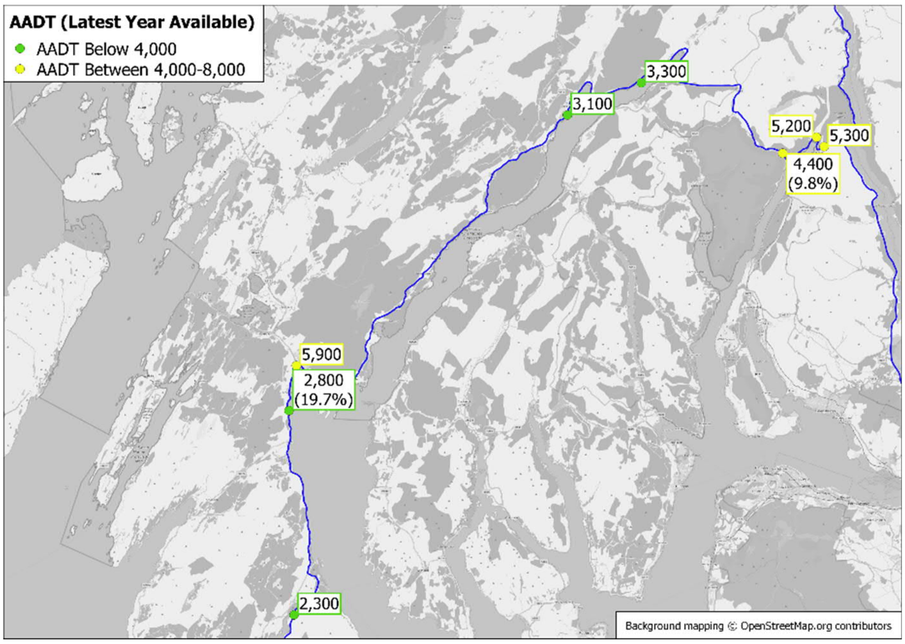


Figure 2.8: A83 Tarbet to Campbeltown - AADT and Percentage HGV, Source: NTDS

2.1.101 Table 2-11 shows traffic levels along the A83 Trunk Road corridor for years when AADT could be estimated. For counters that also provided HGV values, the proportion of HGVs has been included in brackets. AADT values have been rounded to the nearest 100. The table also provides the Compound Annual Growth Rate (CAGR), to give a measure of the average annual percentage change in traffic levels at each site. Based on available ATC data, annual traffic growth in the corridor was in the region of 0-2% per annum in the years between 2015 and 2019.

Table 2-11: A83 Tarbet to Campbeltown - AADT and Percentage HGV, Source: NTDS

ATC COUNTER	CLASSIFICATION	LOCATION	2015	2016	2017	2018	2019	CAGR
A83 North – Tarbet to Lochgilphead								
ATC08104	All Vehicles	A83 West of Tarbet	5,000	5,200	5,300	5,500	5,300	1%
ATC08090	All Vehicles	A83 at Succoth	4,800	5,000	5,100	5,000	5,200	2%
JTC08338	Euro6	A83 RABT	4,100 (9.2%)	4,200 (10.1%)	4,400 (10.1%)	4,300 (10.4%)	4,400 (9.8%)	2%
ATC08063	All Vehicles	A83 East of Inveraray	3,200	3,300	3,400	3,300	-	1%
ATC08055	All Vehicles	A83 at Inveraray	3,000	3,000	3,100	3,100	3,100	1%
ATC08075	All Vehicles	A83 at Lochgilphead	5,900	6,000	6,000	5,700	5,900	0%
A83 South – Lochgilphead to Campbeltown								
JTC08339	CA10	A83 South of Ardrishaig	2,800 (19.2%)	2,700 (19.8%)	2,900 (18.5%)	2,800 (19.7%)	2,800	0%
ATC08058	All Vehicles	A83 South of Tarbert	2,200	2,200	2,200	2,300	2,300	1%

<u>Freight Traffic: Vehicle Composition</u>

2.1.102 The composition of freight traffic in the region has been analysed using 2019 data from the Continuing Survey of Road Goods Transport (CSRGT). The Department for Transport (DfT) provided 2019 CSRGT data for any vehicles with origin and/or destination in the NUTS3 area of UKM63 (Lochaber, Skye & Lochalsh, Arran & Cumbrae and Argyll and Bute), which contains the study area. It should be noted that this dataset does not include through traffic. Moreover, corridor specific data is not available from this dataset.

2.1.103 The CSRGT is operated by the DfT to obtain details of domestic activity of British registered HGVs. The DfT uses details held by the Driving and Vehicle Licensing Agency (DVLA) to draw a random number of HGVs around the UK. The vehicles are chosen from groups which rely on vehicle type, weight, and the traffic area in which the vehicle is registered. Owners of these vehicles are then asked to record the details of the details of any UK travel within a specified survey week.

2.1.104 The survey is conducted continually through the year and is usually based on a sample of around 230 vehicles per week across the UK, with this data then grossed up to population figures through grossing factors calculated using population data for HGVs, for each quarter, from DVLA licensing records. Information for goods traffic to and from the NUTS3 area for 2019 was based on a sample of 54 HGVs.

2.1.105 It should be noted that this dataset does not include through traffic. As shown in Table 2-12, 2019 data for the UKM63 region which includes Argyll and Bute, and Lochaber, Skye and Lochalsh, Arran and Cumbrae suggests that Rigid HGVs with and without trailer represented 6.8% and 60.9% of HGVs travelling to and from the region respectively. 32.3% were Articulated HGVs. A breakdown by carrying capacity is provided in Table 2-13.

Table 2-12: A83 Tarbet to Campbeltown - HGV Traffic By Vehicle Type, Source: CSRGT, 2019

Vehicle Class Group	Percentage
Rigid	60.9%
Rigid with Trailer	6.8%
Articulated	32.3%

Table 2-13: A83 Tarbet to Campbeltown - HGV Traffic by Carrying Capacity, Source: CSRGT, 2019

Carrying Capacity Group	Percentage
Under 10 Tonnes	32.3%
Between 10-20 Tonnes	28.8%
Between 20-30 Tonnes	38.7%
Above 30 Tonnes	0.2%

Freight Traffic: Goods Composition

2.1.106 Table 2-14 shows the percentage of HGV traffic with origin and/or destination in UKM63, by industry type.

Table 2-14: A83 Tarbet to Campbeltown -Regional HGV Traffic By Industry Type, Source: CSRGT 2019

Industry Code	Industry Type	Percentage
H49A	Land Transport	36.8%
B8	Other Mining and Quarrying	10.4%
G46	Wholesale Trade, except of Motor Vehicles and Motor Cycles	10.3%
F43	Specialised Construction Activities	9.4%
E38	Waste Collection and Management	8.4%
O84	Public Administration and Defence, Compulsory Social Security	7.0%
N77	Rental and Leasing Activities	4.5%
H53	Postal and Courier Services	3.8%
N81	Services to Buildings and Landscaping	3.5%
G47	Retail Trade, except of Motor Vehicles and Motor Cycles	1.8%
C22	Manufacturing of Rubber and Plastic Products	1.6%
C16	Manufacturing of Products of Wood	1.3%
F41	Construction of Buildings	0.6%
G45	Wholesale and Retail Trade and Repair of Motor Vehicles and Motor Cycles	0.6%

2.1.107 Land Transport was responsible for the majority of HGV traffic travelling to and from the region, with a share of approximately 37% of freight movements. Mining and Quarrying accounted for 10%, Wholesale Trade for approximately 10%, and Specialised Construction Activities for approximately 9%. Other key sectors were Waste Collection and Management (approximately 8% of freight movements) and the Public Administration and Defence and Compulsory Social Security sector (approximately 7% of freight movements).

2.1.108 Table 2-15 shows the percentage of HGV traffic with an origin or destination in the region by commodity type.

2.1.109 The largest proportion of HGV traffic travelling to/from UKM63 carried Metal Ore and Mining Products at approximately 21%. This correlates with the freight data by industry, which identified Mining and Quarrying as one of the top industries freight serves. Other key commodity types were Secondary Raw Materials and Municipal Wastes (approximately 13%), and Wood and Paper Products (approximately 12% of HGV traffic).

Table 2-15: A83 Tarbet to Campbeltown - Regional HGV Traffic by Commodity Type, Source: CSRGT 2019

Commodity Code	Commodity Type	Percentage
3	Metal Ore and Mining Products	20.8%
14	Secondary Raw Materials, Municipal Wastes	13.1%
6	Wood and Paper Products	12.0%
9	Other Non-Metallic Minerals	8.3%
1	Agriculture, Hunting and Forestry	8.0%
4	Food Products, Beverages and Tobacco	6.7%
18	Grouped Goods	6.3%
19	Unidentifiable Goods	5.4%
15	Mail and Parcels	4.5%
2	Coal, Crude Petroleum and Natural Gas	3.6%
7	Coke and Refined Petroleum	3.5%
8	Chemical and Plastic Products	2.9%
10	Basic and Fabricated Metals	2.2%
17	Goods Moved in Household and Office Removals	1.6%
16	Equipment and Material Utilised in the Transport of Goods	0.5%
12	Transport Equipment	0.5%

Seasonal Variation

2.1.110 Figure 2.9 illustrates the seasonality of traffic flow in the A83 Trunk Road corridor, showing how much higher than the annual average flow the highest flow month is. It should be noted that the highest traffic levels were all recorded in August, reflecting the importance of tourist traffic in the corridor.

2.1.111 August traffic levels exceeded the annual average by 20-25%, with the exception of the two count locations near Lochgilphead, and to the south of Ardrishaig where traffic flows were 12-13% higher than average in August.

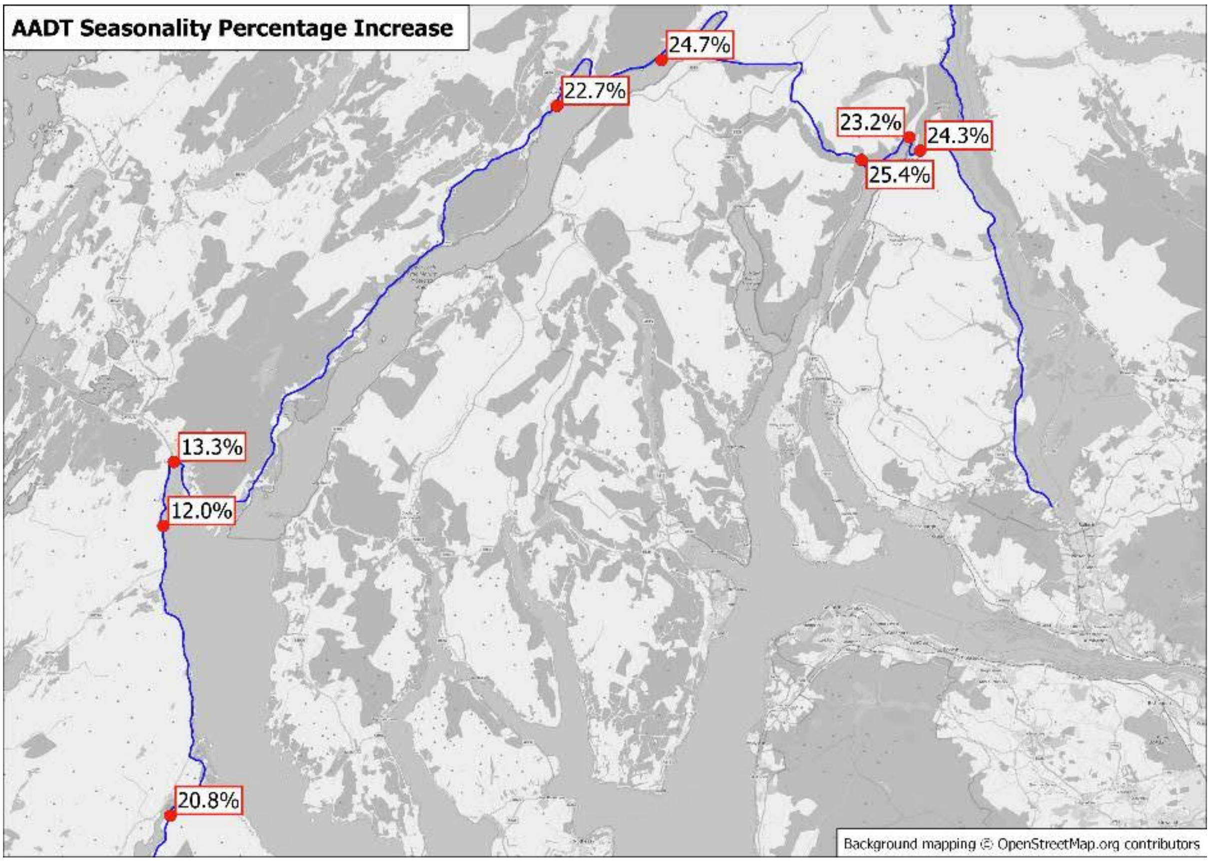


Figure 2.9: A83 - Seasonality, based in most recent count year available, Source: NTDS

2.1.112 Details of the seasonal variation on the A83 Trunk Road at the Rest and Be Thankful are provided in Figure 2.10. Average monthly flows are shown as a percentage of AADT. During the annual peak in July and August, monthly average flows were around 25% above AADT, in this location.

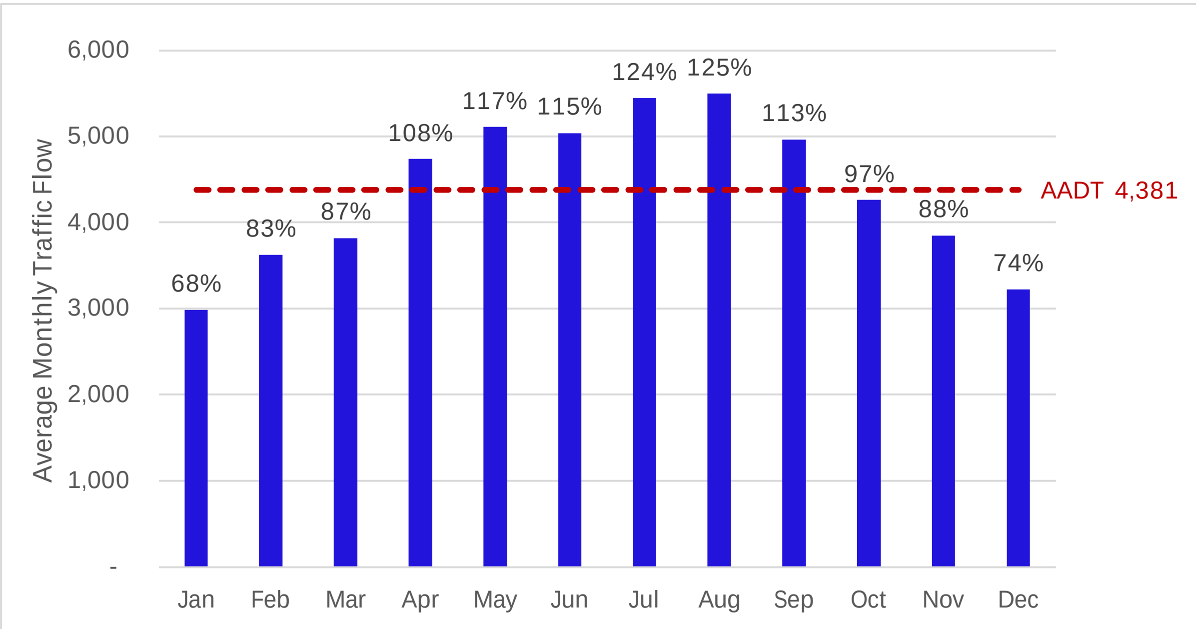


Figure 2.10: A83 Rest And Be Thankful: Average Daily Traffic - Seasonality, Source: NTDS, 2019

A83 Trunk Road Origins and Destinations

2.1.113 Typically, the results of Roadside Interviews (RSIs) would be used to understand trip patterns in an area. However, due to limitations in the availability of RSI data collected on the A83 Trunk Road, key origins and destinations were reviewed based on data from the Transport Model for Scotland (TMfS18) and Mobile Network Data (MND) provided by Telefonica.

2.1.114 TMfS18 represents weekdays during neutral months in 2018. The MND data covered Tuesdays to Thursdays during the period between 1st March 2019 and 30th April 2019. It should be noted that these data sources therefore do not reflect traffic during the peak of the tourist season.

2.1.115 A map showing key origins and destinations of traffic using the corridor is shown in Figure 2.11.

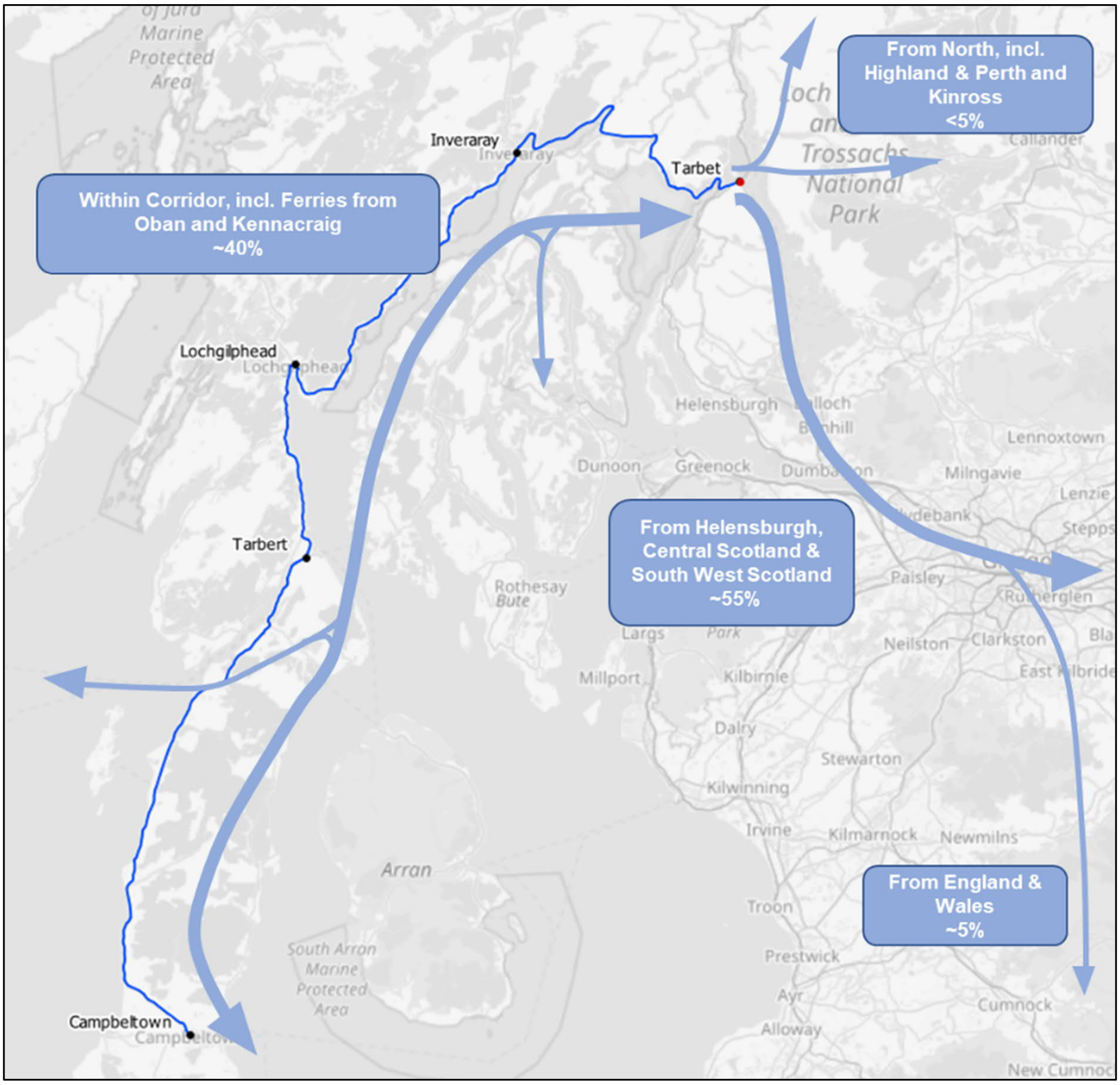


Figure 2.11: Origins and Destinations of Trips in the A83 Corridor, Source: TMfS18 and MND, 2019

2.1.116 Based on the two data sources around 40% of journeys are between origins and destinations within the corridor, origins within Cowal and Kintyre or the Islands accessible via ferry services from Kennacraig. In the region of 55% of journeys using the corridor are to or from the Central Belt and South West Scotland, including the Helensburgh area, with small percentages of journeys originating in the rest of Scotland and England and Wales.

A83 Trunk Road Journey Times

2.1.117 Road journey times have been examined using INRIX data. Journey time averages representing all weekdays during the period 01/01/2019 to 31/12/2019 have been extracted from INRIX's IQ Roadway Analytics interface. Bus journey times have been extracted from Traveline Scotland.

2.1.118 Typical car journey times along the full A83 Trunk Road corridor between Tarbet and Campbeltown are in the region of two hours 20 minutes. Bus journey times are substantially longer, with a typical bus journey between the two destinations lasting approximately 3 hours. Journey times for key strategic journeys using the corridor by car and bus are shown in Table 2-16.

Table 2-16: A83 Strategic Journeys - Average Journey Time, Source: INRIX, 2019 and Traveline Scotland

Route	Average Journey Time (hh:mm)	
	Car	Bus
From Campbeltown to Tarbet	02:16	03:00 – 03:07
From Glasgow to Inveraray	01:24	01:46
From Glasgow to Lochgilphead	01:58	02:35
From Glasgow to Campbeltown	03:08	03:57 – 04:16

2.1.119 Analysis of the daily profile suggests that end to end journey times are slightly longer during the day with the slowest journeys recorded between the hours of 0700 and 1600. INRIX data suggested that at route level there is relatively little variability in journey times during the day. During the busiest hours, average journey times for end to end journeys exceeded minimum journey times by no more than 13 minutes or 10%.

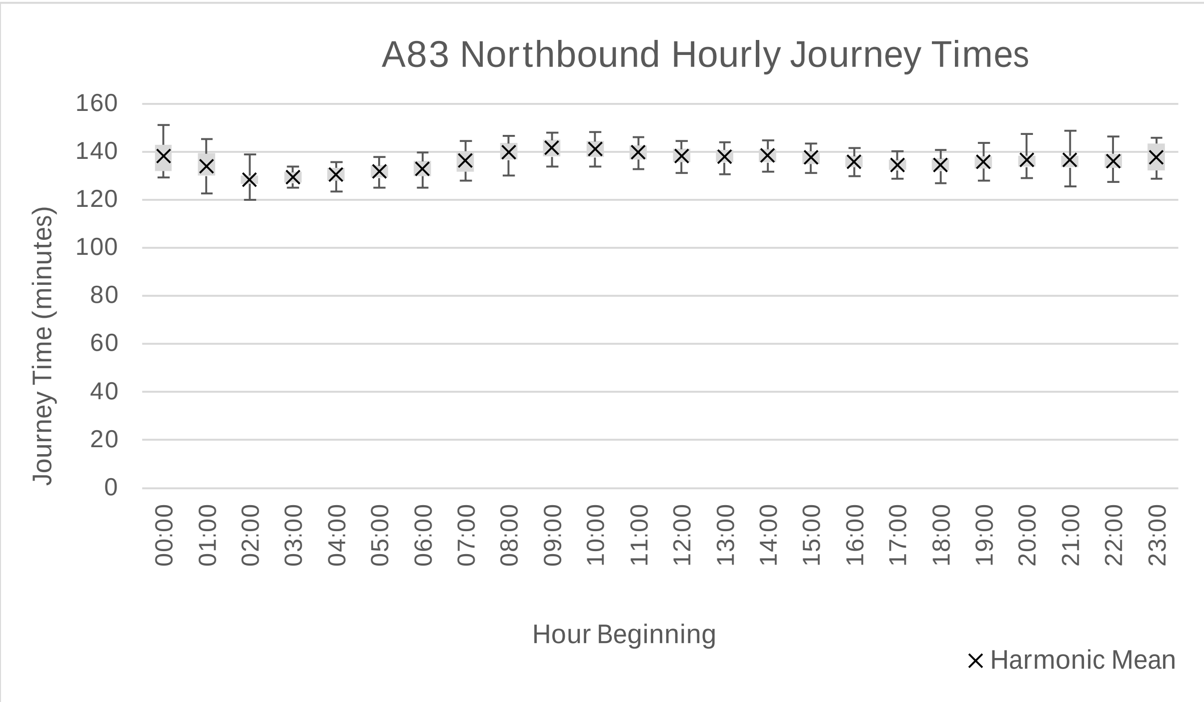


Figure 2.12: A83 Route Journey Times: Hourly Profile, Source: INRIX, 2019

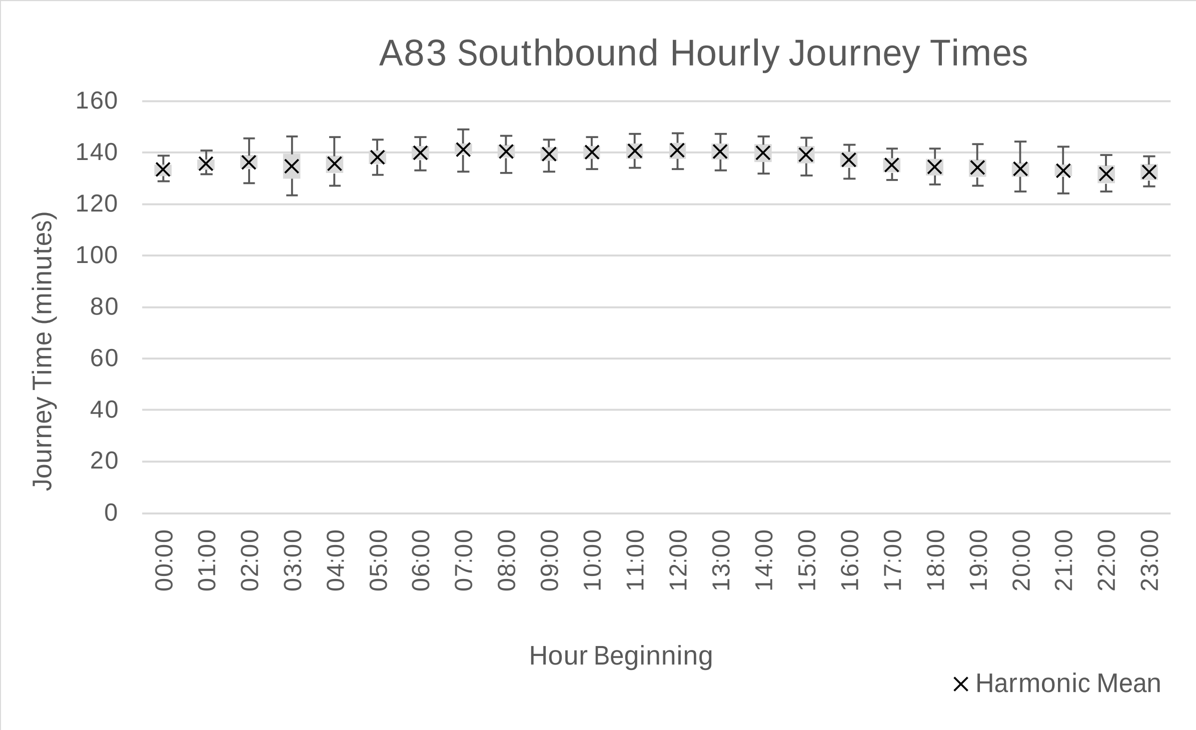


Figure 2.13: A83 Route Journey Times: Hourly Profile, Source: INRIX, 2019

2.1.120 Seasonal variations in journey times were also small, with the slowest monthly average end to end journey times exceeding minimum journey times by no more than 5% depending on the weekday. Based on daily average journey times, there was no conclusive evidence that journey times were higher during the summer months, suggesting that additional traffic during the tourist season does not substantially constrain route capacity. However, the data does not permit conclusions regarding the impact of tourist traffic during specific busy periods.

2.1.121 It should also be noted that the patching process applied by INRIX to fill in gaps in the data may reduce variability and that there is as a consequence a level of uncertainty in regard to the magnitude of the variability.

Road Closures

2.1.122 The A83 Trunk Road is one of only two east-west strategic trunk road network connections between the central belt and Argyll and Bute. During periods of closure, residents, visitors and businesses are affected by lengthy diversions and severance impacts.

2.1.123 A key section of the A83 Trunk Road which is impeded by landslides is the Rest And Be Thankful, between the A83 junctions with the A814 at Arrochar and the A815. Landslides on the nearby hillside can result in a lane closure, or full closure in this location, thereby severing the access to Cowal and Kintyre via the A83 Trunk Road.

2.1.124 Based on anecdotal evidence closures and restrictions cost the local economy £50-60k per day. Moreover, they result in longer-term impacts on business investment within the region and, consequently, the region's job market. Key towns in the area such as Inveraray, Lochgilphead and Campbeltown suffer from travel delays to the central belt during these instances.

2.1.125 Table 2-17 lists information on landslide incidents recorded between 2013 and late 2020, as provided by BEAR Scotland. This information is up to date as of 17th November 2020. It should be noted that landslides which did not come near the A83 Trunk Road or were not considered a risk have been excluded.

2.1.126 As a note on the information provided within the table, the number of days listed may not necessarily be consecutive. For example, following the incident on 13th September 2020 (Reference 20), the A83 Trunk Road has been closed for a total of 37.5 days but opened periodically for either a half or full day, before then being closed again.

Table 2-17: A83 Landslide Incidents, 2013 to November 2020, Source: BEAR Scotland

Reference	Date Started	Material Caught (Tonnes)	Material Reached A83 (Tonnes)	Actual A83 Closure Days	Potential Additional Closure Days	No. of Days OMR in Use	No. of Days OMR Not in Use
1	03/10/2013	-	<10	1	-	-	1
2	09/01/2014	5	-	-	1	-	-
3	15/01/2014	20	-	-	-	-	-
4	06/03/2014	-	400	5	-	5	-
5	28/10/2014	1,000	800	5	13	5	-
6	15/01/2015	5	-	-	1	-	-
7	11/11/2015	46	-	-	2	-	-
8	05/12/2015	1,000	-	-	7	-	-
9	05/12/2015	25	-	-	2	-	-
10	05/12/2015	25	-	-	2	-	-
11	30/12/2015	100-150	100-150	2	-	1	1
12	04/01/2016	-	-	3	-	2.5	0.5
13	11/10/2017	100	-	-	1	-	-
14	09/10/2018	3,000	-	9	15	3.5	5.5
15	29/11/2018	100	-	-	1	-	-
16	01/12/2018	60	-	-	1	-	-
17	Dec 2018 – Jan 2019	-	-	-	2	-	-
18	30/01/2020	-	1,300	2.5	-	2	0.5
19	04/08/2020	2,000	10,000	33.5	-	28	5.5
20	13/09/2020	1,000	5,000	37.5	-	28	9.5

2.1.127 Based on the data provided by BEAR Scotland there has been intermittent disruption from landslides during years between 2013 and 2019. However, in 2020 two major landslides caused substantial disruption in the corridor resulting in a total of 71 days of closure between 4th August and 17th November 2020. Based on traffic news from BEAR Scotland's webpage[27] the road remained closed from 17th November and did not re-open until January 2021. Figure 2.14 shows the total duration of landslide

[27] https://www.bearscot.com/a83-rest-and-be-thankful/

incidents by year, including details of closures, whether the OMR was in use or not, and the number of additional days that the road was under risk of closure.

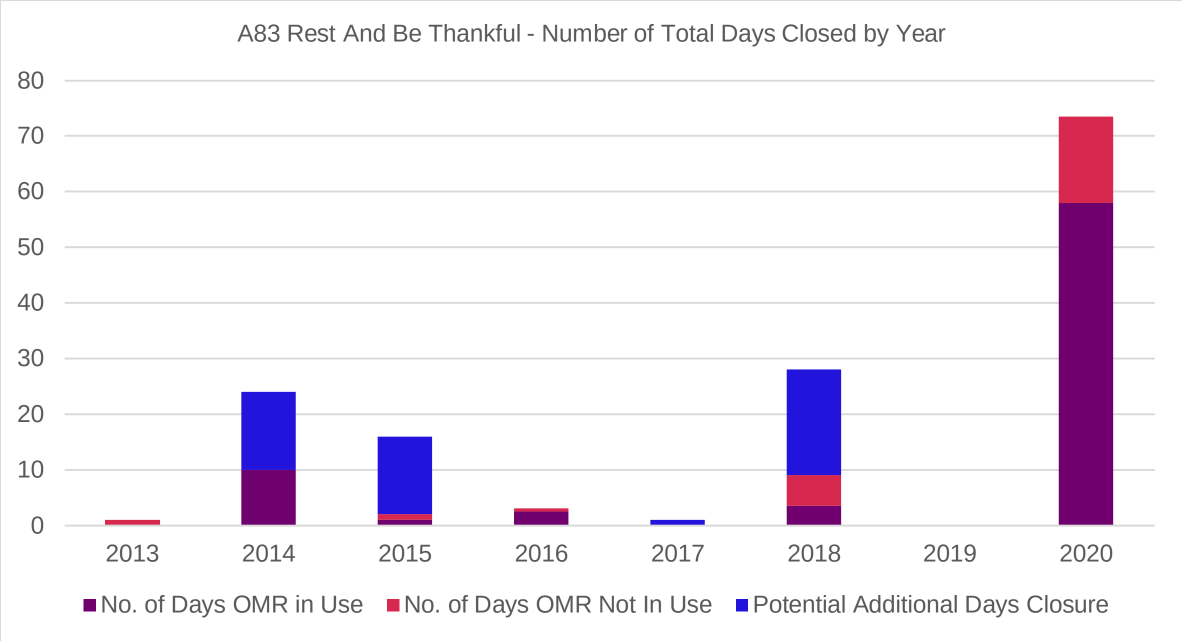


Figure 2.14: A83 Rest And Be Thankful - Number of Total Days Closed by Year, Source: BEAR Scotland [28]

2.1.128 The number of closures due to landslides was relatively small, a total of 9 closures between 2013 and November 2020. However, the duration of these closures varied substantially. Between 2013 and 2019, the A83 Trunk Road at the Rest and Be Thankful was closed for a maximum of 10 days each year, with no closures due to landslides recorded in 2017 and 2019.

2.1.129 Two major incidents occurred during August / September 2020, and a smaller incident in January 2020, resulting in a total of 73.5 days when the A83 at the Rest and Be Thankful was closed by 17th November of that year, with the OMR being available for use for 58 of these days. These incidents have resulted in the diversionary route to the north being the only route for traffic for 15.5 days.

2.1.130 With the exception of 2014, at least some of the closures affected both roads in each year when closures occurred, meaning that travellers had to use the diversionary route to the north. Substantial risk of additional closures was recorded in 2014, 2015 and 2018.

[28] Note: Data for 2020 represents dates between 01/01/2020 and 17/11/2020 only.

3. Description of Alternative Schemes

3.1 General

3.1.1 A Preliminary Assessment of multiple route corridor options was undertaken to assess the performance of each of the route corridors against a range of criteria, with the objective of determining those which merited further consideration and be taken forward to the DMRB Stage 1 Assessment. This process is detailed below, along with a description of the recommended preferred route corridor that has been considered for the DMRB Stage 1 Assessment and the outline preliminary cost estimate.

3.2 Preliminary Assessment

3.2.1 The Preliminary Assessment was a desktop study looking at a total of 15 route corridor options – 11 initially identified as part of STPR2, known as Corridors 1 to 11, with corridor 8 split into 8a and 8b, and four additional route corridors proposed by the public during the consultation held in September and October 2020. The route corridors are outlined below:

Initial Route Corridor Options (see Figure 3.1)

- Route Corridor 1 – Glen Croe
- Route Corridor 2 – Glen Kinglas
- Route Corridor 3 – Glen Fyne
- Route Corridor 4 – A82 – Cowal – Cairndow
- Route Corridor 5 – A82 – Cowal – Lochgilphead
- Route Corridor 6 – Inverclyde – Cowal – Cairndow
- Route Corridor 7 – Inverclyde – Cowal – Lochgilphead
- Route Corridor 8a – North Ayrshire – Cairndow via Colintraive
- Route Corridor 8b – North Ayrshire – Cairndow via Dunoon
- Route Corridor 9 – North Ayrshire – Cowal – Lochgilphead
- Route Corridor 10 – Helensburgh – Cowal – Cairndow
- Route Corridor 11 – Helensburgh – Cowal – Lochgilphead

Additional Route Corridor Options proposed by the Public

- Route Corridor 12 – Inveruglas – Butterbridge
- Route Corridor 13 – Arrochar – Butterbridge
- Route Corridor 14 – Coilessan Glen
- Route Corridor 15 – Arrochar – Butterbridge

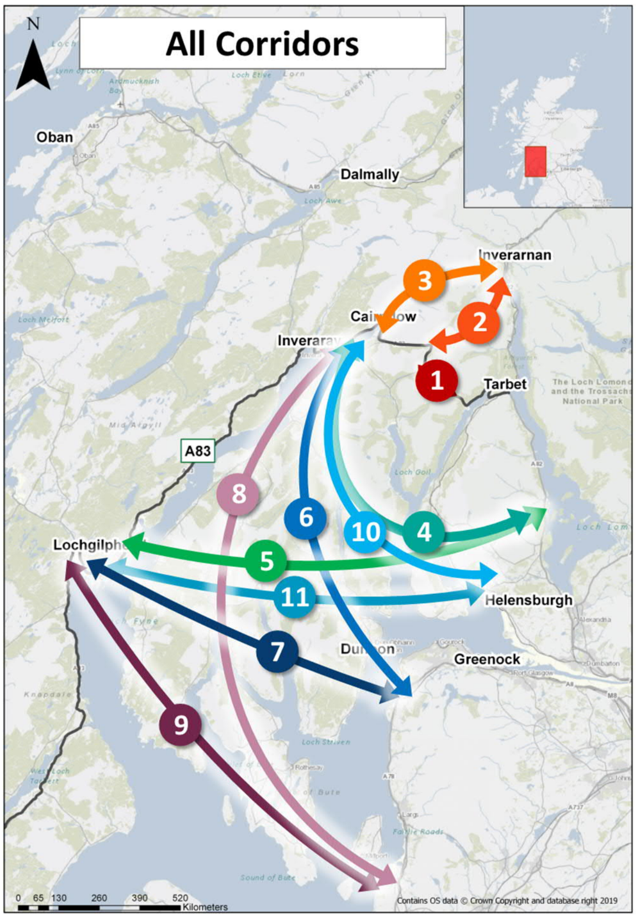


Figure 3.1: Access to Argyll and Bute (A83) STPR 2 Corridor Options

3.2.2 The assessment was primarily based on the performance of each route corridor against the scheme's Transport Planning Objectives (TPOs), a Scottish Transport Appraisal Guidance (STAG) Assessment, and an assessment of Implementability. Based on the assessment, Route Corridor 1 was recommended as the preferred route corridor for the project. Further details of the assessment is presented in the Access to Argyll and Bute (A83) Preliminary Assessment Report (March 2021) which can be found on Transport Scotland's website at the following link:

https://www.transport.gov.scot/publication/preliminary-assessment-report-march-2021-a83-access-to-argyll-and-bute/

3.2.3 An announcement by the Cabinet Secretary for Transport on 18th March 2021 was made, recommending Route Corridor 1 as the preferred corridor to be taken forward to DMRB Stage 2.

3.3 Description of the Preferred Route Corridor

3.3.1 Route Corridor 1 focuses on the wider Glen Croe valley where the existing A83 Trunk Road is located. Starting south-east of the junction between the A83 Trunk Road and the Old Military Road (OMR), it encompasses the full valley, generally following the A83 Trunk Road heading north-west as it rises through Glen Croe and past Loch Restil, ending where the A83 Trunk Road passes by the south-west end of Glen Kinglas near Butterbridge. The route corridor is approximately 6.0km long.

3.3.2 Topography within the route corridor is generally associated with the Glen Croe valley. Ground levels along the centre of the route corridor rise gradually from the south-eastern extents to High Glencroe at the head of the glen where the elevation rises sharply to the saddle where the Rest and Be Thankful car park is located. Both sides of the valley are flanked by steep side slopes to the summits of The Cobbler, Beinn Luibhean, Ben Donich and Coire Culach. From the saddle, the centre of the route corridor descends as it passes Loch Restil to the northern extents at Glen Kinglas. Again, the valley has steep side slopes leading to the summits of Bein an Lochain and Beinn Luibhean.

3.3.3 Land use within the route corridor is generally agricultural with commercial interests in the form of coniferous plantation woodland on the surrounding hillsides, including parts of The Brack and Ben Donich on the south-western side, The Cobbler to the south-east and Beinn Luibhean to the north-east. There are six properties within the Glen Croe corridor which consist of two residential properties, one situated at the northern end of the corridor on the valley floor below the Rest and Be Thankful car park and the other adjacent to the A83 Trunk Road, south of the bridge crossing the Croe Water. Along the valley floor there are four outbuildings/livestock sheds which are located next to the OMR. Within the corridor there is only one junction with a local authority road, the B828, which is adjacent to the Rest and be Thankful car park. This road provides access from the A83 Trunk Road to the communities of Lochgoilhead and Carrick Castle via another local authority road, the B839.

3.4 Description of Possible Route Options within the Preferred Corridor

3.4.1 Within the preferred route corridor, five possible route options named Green, Yellow, Brown, Purple and Pink, also known as the 'coloured' options have been developed. The Green, Yellow, Brown and Purple options build on the initial options identified in the A83 Trunk Road Route Study (February 2013), retaining the same names for continuity. The Pink option was identified as part of this assessment. A description of each possible route option is given below.

Green Route Option

3.4.2 The Green route option would involve the construction of a new single carriageway road, approximately 4.3km long, on the opposite side of the valley to the existing A83 Trunk Road, through an area of land managed by Forestry and Land Scotland. This is shown in Figure 3.2.

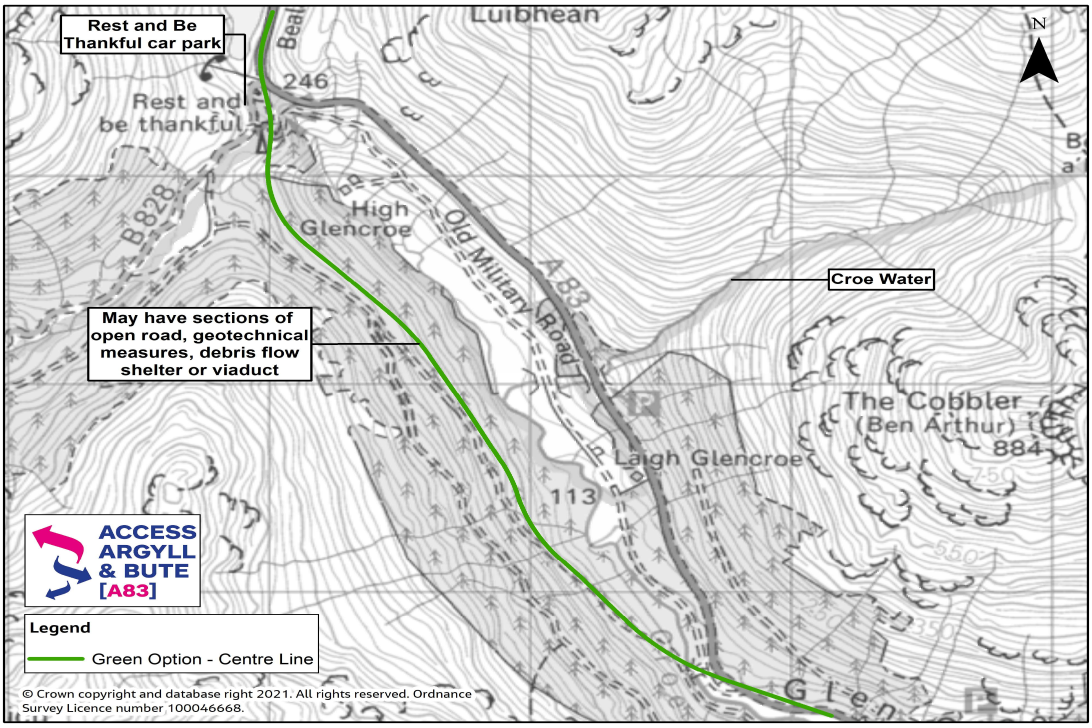


Figure 3.2: Green Route Option

3.4.3 This route would join the existing alignment of the A83 Trunk Road at a point south-east of the lower forestry access track, and the OMR junction, the latter of which is currently used as a means to access the diversion route. It would cross the valley floor and the Croe Water by a bridge for approximately 0.2km.

3.4.4 The new road would generally follow the corridor of the existing lower forestry access track, however it would require a similar average gradient as the existing A83 Trunk Road. Along this section, landslide mitigation works (e.g. viaducts, debris shelters and/or debris fencing) are likely to be required to protect the proposed road from future landslides or debris flows. A length of viaduct approximately 0.3km long would be required for the new road to span the gully located to the north-west of High Glen Croe, across the north-west side of the Rest and Be Thankful car park before joining the existing alignment of the A83 Trunk Road again at a point north of the existing junction between the A83 Trunk Road and the B828 local road.

3.4.5 This route option would require a new realigned junction between the A83 Trunk Road and the B828 local road as well as part of the Rest and Be Thankful car park to be potentially repositioned.

Yellow Route Option

3.4.6 The Yellow route option would involve the construction of a new single carriageway road, approximately 2.1km long, located between the existing A83 Trunk Road and the OMR. It would have a similar average gradient as the existing A83 Trunk Road. This is shown in Figure 3.3.

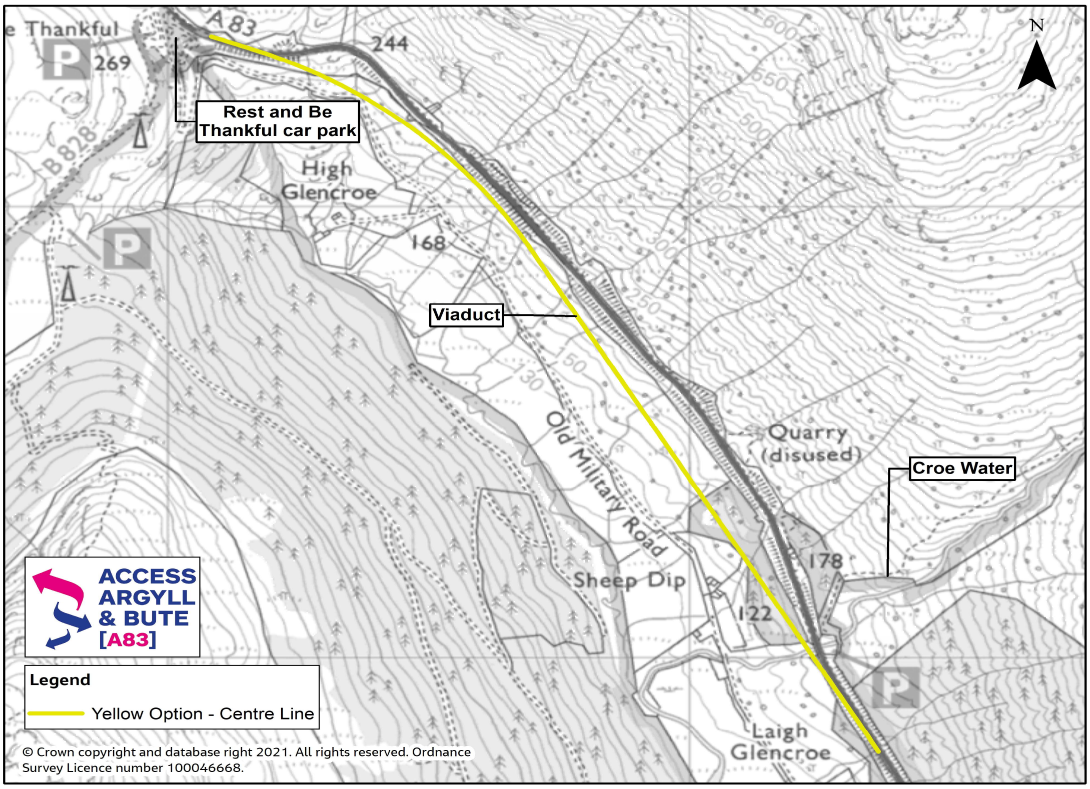


Figure 3.3: Yellow Route Option

3.4.7 This option would include a length of new single carriageway road on a viaduct approximately 1.8km long, from a point where it would tie into the existing A83 Trunk Road alignment near the current Croe Water bridge, to a point where it would tie into the existing A83 Trunk Road alignment near the Rest and Be Thankful car park, along the base of the west-facing slopes of Beinn Luibhean where the landslide/debris flow hazard is significant.

3.4.8 The viaduct would vary in height along its length, with a maximum pier height of approximately 37m and spans between the supporting piers of approximately 40m to 70m. The position of the viaduct and the piers would need to be situated to allow the existing A83 Trunk Road and the OMR to remain open during its construction. It would also need to span the larger channels from the upper slope which could act as a pathway for any future significant landslides or debris flows. The viaduct piers would also require deflector structures to afford protection from any future landslides or debris flows in that area.

Brown Route Option

3.4.9 The Brown route option closely follows the alignment of the existing A83 Trunk Road from the Croe Water bridge heading north-west to the Rest and Be Thankful car park. This is shown in Figure 3.4.

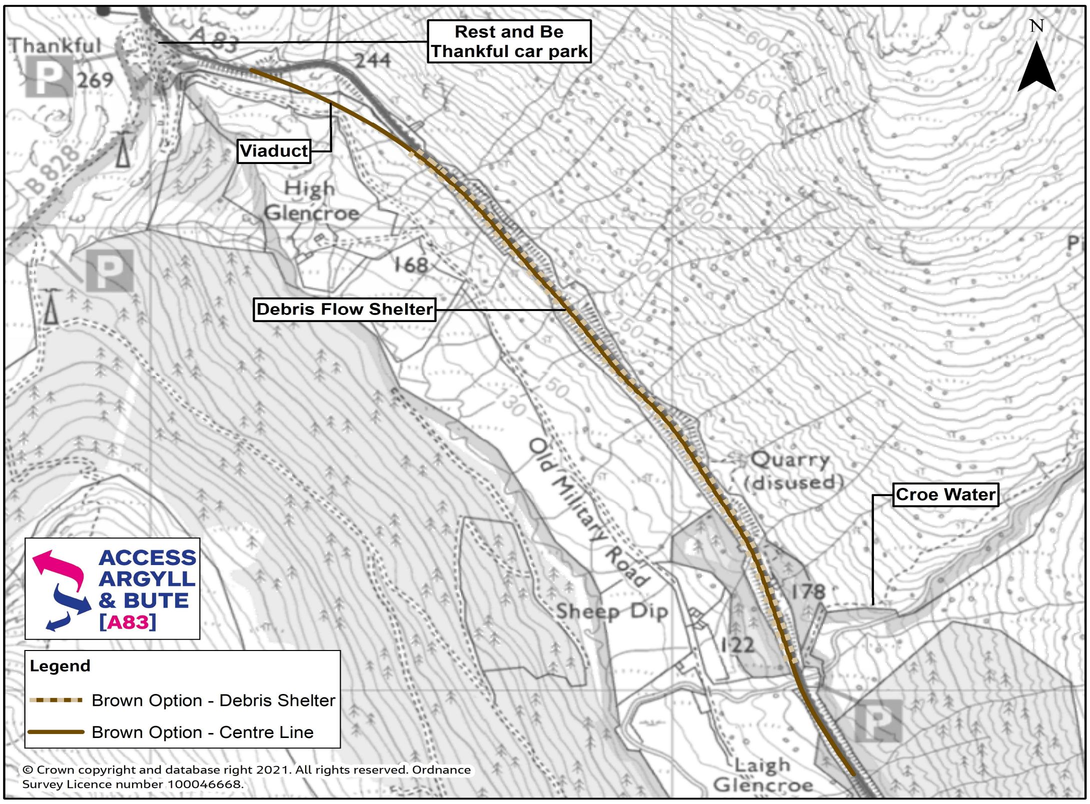


Figure 3.4: Brown Route Option

3.4.10 This route option would involve the construction of a debris flow shelter over a length of approximately 1.3km to protect the road and road users in the event of future landslide and/or debris flow events. Debris flow shelters are structures that would form canopies over the road to protect it from any debris from the slopes above. A debris flow shelter along the existing A83 Trunk Road as proposed would also have to be designed and built to withstand potential impacts from large boulders from above. These structures are constructed to allow any future landslides or debris flows to pass over the top of the structure and continue downhill without disrupting the road or traffic below. Water would be carried by pre-formed channels crossing the top of the structure, enabling water to continue to flow downhill.

3.4.11 These structures could be built over the existing road. However, the road would need to be widened to accommodate the debris flow shelter and maintain the required road width. This would present considerable challenges in being able to keep the A83 Trunk Road open to traffic for the duration of the construction works.

3.4.12 A viaduct approximately 0.3km long would be considered where the debris shelter ends to improve the road alignment on the approach to the Rest and Be Thankful car park. The viaduct piers would require deflector structures to afford protection from any future landslides or debris flows in that area.

Purple Route Option

3.4.13 The Purple route option would involve the construction of a new single carriageway road, approximately 3.2km long located along the valley floor of Glen Croe. This route would run from the existing A83 Trunk Road at a point south of the existing Croe Water bridge, gradually dropping down the side of the slope towards the valley floor before crossing the existing OMR along an embankment. This is shown in Figure 3.5.

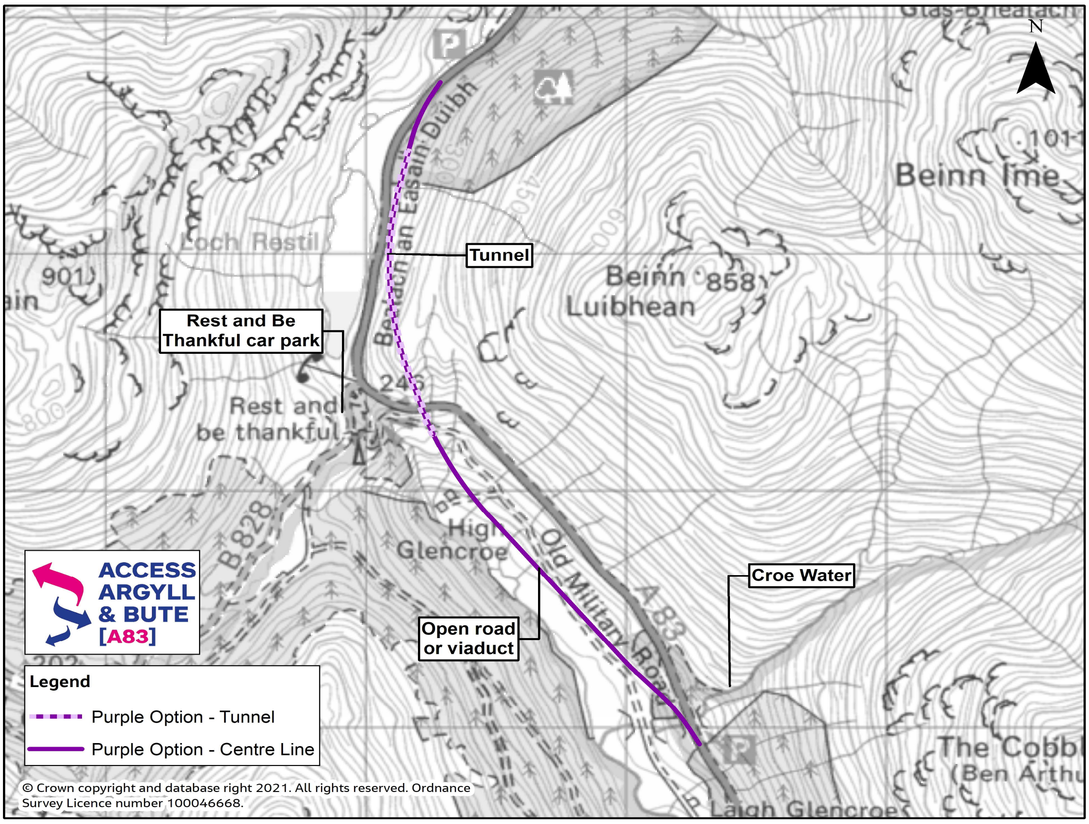


Figure 3.5: Purple Route Option

3.4.14 The route would then run generally north-west between the OMR and the Croe Water as either an open road and along an embankment of up to 50m in height above the existing ground, or alternatively along a viaduct. With the viaduct option, the piers would require deflector structures to afford protection from any future landslides or debris flows in that area. The route would then enter a tunnel approximately 1. 2km long passing under the OMR and the A83 Trunk Road near High Glen Croe. The tunnel would climb from High Glen Croe and the road would re-emerge next to the junction between the A83 Trunk Road and an existing access track north of Loch Restil, before re-joining the existing alignment of the A83 Trunk Road.

3.4.15 The tunnel portals (entrance/exit) will be positioned to take account of the landslide and debris flow hazards within the area and these, along with the sections of the road on the approaches to the tunnel, may require additional measures to mitigate landslide and debris flow hazards. For this option, the B828 local road would likely be extended to the north tunnel portal by using part of the existing A83 Trunk Road from the Rest and Be Thankful car park and a new junction created between the A83 Trunk Road and B828 local road.

Pink Route Option

3.4.16 The Pink route option would involve the construction of a new single carriageway road, approximately 4.1km long, of which approximately 2.9km would be within a tunnel. This route would tie into the existing alignment of the A83 Trunk Road at a point approximately 1.0km south of the existing Croe Water bridge, with the new road initially located between the existing A83 Trunk Road and the Croe Water. This section of the route would be an open road, approximately 0.7km long, generally at ground level or on embankments on the approach to the southern tunnel portal (entrance/exit). This is shown in Figure 3.6.

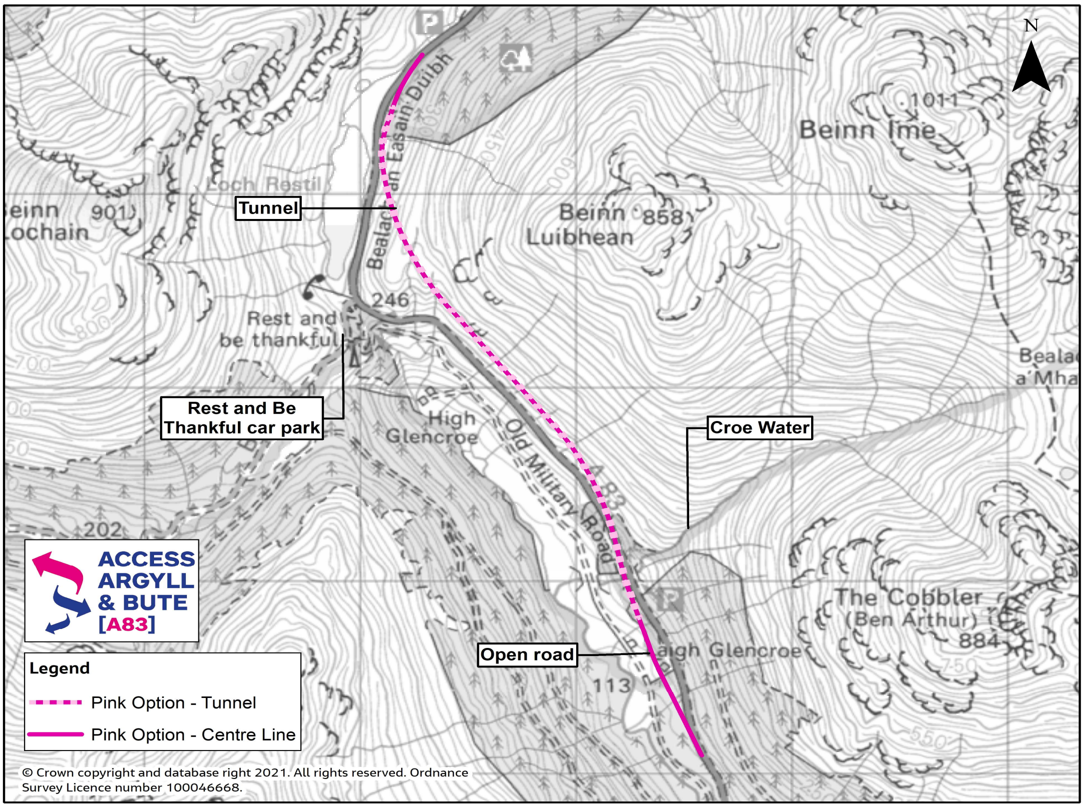


Figure 3.6: Pink Route Option

3.4.17 The route would then enter the tunnel, which would be offset down the slope from the A83 Trunk Road and approximately 0.3km south of Croe Water. The tunnel would pass beneath the Croe Water and the A83 Trunk Road and would emerge next to the junction between the A83 Trunk Road and an existing access road north of Loch Restil before re-joining the existing alignment of the A83 Trunk Road.

3.4.18 The tunnel portals will be positioned to take account of the landslide and debris flow hazard within the area and these, along with the sections of road on the approaches to the tunnel, may require additional measures to mitigate hazard. For this option the B828 local road would likely be extended to the north tunnel portal by using part of the existing A83 Trunk Road from the Rest and Be Thankful car park and a new junction created between the A83 Trunk Road and B828 local road

3.4.19 An additional Blue option was also identified in the A83 Trunk Road Route Study (February 2013) which looked to have an open road carriageway through the valley and connect into the Rest and Be Thankful car park. However, during early indicative design development it was identified that a potential alignment would be significantly sub-standard and deemed unsuitable for arterial trunk road. Therefore, it has been excluded from further consideration.

3.4.20 Due to the early stage of the assessment, all assumptions relating to, and design work undertaken for each of the coloured options is indicative and accounts for no associated highways, structures or earthworks infrastructure. Each option will be further developed and refined during subsequent stages of the DMRB scheme assessment process.

3.5 On-going Mitigation Works in Glen Croe

3.5.1 While the approach to this DMRB Stage 1 Assessment is focused upon major improvements within Route Corridor 1 through Glen Croe, for the purposes of the DMRB Stage 1 assessment, the Do-minimum scheme is taken to be the short and medium term plans involving the ongoing maintenance work on the A83 Trunk Road and the medium term improvements to improve the resilience of the diversion route through the Glen Croe corridor.

3.5.2 To date, numerous improvement schemes have been implemented within Glen Croe, typically associated with the mitigation of impacts associated with landslide incidents and protection measures to minimise future impacts. As part of the £87M invested in maintaining the A83 Trunk Road since 2007, Transport Scotland have spent over £15M in landslide measures at the Rest and Be Thankful. This has helped to keep the A83 Trunk Road open for an estimated 48 days, when it would otherwise have closed. Interventions are typically required each year as a result of ongoing slope stability issues.

3.5.3 Ongoing maintenance of the route and in particular works associated with improving the resilience of the OMR will also form part of the Do-Minimum scenario.

3.5.4 Given the historic nature for land slips through Glen Croe and the anticipated increase in frequency, it is recognised that a Do Minimum scenario will continue to provide temporary mitigation for the problem to a point, but a long term solution is required.

3.6 Preliminary Cost Estimates

3.6.1 A preliminary cost estimate has been developed for the provision of a new route within the route corridor. This is based on costs derived from schemes of a similar nature to the Access to Argyll and Bute (A83) project with roads, tunnels and structures costs being determined using indicative lengths, and accounts for preparation, land, supervision, non-recoverable VAT costs and are effectively present day prices.

3.6.2 Optimism bias has been included in the estimate. Optimism Bias is the demonstrated systematic tendency for appraisers to be overly optimistic about key parameters. As such, an uplift of 44% for roads infrastructure and 66% for tunnels and complex structures has been included in to reflect this early stage of the design development as is normal practice in line with the Treasury publication, The Green Book: appraisal and evaluation in central government, 2013.

3.6.3 The estimated cost range which takes account of the different type of works associated with the possible route options is shown in Table 3.1 and individual coloured option estimate costs in Table 3.2 below.

Table 3.1: Preliminary Cost Estimate for Corridor 1

Route Corridor 1	Low	High
Cost	£268m	£860m

Table 3.2: Preliminary Cost Estimate for Possible Route Options

Route Corridor 1 Colour Option	Green	Yellow	Brown	Pink	Purple
Upper Cost	£412m	£353m	£645m	£860.m	£614m

Route Corridor 1 Colour Option	Green	Yellow	Brown	Pink	Purple
Lower Cost	£313m	£268m	£490m	£654m	£467m

4. Engineering Assessment

4.1 Introduction

4.1.1 A broad assessment of the engineering issues associated with possible route options for the A83 Trunk Road within the preferred corridor has been undertaken in relation to the following topics:

- Alignment and Cross-section;
- Junctions, Access and Lay-bys;
- Geotechnics and Earthworks;
- Hydrology, Hydrogeology and Drainage;
- Structures;
- Pavements;
- Vehicle Restraint Systems;
- Public Utilities;
- Non-Motorised User (NMU) Provision; and,
- Constructability.

Engineering Standards

4.1.2 While DMRB Stage 1 is typically a corridor assessment, given the preliminary assessment work already concluded and the initial development of the five potential possible route options within the preferred corridor as described in Chapter 3 of this report, each of these possible route options has been considered in the Engineering Assessment.

4.1.3 To support the assessment, an indicative alignment has been developed for each of the possible route options. Further development of these options will be undertaken at DMRB Stage 2 and of the preferred route option at DMRB Stage 3. Cognisance has been given to the following DMRB standards in the development and assessment of the possible route options:

- CD 109 – Highway Link Design;
- CD 123 – Geometric Design of At-grade Priority and Signal-controlled Junctions;
- CD 127 – Cross-sections and Headrooms;
- CD 169 – The Design of Lay-bys, Maintenance Hardstandings, Rest Areas, Service Areas and Observation Platforms;
- CD 352 – Design of Road Tunnels;
- CD 377 – Requirements for Road Restraint Systems; and
- CG 501 – Design of Highways Drainage Systems.

4.2 Alignment and Cross-section

Alignment

4.2.1 The following section outlines the indicative alignments produced for each of the five possible route options. For their development, a design speed of 100kph has been assumed for each of the alignments. This is in line with roads of a similar nature and consistent with the national speed limit for a single carriageway road, the current speed limit on the A83 Trunk Road.

4.2.2 Where possible, the indicative alignments follow desirable minimum geometric standards as per DMRB design standard CD 109 – '*Highway Link Design'*. At this stage the horizontal and vertical geometry have been developed according to this standard. Other design parameters including application of superelevation on approach to and through curves, provision of transition lengths on approach and departure from curves, detailing of existing carriageway tie-ins and provision of visibility requirements such as localised verge widening on approach to and through curves will be considered at DMRB Stage 2.

4.2.3 The DMRB permits geometric standards below the specified desirable minimum standards to be applied in certain circumstances. With reference to Table 4.5 of DMRB design standard CD 109 – '*Highway Link Design'*, Relaxations from Standards in horizontal alignment geometry up to 3 steps below desirable minimum is permitted depending on alignment and layout constraints. The indicative alignment designs developed do not contain elements with more than 2 steps below desirable minimum standards and therefore no Departures from Standards are anticipated based on the current indicative designs. There is the potential that further Relaxations from Standards may be introduced at future design stages, or that combinations of horizontal curvature relaxations with vertical geometry or sight distances occur that could result in Departures from Standards. Such Departures from Standards would only be considered where the designer is satisfied that safety is not adversely affected.

4.2.4 Given the early stage of the scheme, the accuracy and detail of the available topographical information is limited which in turn influences the level of alignment accuracy that can be achieved at this stage. This should be taken into consideration when reading the following sections as the alignments are subject to change and further development as more information is obtained at future design and assessment stages.

4.2.5 At DMRB Stage 1, overtaking opportunities have not been considered on the route options. During DMRB Stage 2, it will be necessary to establish the need for overtaking opportunities. If it is deemed that overtaking opportunities along the alignments are not compliant with DMRB design standard CD 109 – '*Highway Link Design'* then further refinement of alignments may be necessary, including consideration of mitigation such as climbing lanes depending on the vertical geometry. If this is needed, this would introduce an additional lane in the uphill direction of travel, resulting in an increased carriageway footprint and overall wider cross section which in turn will increase cost.

Cross-section

4.2.6 An S2 rural all-purpose road has been assumed based on the existing speed limit, although the existing A83 Trunk Road is generally not to this standard. In line with DMRB design standard CD 127 – '*Cross-sections and Headrooms'*, this features a 7.3m wide carriageway, with 1m hard strips and 2.5m verges on both sides; representing an improvement in the cross-section on the existing A83 Trunk Road through Glen Croe.

4.2.7 The above dimensions are based on a typical a cross-section. Verge widths may need to be locally increased to accommodate road furniture (for example traffic signs), utilities or to allow for the required standard of forward stopping sight distance and other visibility requirements, and this will be determined as the design develops.

4.2.8 Consideration of cross-section within tunnelled sections of the possible route options are outlined in the following sections.

Possible Route Options Alignment Design

4.2.9 The following sections provide an overview of the horizontal and vertical geometry and identifies key constraints to be considered for each of the five possible route options which may influence the alignment and need to be considered in greater detail at DMRB Stage 2.

Green Option – Geometry

4.2.10 Vertical geometry compliant with DMRB design standard CD 109 – '*Highway Link Design'* is achievable with a maximum gradient on the indicative alignment of approximately 5.3% over a length of approximately 725m. On average, it is closer to 5% which is similar to the existing A83 Trunk Road.

4.2.11 The horizontal geometry is also compliant based on the indicative alignment with Relaxations from Standards to two steps below desirable minimum standards identified.

4.2.12 For Plan and Profile drawings of the Green Option, refer to drawings A83AAB-JAC-HML-COR_01-DR-CH-9241 to 9243 in Appendix B.

Green Option – Constraints

4.2.13 There are three aspects of the Green Option which have notable constraints, likely to impact the route alignment. These are the crossing of Croe Water to the south, the tie-in to the existing alignment of the A83 Trunk Road to the north and the design of the road link.

4.2.14 To allow the alignment to be located on the western side of the glen, it will be necessary to provide a structure over Croe Water. However, to do so, the following must be considered.

- As a result of the close proximity of the A83 Trunk Road, Croe Water and the Old Military Road (OMR) within this area, combined with the flood level of the Croe Water, the eastern tie in of the Green Option to the A83 Trunk Road will require careful consideration of vertical and horizontal alignment and any structures that may necessary to allow the A83 Trunk Road to remain operational during the tie in construction.

4.2.15 At the northern tie-in with the A83 Trunk Road, the following needs to be taken into consideration.

- An alignment will need to be located offline of the OMR, likely to the west, as depending on the medium term solution that is in place, it may be necessary to keep the OMR open as the diversion route during construction. If the OMR is not maintained as the diversion route then there is also the continued private use of the road, which will need to be taken into consideration. Furthermore, there is a large gully immediately south of the tie in location which will require a structure. The span, orientation and structure type will also need to be considered with the alignment design; and,
- The existing B828 local road alignment, bus stop and jug handle turning point and viewpoint car park are all located close to the A83 Trunk Road. Any alignment taken through this constrained area will likely impact on one or more of the existing features and relocation or mitigation may be required.

4.2.16 For the development of the road link design, the following needs to be taken into consideration:

- In order to provide a route along the western slope, it is likely that geotechnical and structural solutions potentially including viaducts, rock cuttings, debris flow shelters and retaining walls. Careful consideration will need to be given to the vertical and horizontal geometry to ensure that the elevation gain through the glen is achieved while taking cognisance of any potential structural and geotechnical requirements.

Yellow Option – Geometry

4.2.17 Vertical geometry compliant with DMRB design standard CD 109 – '*Highway Link Design'* is achievable with a maximum gradient of approximately 5.3% for the indicative alignment. In order to achieve the level difference between the start and end points, this 5.3% gradient would be constant along the entire length of the route and is a slightly steeper gradient than the existing A83 Trunk Road through Glen Croe.

4.2.18 The horizontal geometry is also compliant based on the indicative alignment with no Relaxations from Standards below desirable minimum standards identified.

4.2.19 For Plan and Profile drawings for the Yellow Option, refer to drawings A83AAB-JAC-HML-COR_01-DR-CH-9251 and 9252 in Appendix B.

Yellow Option – Constraints

4.2.20 There are two aspects of the Yellow Option which have notable constraints, likely to impact the route alignment. These are the position of a viaduct and the tie-in to the A83 Trunk Road to the north.

4.2.21 For the Yellow Option, a route will essentially be on viaduct for its entirety. As such, the following should be considered.

- The development of an alignment will require careful consideration and collaboration with the structures team given the relatively steep vertical geometry anticipated along the length, the impact on pier heights, the crossing of Croe Water, the horizontal curvature required to tie back into the A83 Trunk Road and the positioning and construction challenges of the abutment at the northern end; and,
- Similar to the Green Option, the A83 Trunk Road will need to remain open during construction and depending on the medium term solution that is in place for the OMR, this will also need to remain open if the road is still being used as the diversion route. An alignment will need to be positioned such that it minimises construction and operational impacts while providing suitable space for construction and positioning of any protection measures for the viaduct piers.

4.2.22 At the northern tie-in with the A83 Trunk Road, the following needs to be taken into consideration.

- The existing Rest and Be Thankful car park is located approximately 6m west of the proposed northern tie-in to the A83 Trunk Road while a substantial rock outcrop is located to the east. Consideration will be required at future stages of the design to minimise the impact on the car park at the tie in point.

Brown Option – Geometry

4.2.23 Vertical geometry compliant with DMRB design standard CD 109 – '*Highway Link Design*' is achievable. As this is an online option, gradients will generally match that of the existing A83 Trunk Road which is approximately 5%.

4.2.24 The horizontal geometry is also compliant based on the indicative alignment with Relaxations from Standards to two steps below desirable minimum standards identified.

4.2.25 For Plan and Profile drawings for the Brown Option, refer to drawings A83AAB-JAC-HML-COR_01-DR-CH-9261 and 9262 in Appendix B.

Brown Option – Constraints

4.2.26 There are three aspects of the Brown Option which have notable constraints, likely to impact the route alignment. These are the alignment of the viaduct section, the tie-in to the A83 Trunk Road to the north and the requirement for building and accommodating the debris shelter on the existing A83 Trunk Road.

4.2.27 A section of viaduct may be required at the northern end of the route. As such, the following needs to be considered.

4.2.28 The development of an alignment will require careful consideration and collaboration with the structures team given the impact it will have on pier heights, the horizontal curvature required to tie back into the

A83 and positioning and construction challenges of both abutments for the viaduct. At the northern tie-in with the A83 Trunk Road, the following needs to be taken into consideration.

- Similar to the Yellow Option, consideration will be required at future stages of the design to minimise the impact on the car park at the tie in point.

4.2.29 The majority of the route will feature a debris shelter over an online carriageway. As such, the following needs to be taken into consideration.

- Both sides of the cross-section will have a physical upstand from the shelter walls located at the back of the verge, potentially restricting visibility on curves. As an online option, the need for a complex structure and given the challenging topography immediately adjacent, widening the verge or straightening curves may not always be possible, consideration of this will be required when developing both the road and structural designs.

Purple Option – Geometry

4.2.30 Vertical geometry compliant with DMRB design standard CD 109 – '*Highway Link Design'* is achievable with a maximum gradient on the indicative alignment of approximately 5.5% on the open cut/fill section for a length of approximately 100m, and approximately 4.8% for approximately 1150m in the tunnel. This is somewhat steeper than the 5% average of the existing A83 Trunk Road.

4.2.31 The horizontal geometry is also compliant based on the indicative alignment with no Relaxations from Standards below desirable minimum standards identified.

4.2.32 For Plan and Profile drawings for the Purple Option, refer to drawings A83AAB-JAC-HML-COR_01-DR-CH-9331 to 9333 in Appendix B.

Purple Option – Constraints

4.2.33 There are four aspects of the Purple Option which have notable constraints, likely to impact the route alignment. These are the approach alignment to the tunnel, the tie-in to the existing alignment of the A83 Trunk Road to the north, the tunnel itself and the tie-in to the existing alignment of the B828 local road.

4.2.34 The approach alignment through Glen Croe to the tunnel may take the form of a carriageway on embankment or a viaduct. As such, the following needs to be considered.

- For an embankment, the overall height will likely be significant and as such, the vertical and horizontal geometry need to take cognisance of this in order to minimise footprint and its impact on the existing environment, particularly the properties located at High Glencroe.
- For a viaduct, the development of an alignment will require careful consideration and collaboration with the structures team given the relatively steep vertical geometry anticipated along the length, the impact on pier heights, and the positioning and construction challenges of the abutment at the northern end.

4.2.35 For both options, an alignment will need to cross Croe Water and the OMR. While different challenges present themselves dependent on approach taken, they will need to be considered to ensure that suitable construction space is provided and that uninterrupted operation of the OMR is retained if this is still being maintained as the medium term diversion route for the A83 Trunk Road. At the northern tie-in to the existing alignment of the A83 Trunk Road the following needs to be taken into consideration.

- It is likely that an alignment will run in parallel with the existing A83 Trunk Road as it emerges from the tunnel at the northern end. The alignment will need to provide a suitable working area for the construction of the tunnel portal and new route, while keeping the A83 Trunk Road operational. Given that a large length of the alignment will utilise a tunnel, the following should also be considered.

- Similar to the Brown Option, the walls of the tunnel structure could potentially restrict visibility on curves. While there are less constraints below ground, and thus more flexibility in an alignment, this will be dictated by the location of tunnel portals. A balance will need to be achieved between the highway design, both within the tunnel and on approach, the tunnel design itself and cost.

4.2.36 To tie-in the existing alignment of the B828 local road to the new A83 Trunk Road alignment, the following should also be considered.

- While it is likely that the existing A83 Trunk Road carriageway between the current junction with B828 local road and the proposed tunnel can be used, the design of a new junction will be dictated by the location of the tunnel portal. This will likely be challenging due to the constrained topography north of the car park, and the proximity of the Beinn an Lochain Site of Special Scientific Interest (SSSI) west of the existing A83 Trunk Road.

Pink Option – Geometry

4.2.37 Vertical geometry compliant with DMRB design standard CD 109 – '*Highway Link Design'* is achievable with a maximum gradient on the indicative alignment of approximately 3.6% for approximately 350m on the open cut/fill section, and approximately 3.8% for a length of approximately 2400m in the tunnel. This is somewhat shallower than the 5% average of the existing A83 Trunk Road.

4.2.38 The horizontal geometry is also compliant based on the indicative alignment with no Relaxations from Standards below desirable minimum standards identified.

4.2.39 For Plan and Profile drawings for the Pink Option, refer to drawings A83AAB-JAC-HML-COR_01-DR-CH-9291 to 9293 in Appendix B.

Pink Option – Constraints

4.2.40 There are three aspects of the Pink Option which have notable constraints that are likely to impact the route alignment. These are the tie-in to the existing alignment of the A83 Trunk Road at the north and south, the tunnel and the tie-in to the existing alignment of the B828 local road.

4.2.41 At the northern tie-in to the existing alignment of the A83 Trunk Road the following needs to be taken into consideration.

- Similar to the Purple Option, it is likely that an alignment will run in parallel with the existing A83 Trunk Road as it emerges from the tunnel at the northern end. An alignment will need to provide a suitable working area for the construction of the tunnel portal and new route, while keeping the A83 Trunk Road operational.

4.2.42 At the southern tie-in to the existing alignment of the A83 Trunk Road the following needs to be taken into consideration.

- The southern tunnel portal may be susceptible to geotechnical hazards depending on location. If positioned to the south of Croe Water, the tunnel alignment will need to cross below Croe Water and should be developed with the tunnels team. Furthermore, this could result in the approach alignment being in proximity to an existing property.

4.2.43 The majority of the alignment will feature a tunnel. As such, the following needs to be taken into consideration

- Similar to the Brown and Purple Options, the walls of the tunnel structure could potentially restrict visibility on curves. While there are less constraints below ground, and thus more flexibility in an alignment, this will be dictated by the location of tunnel portals. A balance will need to be achieved between the highway design, both within the tunnel and on approach, the tunnel design itself and cost.

4.2.44 To tie-in the existing alignment of the B828 local road to the new A83 Trunk Road alignment, the following should also be considered.

- While it is likely that the existing A83 Trunk Road carriageway between the current junction with B828 local road and the proposed tunnel can be used, the design of a new junction will be dictated by the location of the tunnel portal. This will likely be challenging due to the constrained topography north of the car park, and the proximity of the Beinn an Lochain SSSI west of the existing A83 Trunk Road.

4.3 Junctions, Accesses and Lay-bys

4.3.1 Within the extents of the preferred route corridor, there is/are:

- 1 at-grade junction with the B828 local road;
- 7 at-grade direct accesses including; an access to the OMR, a residential access and several access tracks / field access.
- 1 lay-by which exhibits a small kerbed segregation island;
- 5 lay-bys similar in layout to a Type B arrangement but with variations; and
- 4 informal lay-bys.

4.3.2 In addition to the above, there is also a bus turning area with an associated bus stop, located adjacent to the A83 Trunk Road, but with access off the B828 local road.

Junctions and Accesses

4.3.3 Each of the possible route options have varying effects on existing junctions and accesses within the preferred route corridor. Table 4-1 outlines these and potential means of mitigating them.

Table 4-1: Existing junction and access impacts associated with each of the Possible Route Options

Possible Route Option	Junctions Affected	Effect of Route Option	Potential Mitigation
Green	B828 local road	Junction stopped up by open cut/fill section.	Form a new at-grade major/minor junction at a suitable location on the Green Option to provide a connection to the B828 local road, and a new at-grade direct access to the car park.
	OMR (North and South)	Junction stopped up by open cut/fill section.	Form new at-grade direct accesses at suitable locations on the Green Option to provide connections to the OMR.
Yellow	Access at Croe Water	Access bypassed by viaduct section.	Form a new at-grade direct access at the south of Yellow Option to allow connection to the Access at Croe Water.
Brown	None	N/A	N/A
Purple	B828 local road	Junction bypassed by tunnel section.	Form a new at-grade major/minor junction at the north end of Purple Option to provide a connection back to the B828 local road.

Possible Route Option	Junctions Affected	Effect of Route Option	Potential Mitigation
	OMR	Access along OMR potentially restricted by alignment.	Form new access between the Purple Option and the OMR, divert the OMR to avoid the Purple Option or bridge over the OMR.
	Access at Croe Water	Access bypassed by viaduct section.	Form a new at-grade direct access at south of Purple Option to allow connection to the Access at Croe Water.
	Forestry and Land Scotland Access north-west of Loch Restil	Access bypassed by tunnel section.	Form a new at-grade direct accesses at north end of Purple Option with the A83 to allow connection back to the Forestry and Land Scotland Access.
Pink	B828 local road	Junction bypassed by tunnel section.	Form a new at-grade major/minor junction at the north end of Pink Option to provide a connection back to the B828 local road.
	Residential Access at Laigh Glencroe	Access bypassed by open cut/fill section.	Form a new at-grade direct access at south end of Pink Option to allow connection or maintain existing A83 to provide access at same point.
	Maintenance Accesses	Accesses bypassed by tunnel section.	Maintain existing A83 to provide access to same points.
	Forestry and Land Scotland Access north-west of Loch Restil	Access bypassed by tunnel section.	Form a new at-grade direct accesses at north end of Purple Option with the A83 to allow connection back to the Forestry and Land Scotland Access.

Lay-bys

4.3.4 Each of the possible route options have varying impacts on existing lay-bys, which are provided sporadically along the length of the preferred route corridor, with no consistent spacing or lay-by type. DMRB design standard CD 169 - '*The Design of Lay-bys, Maintenance Hardstandings, Rest Areas, Service Areas and Observation Platforms*' recommends lay-by spacing of between 5km and 8km for this standard of road and the expected AADT of the A83 Trunk Road through Glen Croe.

4.3.5 The distance between existing signed lay-bys located either side of the extents of the preferred route corridor is approximately 6.5km in the westbound direction and therefore lay-by spacing would be acceptable with the recommendations of DMRB design standard CD 169 - '*The Design of Lay-bys, Maintenance Hardstandings, Rest Areas, Service Areas and Observation Platforms*', even if no lay-bys were provided within the possible route options. In the eastbound direction there appears to be somewhat informal areas that parking can occur, however these areas are not signed as formal lay-bys and spacing between existing formal and signed lay-bys, located either side of the extents of the preferred route corridor, appears to exceed that recommended in the design standard.

4.3.6 The retention of existing lay-bys within the route corridor may be considered at a later stage of scheme development but would present a challenge depending on constraints associated with each of the possible route options. These are outlined in Table 4-2 below.

Table 4-2: Existing lay-by impacts associated with each of the Possible Route Options

Possible Route Option	Number of Lay-bys Affected	Retention Issues
Green	5 (1x kerbed island, 2x type B variant, 2x informal)	Provision of lay-bys on the new route at a similar spacing to that existing spacing could be challenging within the topography of the ground profile associated with the new road, local widening for lay-bys could be

Possible Route Option	Number of Lay-bys Affected	Retention Issues
		challenging in the steep side long ground. However, this is broadly similar topography to the existing A83.
Yellow	3 (1x type B variant, 2x informal)	Provision of lay-bys on the new route at a similar spacing to that existing spacing would increase viaduct costs associated with local widening of bridge decks to accommodate lay-bys.
Brown	3 (1x type B variant, 2x informal)	Provision of lay-bys on the new route at a similar spacing to that existing spacing would locally increase, the already larger footprint of the debris flow shelter.
Purple	6 (1x kerbed island, 3x type B variant, 2x informal)	Retention of lay-bys at their existing spacing, within the tunnel section of the possible route option is considered not likely to be reasonably practicable, given that the lay-by spacing already meets the DMRB design standard recommendations.
Pink	7 (1x kerbed island, 4x type B variant, 2x informal)	Retention of lay-bys at their existing spacing, within the tunnel section of the possible route option is considered not likely to be reasonably practicable, given that the lay-by spacing already meets the DMRB design standard recommendations.

4.4 Geotechnics and Earthworks

Introduction

4.4.1 This section provides a summary of the ground conditions within Glen Croe, informed by a desk-based review of the published geology and information held by the British Geological Survey (BGS) in the National Landslide Database. Additional data has been obtained from the BGS to inform the assessment including GeoSure landslides and GeoSure debris flow landslides datasets. Aerial photography and previous site investigation records have also been consulted. The geotechnical hazards present are described, and the key constraints identified. The extent to which these hazards and constraints are considered to affect each possible route option is summarised, as well as the engineering considerations specific to each option.

4.4.2 Restrictions due to the Covid-19 pandemic have prevented site inspections at the time of preparing the DMRB Stage 1 Assessment Report and the assessment has been informed by desk-based review only.

4.4.3 The study area is bisected by the boundary between two geological map sheets of different ages; Sheet 37E (1990) and 38W (1987). Sheet 37E covers the western parts of the study area including the summits of Beinn an Lochain and Ben Donich, and the west-facing slopes of Beinn Luibhean. Sheet 38W covers the eastern parts of the study area including the summits of Beinn Luibhean, The Cobbler and The Brack. The resolution of the mapping differs between these sheets with Sheet 37E appearing to be more detailed. Much of the area has been subject to recent re-mapping in light of the dates of publication of the existing map sheets (Finlayson, 2020)[1].

4.4.4 The engineering assessment considers a Route Corridor 1 study area as shown in Figure 1 included in Appendix A. The assessment of geotechnical hazards, and in particular the landslide and debris flow hazard, requires the consideration of a larger study area extending to include the full catchment of Glen Croe. This is on the basis that potential hazard source areas could be located high on the slopes above

[1] Finlayson, A. (2020). Glacial conditioning and paraglacial sediment reworking in Glen Croe (the Rest and Be Thankful), western Scotland. *Proceedings of the Geologists' Association*, 131(2), 138-154.

Glen Croe outside the Route Corridor 1 study area, but which could still have an effect on the various possible route options. This larger geotechnical study area is shown in Figure 6 included in Appendix A and for the remainder of Section 4.4 of this report the term 'study area' will mean this larger area.

4.4.5 The catchment is defined by the summits and ridge lines of the mountains on both sides of the glen; Beinn an Lochain, Ben Donich and The Brack on the western side, and Beinn Ime and The Cobbler on the eastern side.

Overview of Ground and Groundwater Conditions

4.4.6 A summary of the underlying ground conditions within the study area is provided below.

4.4.7 The study area is characterised by the U-shaped valley of Glen Croe, formed during a number of periods of glaciation the last of which ended approximately 11,500 years ago (Finlayson, 2020). Phases of glacier advance and retreat have resulted in erosion forming the steep valley sides with subsequent deposition of material on both the valley floor and sides. The mountain summits on both sides of the glen are typically rugged due to rock exposure.

4.4.8 The slopes are drained by numerous watercourses which flow into the Croe Water which in turn flows south-east to Loch Long at Ardgartan. The Croe Water rises in Coire Croe, and is fed by watercourses draining the slopes of Beinn Luibhean, Beinn Ime and The Cobbler. Loch Restil is located at the toe of the slopes of Beinn an Lochain, to the north of the car park at the Rest and Be Thankful. The loch drains to the north, initially across relatively flat land and shallow slopes then more steeply, particularly at Easan Dubh Fall, flowing roughly parallel to the existing A83 Trunk Road to its confluence with the Kinglas Water at the north end of the study area.

4.4.9 The published geology indicates the superficial deposits underlying the majority of the study area comprise glacial Till (diamicton), typically along the lower slopes of Glen Croe but also extending into mid-slope areas and notably into Coire Croe; however, large areas on the upper slopes remain unmapped indicative of thin or absent superficial cover. Superficial deposits are also not recorded in High Glencroe across an area to the south and east of the junction between the A83 Trunk Road, the OMR and the B828 local road.

4.4.10 Hummocky (Moundy) Glacial Deposits comprising diamicton, sand and gravel are recorded on the lower slopes of Beinn Luibhean to the east and north-east of Loch Restil; on the lower slopes between Beinn an Lochain and Loch Restil; adjacent to the B828 local road between Beinn an Lochain and Ben Donich; and along the lower slopes of Ben Donich to the south of High Glencroe.

4.4.11 A more recent re-mapping exercise has identified an extensive band of debris cones and debris aprons across the middle and lower slopes of Beinn Luibhean but also more locally on the west and south-facing, middle and lower slopes of The Cobbler (Finlayson, 2000).

4.4.12 Alluvium (clay, silt, sand, gravel) and River Terrace Deposits (gravel, sand, silt, clay) are recorded locally in low-lying areas of the study area, typically along the valley floor adjacent to the watercourses. The main areas are at the confluence between the Allt Beinn Ime and the Kinglas Water at the northern end of the study area; to the north of Loch Restil adjacent to its out-flow; to the south of High Glencroe along the toe of the south-west facing slopes of Beinn Luibhean (and typically to the south-west of the OMR; and along the length of the Croe Water down to Ardgartan where it flows into Loch Long.

4.4.13 The published geology does not record peat within the study area; however, peat is anticipated to be present locally. The Carbon and Peatland Map (NatureScot, 2016) indicates the presence of nationally important carbon-rich soils (peatland) throughout the study area; of particular note are areas of Class 1 peatland on the middle north-east facing slopes of Ben Donich, recorded immediately above the treeline, and Class 2 peatland/potential peatland on the south and south-east facing slopes of The Cobbler (An t-Sròn) in the south of the study area.

4.4.14 Similarly, the published geology does not record the presence of artificial ground within the study area; however, made ground is anticipated in association with existing development. This includes the A83 Trunk Road, the B828 local road, the forestry access tracks on both sides of Glen Croe, the car park at the Rest and Be Thankful and individual properties within the study area which are typically adjacent to the A83 Trunk Road or the OMR.

4.4.15 The bedrock geology is recorded to typically comprise metamorphic rocks of Dalradian age and belonging to the Southern Highland Group. The dominant rock types are recorded to be psammite, pelite and semi-pelite belonging to the Beinn Bheula Schist Formation. These rocks are typically fine to medium grained and with mineralogy comprising largely of quartz, feldspar and mica. Schist and metawacke belonging to the same formation are also recorded underlying the hillsides of Beinn an Lochain and Ben Donich. The composition of schist is generally similar to that for psammite, pelite and semi-pelite above; metawacke typically comprises medium and coarse grain minerals within a fine-grained matrix and of variable mineralogy.

4.4.16 The metamorphic strata are often characterised by pronounced mineral alignment and layering (foliation) and are also commonly intensely folded as a result of multiple phases of deformation during a complex metamorphic history.

4.4.17 An extensive igneous intrusion is recorded generally underlying the majority of the floor of Coire Croe. The intrusion also extends beneath the lower slopes of Beinn Luibhean and The Cobbler, and into Glen Croe as far as the existing A83 Trunk Road where it underlies a small area to the north of the Croe Water. There is a second, smaller intrusion on the slopes of Beinn Luibhean which is isolated (at the surface at least) from the main intrusion. The rocks belong to the South of Scotland Granitic Suite and are generally indicated to comprise medium to coarse grained pyroxene-mica diorite although localised areas of other igneous lithologies are recorded including tonalite and breccia.

4.4.18 Numerous igneous dykes are recorded in the west of the study area underlying the east facing slopes of Beinn an Lochain and Ben Donich, and also at High Glencroe. The orientations are variable but typically range from northeast-southwest to northwest-southeast. The rocks comprise:

- Lamprophyre belonging to the North Britain Siluro-Devonian Calc-Alkaline Dyke Suite; and
- Quartz-Microgabbro belonging to the Central Scotland Late Carboniferous Tholeiitic Dyke Swarm.

4.4.19 The strata underlying the western areas of the study area beneath Beinn an Lochain and Ben Donich are recorded to be faulted, particularly between the Rest and Be Thankful and Ben Donich. The fault orientations are variable but generally northeast-southwest. At least two faults are indicated to cross the existing A83 Trunk Road above High Glencroe on approach to the Rest and Be Thankful.

4.4.20 As noted in Section 4.4.3, the resolution of mapping within the study area is variable. The geological map sheet covering the eastern part of the study area does not record any faults to be present; it is considered that there is potential for unmapped faults to be present.

4.4.21 The Hydrogeological Map of Scotland (1:625,000 scale) published by the BGS indicates that the study area is underlain by bedrock regionally characterised by low productivity aquifers where only small volumes of groundwater are present in near surface weathered zones and secondary fractures. Further commentary on groundwater is provided in Section 4.5 of this report and in Appendix C of the Strategic Environmental Assessment.

Overview of Geotechnical Hazards and Key Constraints

4.4.22 An assessment to identify the geotechnical hazards and key constraints present within the study area has been undertaken.

4.4.23 The methodology involved a review of the available topographical information across the study area. A

Digital Terrain Model (DTM) associated with STPR work in 2013 has been used to develop a plan showing slope angles within the study area, presented in Figure 7 included in Appendix A. Twenty-six terrain zones were then defined based on review of topography (catchment and sub-catchments), geomorphology and landforms to allow evaluation of each and assessment of the hazards and constraints. The defined terrain zones are presented in Figure 8 included in Appendix A.

4.4.24 The assessment has relied on review of aerial photography to identify features of interest. The visibility of features is variable, and within forested areas is quite limited, affecting the degree of certainty with which features have been identified. Furthermore, the locations are indicative as there are discrepancies between the various dates of aerial imagery available. Accordingly, the features identified and their locations must be verified by site inspection when possible.

4.4.25 This assessment has identified the potential presence of geotechnical hazards due to the natural terrain within the study area including but not limited to:

- Landslide;
- Debris flow;
- Boulder fall; and
- Rock fall.

4.4.26 Boulders have been identified at surface throughout the study area, comprising both discrete boulders and larger areas characterised by boulder-fall and associated debris. Some of the boulders are of significant size, e.g. greater than 25m^3. Additionally, boulders are likely to be present within the superficial deposits and there is potential for boulders to be entrained within landslides and debris flows or destabilised due to such events. It should be noted that the identification of boulders has been informed by review of aerial photography and, due to the limitations of this method, provides an indicative overview of the presence of boulders at surface rather than forming an exhaustive inventory of boulders within the study area.

4.4.27 The assessment has enabled the preparation of a Geotechnical Constraints Plan which is presented in Figures 9A to 9F with accompanying key sheet, included in Appendix A. This provides a summary of the key constraints identified within the study area and includes a replication of the National Landslide Database point data and mass movement deposits, as recorded by the British Geological Survey.

Route Option Considerations

4.4.28 The geotechnical engineering considerations are summarised in Table 4-3 which covers both general considerations and the specific constraints and their relevance to each possible route option. These include implications for earthworks and the likely specialist geotechnical measures that may be required.

Table 4-3: Summary of geotechnical engineering considerations per possible route option

Possible Route Option	Geotechnical Engineering Considerations
General	▪ Landslide/debris flow hazard (refer to above text and Figures 9A to 9F). ▪ Boulder fall and rock fall hazard (refer to above text and Figures 9A to 9F). ▪ Potential for soft, compressible ground associated with deposits of Alluvium, River Terrace Deposits and debris from past landslide/debris flow events with possible implications for road alignments. These deposits may require excavation and replacement with suitable fill, or treatment to improve material properties. ▪ Potential for highly fractured rock due to faulting which may lead to instability of excavations in rock and reduce pile capacity.

	▪ Potential for preferential groundwater flows through highly fractured rock due to faulting. ▪ Potential for shallow bedrock and variable rock strengths which may cause difficulties for excavations in rock.
Green	▪ Landslide/debris flow hazard requires accurate modelling to identify susceptible locations and estimate magnitudes of potential events to inform the mitigation measures required (e.g. structures, debris flow shelters, debris fences, etc.), and an understanding of potential frequency to inform maintenance requirement. ▪ The design of any mitigation measures must allow these to withstand debris flow events and potential large boulder impacts. ▪ The possible route option traverses sidelong ground; earthworks may require strengthening to achieve sensible geometries (e.g. installation of soil nails) and possible engineering measures to provide support on the down-slope side (e.g. piling).
Yellow	▪ Landslide/debris flow hazard requires accurate modelling to identify susceptible locations and estimate magnitudes of potential events to inform the appropriate siting of piers and deck elevation of viaduct, and an understanding of potential frequency to inform maintenance requirement. ▪ Up-slope deflector structures are likely to be required to protect piers from landslide/debris flow hazard.
Brown	▪ Landslide/debris flow hazard requires accurate modelling to identify susceptible locations and estimate magnitudes of potential events to inform the length of debris flow shelter required and the appropriate sizing of roof and supporting walls or piers, siting of piers and deck elevation of short viaduct, and an understanding of potential frequency to inform maintenance requirement. ▪ Design of the shelter must allow it to withstand debris flow events and potential large boulder impacts, as well as include down-slope protection to prevent undermining of the alignment. ▪ Up-slope deflector structures are likely to be required to protect viaduct piers from landslide/debris flow hazard.
Pink	▪ Landslide/debris flow hazard requires accurate modelling to identify susceptible locations and estimate magnitudes of potential events to inform the siting of tunnel portals and any intermediate shafts, and the protective measures required, as well as an understanding of potential frequency to inform maintenance requirement. ▪ Potential for difficulties in rock excavation due to: ▫ highly fractured rock due to faulting which may lead to instability of tunnel excavations; ▫ preferential groundwater flows through highly fractured rock due to faulting which may lead to difficult groundwater conditions during excavations; ▫ high strength, abrasive rock due to the presence of igneous intrusions which may lead to increased wear of excavation plant and equipment; or ▫ squeezing rock mass which may lead to entrapment of excavation plant and equipment. ▪ Design of tunnels should take into account the potential for difficulties listed above to inform the appropriate construction methods and tunnel lining requirements.
Purple	▪ As above for the ‘Pink’ route option. ▪ The approach to the proposed southern portal location requires a substantial embankment of significant height with implications for constructability, surface water management and drainage, and landscape and aesthetics.

4.4.29 Further assessment should review the geotechnical hazards within the study area and particularly the significance of the specific features identified against potential receptors as design development of the possible route options progresses. Accurate landslide/debris flow modelling should be undertaken at later stages to allow assessment of potential future event locations and magnitudes. Such modelling is considered to be critical to inform the development of the preferred route option, once selected.

4.5 Hydrology, Hydrogeology and Drainage

Introduction

4.5.1 This section provides an overview of the hydrological and hydrogeological considerations within the Glen Croe route corridor. Furthermore, it provides comment on the main drainage requirements likely to be considered as part of the possible route options. This section has been informed by a desk-based review of available information including SEPA flood maps, Ordnance Survey mapping and previous engineering reports applicable to the geographic area.

Hydrology and Surface Water Features

4.5.2 Numerous watercourse crossings will be required as part of the scheme, however the actual number of required crossings will be dependent on the route option taken forward. The estimated number of watercourse crossings required for each route option is presented in Table 4-4.

Table 4-4: Number of Watercourse Crossings for each Possible Route Option

Route Option	No. of Watercourse Crossings
Green	7
Yellow	19
Brown	13
Purple	25
Pink	15

4.5.3 Should the carriageway encroach into watercourses or lochs, in-water engineering works will be required. Any proposed construction works in-channel or in-loch will require to be timed to avoid sensitive periods for aquatic mammals and fish. Restrictions on future operational and maintenance activities may also be considered.

4.5.4 Temporary or permanent watercourse diversions may be required as part of the scheme. This could affect the existing hydrological regimes and morphology of watercourses, which may in turn affect watercourse water quality and biodiversity. Design of watercourse diversions should consider fish passage and riparian mammal activity in the area. Temporary diversions during construction will be timed to avoid sensitive periods for aquatic mammals and fish and the appropriate authorities will be consulted with ahead of the works.

4.5.5 Watercourse crossings and diversions will be designed in accordance with the latest guidance and best practice to ensure that disruption to the existing hydromorphology and hydraulic regime of the watercourses are minimised, including:

- Engineering in the water environment: good practice guide (SEPA 2010)
- DMRB CD 529 - Design of outfall and culvert details (Highways England et al., 2020); and
- CIRIA (2019). Culvert, screen and outfall manual, CIRIA C786.

Flood Risk

4.5.6 Areas within the preferred route corridor lie within the functional floodplain, defined as the 0.5% AEP (200-year) fluvial flood extents, including sections of the existing A83 Trunk Road carriageway and OMR. The possible route options may require works within the functional floodplain, this may lead to the carriageway being flooded but also potentially increase the risk of flooding to any nearby receptors, such as properties or agricultural land, due to a reduction in of the flood storage area.

4.5.7 Areas of the OMR may be at risk from pluvial flooding under the 0.5% AEP (200-year) flood event in localised areas within the lower Glen Croe. The existing A83 Trunk Road carriageway does not however appear to be at risk of pluvial flooding.

4.5.8 The possible route options overlap with the 0.5% AEP (200-year) fluvial and pluvial extents to various degrees. Table 4-5, below shows the overlap of SEPA flood extents with the possible route plus a 50m buffer. The Green Option has the greatest overlap with the flood extents for both pluvial and fluvial. The Yellow Option has the least overlap with the fluvial extents and does not overlap with the pluvial extents.

Table 4-5: Overlap of Proposed Route Options (plus 50m buffer) with SEPA flood mapping extents

Route Option	SEPA Fluvial 0.5% AEP (200-year) overlap with design (ha)	SEPA Pluvial 0.5% AEP (200-year) overlap with design (ha)
Green	1.96	0.67
Yellow	0.84	-
Brown	0.88	-
Purple	0.84	0.05
Pink	0.84	0.14

4.5.9 Hydrological modelling will be undertaken at DMRB Stage 2 and Stage 3 to provide greater resolution flood extents for the proposed route options. This should be used to inform the design. Where feasible, the design will aim to avoid locating construction works or locating the carriageway within the functional floodplain. Where avoiding the functional floodplain is not possible, compensatory flood storage will be provided.

4.5.10 The design of watercourse crossings should seek to cause no increase in flood risk and ensure sufficient capacity for the design event (including climate change). The carriageway should also be positioned above the predicted flood levels in the adjacent watercourses, including an appropriate allowance for climate change.

Groundwater

4.5.11 The possible route options may affect groundwater quality, flow direction and levels, which may in turn affect secondary groundwater receptors, such as Groundwater Dependent Terrestrial Ecosystems or private water supplies. Where required, groundwater monitoring would be undertaken. The design should consider the effects of dewatering from the construction of sub-surface structures, such as piers or tunnels, where appropriate.

Drainage Philosophy and Collection Method

4.5.12 The highways drainage system will be developed in line with DMRB design standard CG 501 –*'Design of Highway Drainage Systems'* and tunnel drainage in line with DMRB design standard CD 352 – *'Design of Road Tunnels'*.

4.5.13 Typically, a drainage system will remove surface water from the carriageway through a positive collection method, where it is conveyed by gravity through pipes downstream from a high point and discharged to a local watercourse via a series of treatment methods. To avoid flooding or overwhelming the receiving watercourse, attenuation of the captured water is provided as required.

4.5.14 A range of surface water collection methods are available with the type usually being determined by site specific constraints and the characteristics of the road. Consequently, each of the possible route options will likely include a combination of types and differ between one another. No drainage design has been developed at DMRB Stage 1; however, based on experience from other projects, the possible drainage regime for each of the possible route options has been outlined in Table 4-6.

Table 4-6: Drainage Collection Methods

Route Option	Location	Anticipated Verge Type	Likely Collection Method
Green	Sections of cut/fill	Unkerbed, grass verge	Filter Drain
	Structures and sections of retaining wall	Kerbed, hardened verge	Gullies or Combined/Bridge Kerb Drainage
Yellow	Sections of cut/fill	Unkerbed, grass verge	Filter Drain
	Viaduct/Structure	Kerbed, hardened verge	Gullies or Combined/Bridge Kerb Drainage
Brown	Sections of cut/fill	Unkerbed, grass verge	Filter Drain
	Viaduct/Structure	Kerbed, hardened verge	Gullies or Combined/Bridge Kerb Drainage
	Debris Shelter	Kerbed, hardened verge	Gullies
Purple	Sections of cut/fill	Unkerbed, grass verge	Filter Drain
	Viaduct/Structure	Kerbed, hardened verge	Gullies or Combined/Bridge Kerb Drainage
	Tunnel	Kerbed, hardened verge	Gullies
Pink	Sections of cut/fill	Unkerbed, grass verge	Filter Drain
	Tunnel	Kerbed, hardened verge	Gullies

4.5.15 Further to carriageway surface water, it may also be necessary to protect the possible route options by capturing runoff from adjacent slopes falling towards the road. Given the topography of Glen Croe, it is likely that cut off ditches or filter drains will need to be employed on the upstream and downstream slopes of the open cut/fill sections of alignment. These will discharge to existing watercourse and generally do not require treatment or attenuation.

Sustainable Drainage Systems (SuDS) and Treatment Requirements

4.5.16 Prior to discharging carriageway drainage, it will be necessary to ensure that water collected in the drainage system is of a suitable quality and treated as required in order to mitigate any harmful or adverse effects on the receiving watercourse.

4.5.17 Typically, in Scotland, Scottish Environmental Protection Agency (SEPA) require road drainage to pass through two levels of SuDS treatment prior to discharge; however, for particularly sensitive receptors, this may be increased to three levels. At subsequent stages of the scheme design and assessment, the effect of surface water quality from the runoff should be assessed using the Highways England Water Risk Assessment Tool (HEWRAT) and consultation with SEPA to determine and agree requirements.

4.5.18 To achieve the two levels of treatment, a combination of filter drains and SuDS feature such as retention ponds are generally used on the Scottish Trunk Road Network. For the Green Option, this approach is expected to be more straight forward to apply. However, it is challenging to provide a level of treatment in sections with hardened verges, such as tunnels and structures, or kerbs. As the Brown, Yellow, Pink and Purple options will predominantly have a hardened verge, alternative combinations of SuDS measures will need to be considered following the HEWRAT assessment. This will most likely be achieved through treatment downstream via a series of ponds/ basins/ wetlands, swales, or other surface water treatment measures such as vortex separators.

4.5.19 Due to the topography in Glen Croe and the various spatial constraints throughout, it is anticipated that positioning SuDS features will be challenging for all possible route options, particularly where two in series may be required.

Drainage Outfalls

4.5.20 Following treatment, the carriageway drainage will be discharged into to a receiving watercourse. For all possible route options, Croe Water is the most suitable watercourse for outfalling south of the high point at the Rest and Be Thankful car park. If an outfall north of this is required, it will likely be into Loch Restil or its outflow river.

4.5.21 Outfall locations will be developed at DMRB Stage 2 and will vary for each of the possible route options, predominantly being determined by available space and positioning of SuDS features. Their design will be carried out in line DMRB standards and comply with SEPA requirements and The Water Environment (Controlled Activities) (Scotland) Regulations, also known as CAR.

4.6 Structures

4.6.1 The following provides a summary and preliminary engineering assessment of the structure requirements against each of the possible route options.

Green Route Option

4.6.2 The principal structures in this possible route option comprise:

- A viaduct approximately 0.2km in length, crossing the valley floor and the Croe Water as shown in Figure 4.1; and
- A viaduct approximately 0.3km in length, to span the gully located to the north west of High Glen Croe as shown in Figure 4.2.

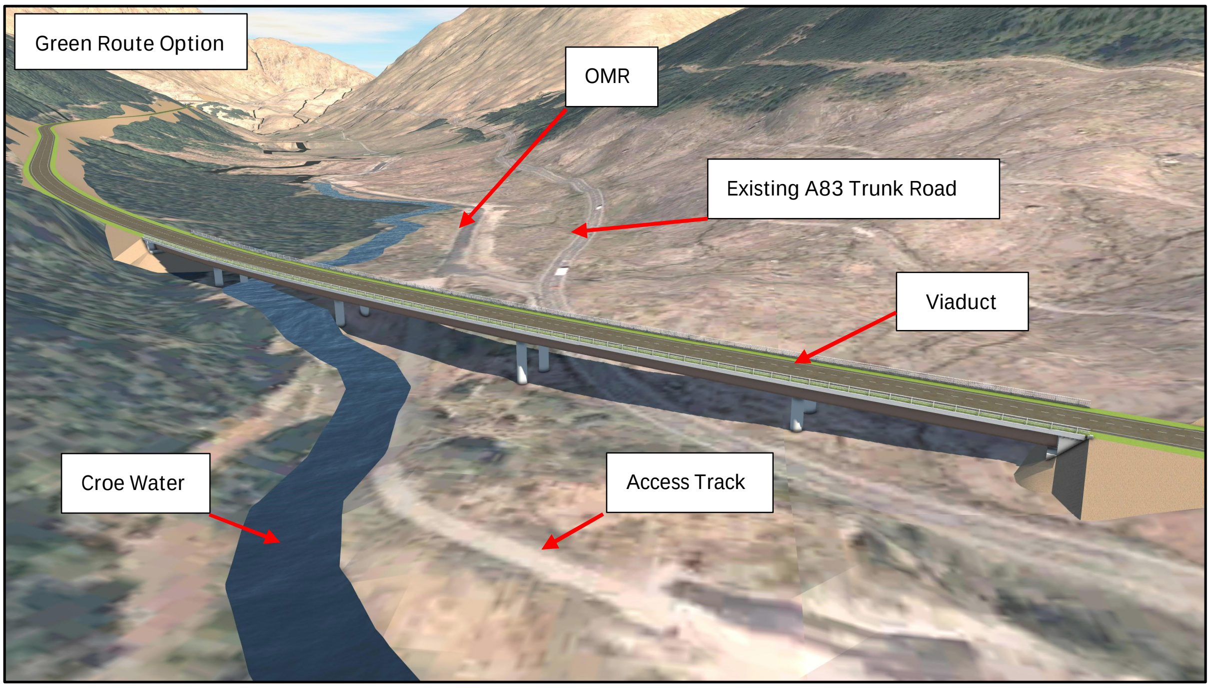


Figure 4.1: Indicative viaduct crossing valley floor including Croe Water, OMR and A83 Trunk Road

4.6.3 The piers are likely to range between 5m and 9m in height. It is envisaged spans of between 40m and 70m are likely to be required. Span arrangements would have to take into consideration Croe Water and the existing OMR. The impact of the abutments and piers on the flood plain of Croe Water would have to be assessed. Freeboard height of the Croe Water would have to be assessed and headroom clearance to the OMR considered.

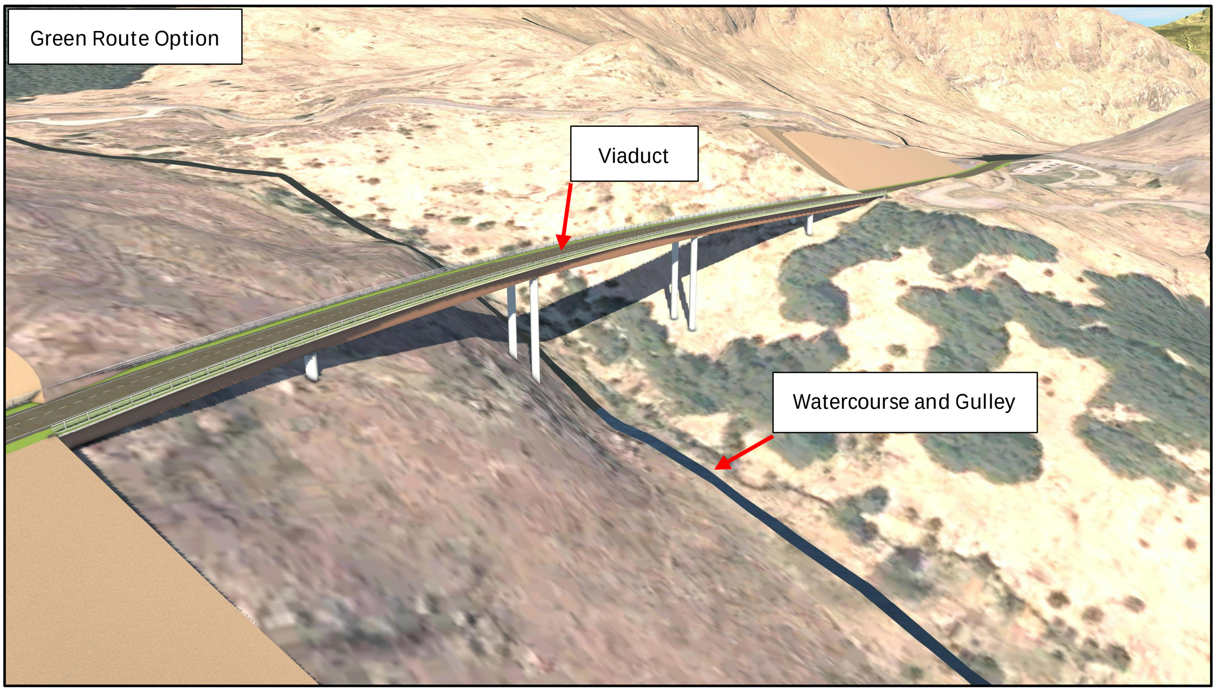


Figure 4.2: Indicative viaduct spanning gully located to the north-west of High Glen Croe

4.6.4 The piers are likely to range between 8 m and 35 m in height. It is envisaged spans of between 40 m and 70 m are likely to be required. Span arrangements would have to take into consideration the location of the existing watercourse that contributes to Croe Water. Additional risks and potential issues for the structure are provided within the Preliminary Assessment Report, Appendix G, Section 2.4.

4.6.5 At this preliminary stage, no assessment has been carried out on whether retaining structures will be required. It is, however, possible that some retention will be required to supplement and enhance the stability of cuttings and minimise the footprint of the proposed option. Assessment of extent retaining structures will be reviewed at the next stage.

4.6.6 The green option has a similar arrangement to the existing A83 alignment with run-off from the hillside requiring to be channelled under the new road. It is anticipated that various sized culverts/principal structures will be required following more detailed topographic surveys and water assessments.

4.6.7 Auxiliary structures such as deflector/arrestor retaining structures or debris flow shelters may be required at intervals to be determined along the length of the route.

4.6.8 Details of the structures design and construction issues within the Green route option are provided within the Preliminary Assessment Report, Appendix G, Section 2.4.

Yellow Route Option

4.6.9 The principal structure in this route comprises a viaduct approximately 1.8km in length from Croe Water to the Rest and Be Thankful car park along the toe of the west facing slopes of Beinn Luibhean where landslide hazard is significant as shown in Figure 4.3.

4.6.10 The viaduct runs approximately parallel to the existing A83 Trunk Road and re-joins the alignment of the existing A83 Trunk Road before the bend prior to the junction with the B828 local road and the access to the Rest and Be Thankful car park. The viaduct is situated between the existing A83 and the OMR. This structure would be built on side-long ground, which is prone to landslides, and would require protection and deflector structures. It would generally follow a similar profile to the existing road with an average climbing gradient of approximately 5%.

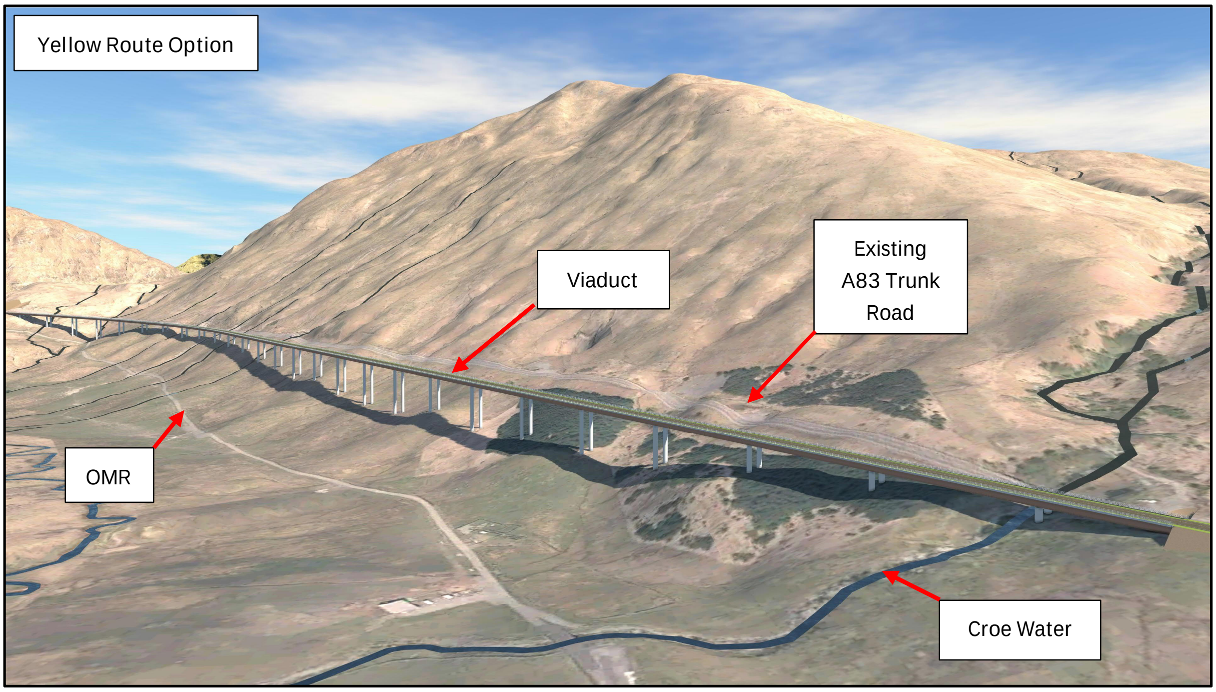


Figure 4.3: Indicative viaduct spanning gully located to the north-west of High Glen Croe

4.6.11 The piers will vary in height, to a maximum of approximately 38 m. It is envisaged spans of between 40 m and 70 m are likely to be required.

4.6.12 The viaduct structure would be set at a suitable level to permit debris flow events to pass below the A83 Trunk Road. There is no specific guidance on clearances to permit potential landslide, debris flow or rock-fall events to pass beneath structures; however, design development of any viaduct structure would have to consider factors such as, but not necessarily limited to; the magnitude of any event, source locations and pathways, relative position and spacing of piers and any deflector structures.

4.6.13 Details of the structures design and construction issues within the Yellow route option are provided within the Preliminary Assessment Report, Appendix G, Section 2.2.

Brown Route Option

4.6.14 The principal structures in this possible route option comprise:

- A debris flow shelter approximately 1.3 km in length as shown in Figure 4.4; and
- A viaduct approximately 0.34 km in length at the north end where debris flow shelter ends as shown in Figure 4.5.

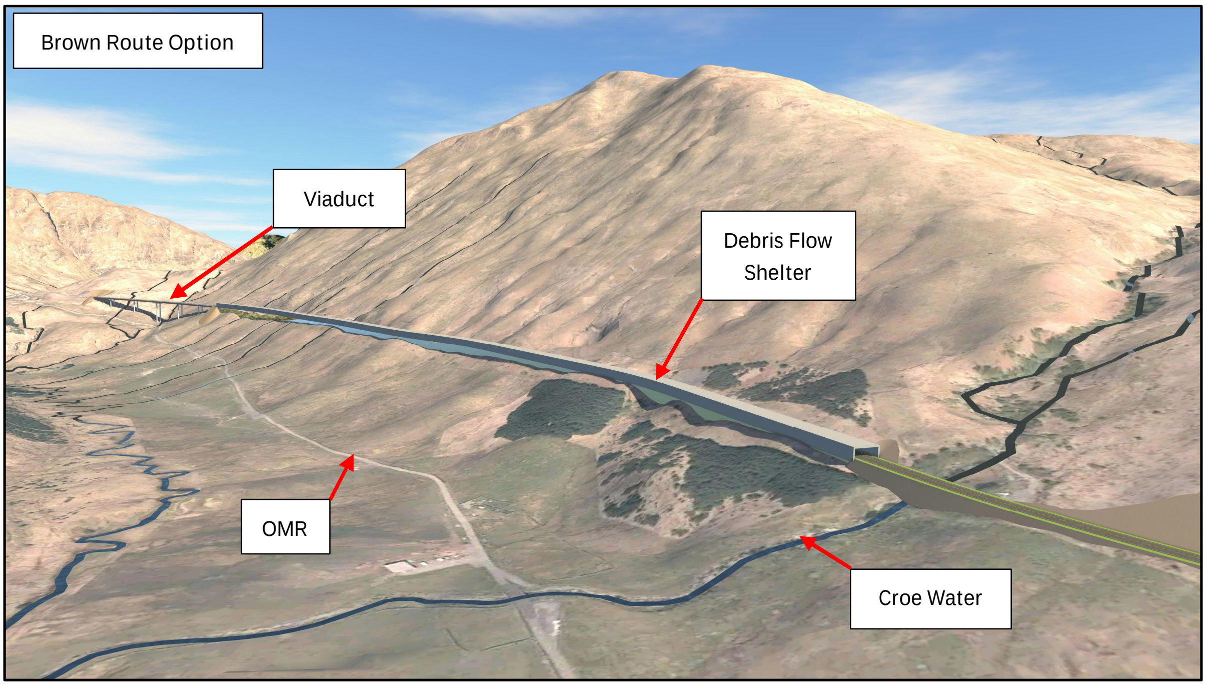


Figure 4.4: Brown Option - Debris Flow Shelter (Indicative)

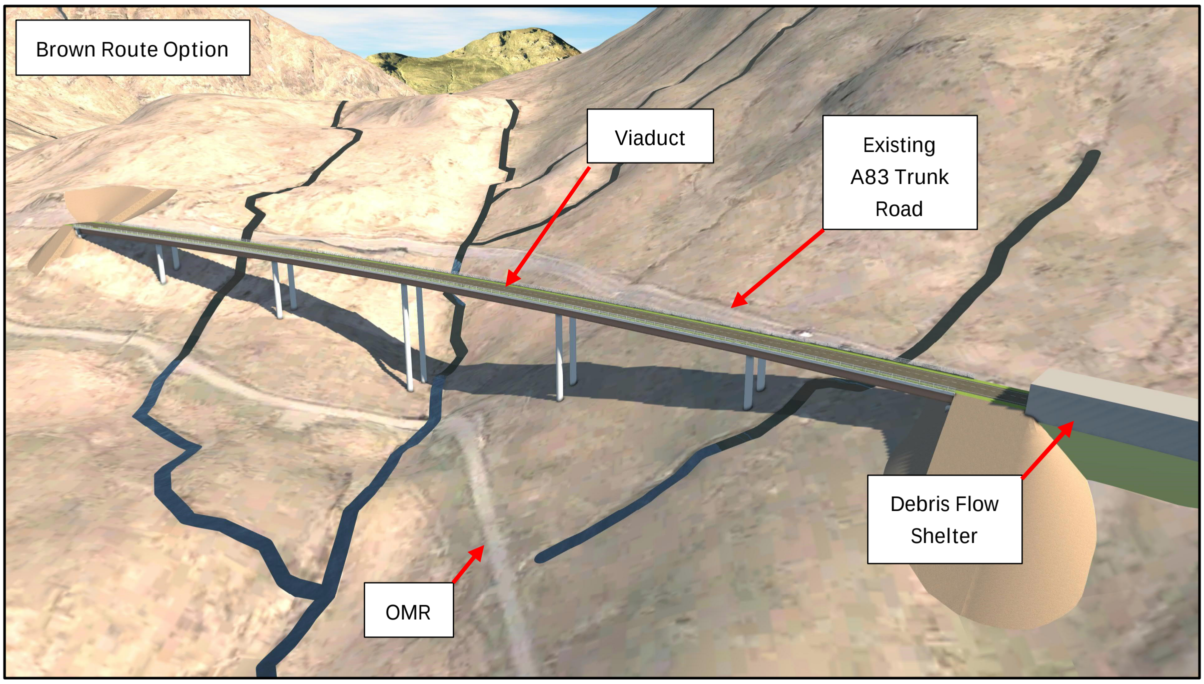


Figure 4.5: Brown Option - Indicative viaduct at north end where debris flow shelter ends

4.6.15 The piers will vary in height, to a maximum of approximately 37 m. It is envisaged spans of between 40 m and 70 m are likely to be required. Span arrangements would have to take into consideration the location of the existing watercourse features that run-off Beinn Luibhean which contribute to Croe Water.

4.6.16 The debris flow shelter option considers the possibility of an online solution following the route of the existing A83 Trunk Road. However, the challenge in providing such a structure, especially over the length required, is considerable. Debris flow shelters, which are of a similar form to widely used rockfall or avalanche shelters, are engineered structures that form canopies over a section of road prone to debris flows. These structures are usually constructed from reinforced concrete and allow landslides to slide over the top of the structure without disrupting traffic flow.

4.6.17 The route maintains the alignment of the existing A83 Trunk Road. It is anticipated that the alignment may require some minor modification to attain a balance between cut on the upslope and fill on the downslope whilst accommodating the geometry of the structure. This may afford some opportunity to improve the existing horizontal alignment although this will be limited.

4.6.18 There is little opportunity to significantly modify the existing vertical alignment so this would be maintained at the existing approximately constant 5% gradient.

4.6.19 However, for the A83 Trunk Road, the design aim must be, as far as is practicable, to enable construction over the existing road with live traffic and this greatly increases the construction difficulty.

4.6.20 The uphill topography varies, with a number of channels eroded by existing watercourses and debris flow events and the slope below the existing A83 Trunk Road may be susceptible to instability as well as be affected by debris flows originating from above the road. The width available for construction of such a structure is severely limited and includes only the width of the existing road and some very limited space created by the existing catchpits alongside the road. These exist only on a limited length and in places the available width is further constrained.

4.6.21 Where structures such as these are deployed to arrest rock fall, impact energy is dissipated by placing a depth of granular material on the roof of the structures. However, the nature of the A83 Trunk Road landslides is such that the structure must be able to deflect a mixture of large boulder rock falls, gravel and slurry and water movements.

4.6.22 It is therefore proposed that a debris flow shelters would take the form of an open sided arch structure exemplified by the form shown in Figure 4.6. A similar structure can be viewed on Google Earth 47°13'20.7"N 11°03'44.4"E, Kuehtai mountain pass road, Austria.

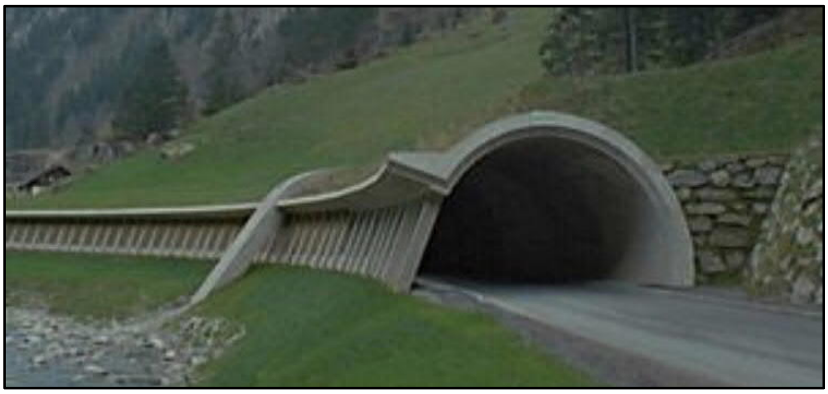


Figure 4.6: Example of a Debris Shelter to Protect Road from Rockfall

4.6.23 Details of the structures design and construction issues within the Brown route option are provided within the Preliminary Assessment Report, Appendix G, Section 2.3.

Purple Route Option

4.6.24 The principal structures in this possible route option are:

- A tunnel approximately 1.2km in length as shown in Figure 4.7.
- A viaduct, approximately1.45km in length viaduct from Croe Water to south entrance of tunnel as shown in Figure 4.8.

4.6.25 An alternative proposal to the viaduct is an embankment which will require the following structures:

- A structure over Croe Water similar in length to existing Cobbler bridge; and
- A structure over the OMR.

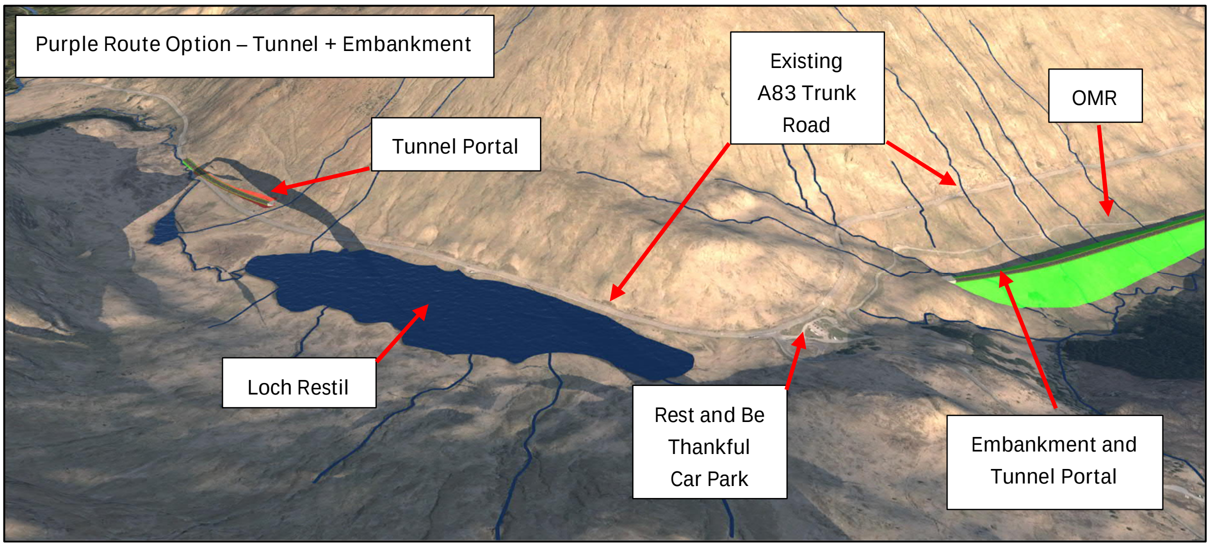


Figure 4.7: Route of Tunnel Around the Flanks of Beinn Luibhean

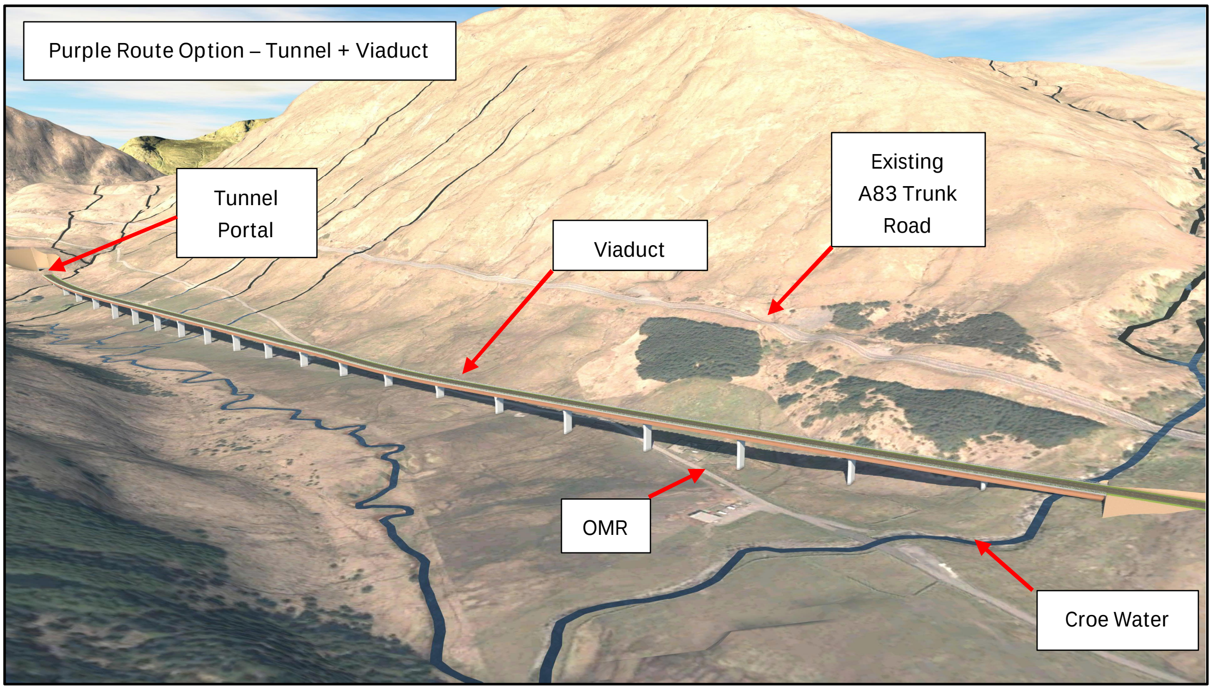


Figure 4.8: 1.45km viaduct from Croe Water to south entrance of tunnel

4.6.26 The piers are likely to range between 5m and 22m in height. It is envisaged spans of between 40m and 70m are likely to be required. Span arrangements would have to take into consideration Croe Water and the existing OMR.

4.6.27 The viaduct structure would be set at a suitable level to permit debris flow events to pass below the A83 Trunk Road. There is no specific guidance on clearances to permit potential landslide, debris flow or rock-fall events to pass beneath structures; however, design development of any viaduct structure would have to consider factors such as, but not necessarily limited to; the magnitude of any event, source locations and pathways, relative position and spacing of piers and any deflector structures.

4.6.28 Design and construction issues of the viaduct will be similar to the Yellow route option, these are provided within the Preliminary Assessment Report, Appendix G, Section 2.2.

Tunnel Design and Construction Considerations

4.6.29 The tunnel will provide for a 7.3m wide single carriageway with 1.2m wide hardened verge/emergency egress footway each side. Cyclist access to the tunnel will not be permitted, and an alternative routing for cyclists would need to be considered. The cross-section will allow for ducts over the roadway for the provision of semi-transverse ventilation, as well as a fire-protected low-pressurised passageway at one side for the emergency evacuation in the case of fire, with typically doorways for access to the passageway at 150m intervals. The use of the tunnel by vehicles carrying potentially hazardous materials or dangerous goods (such as fuel tankers) is largely dependent on fire safety and ventilation, and may require a tunnel ventilation system that allows for a larger design fire size. The gradient in the tunnel upwards from south to north is approximately a constant 4.8% over about 1.4km total length, curving to the right with a compliant curvature, allowing for stopping sight distances. Overtaking should not be permitted for a 7.3m wide carriageway due to changed perceptions by drivers in a tunnel.

4.6.30 A considerable amount of excavation and ground support is anticipated to be designed at each of the portals, to stabilise the loose scree and boulder material, and to provide access to a vertical or sub-vertical rock face from which the tunnelling can be advanced. In addition the portal face may need to be stabilised and catch fences added to ensure that the portal and personnel entering the portal are protected.

4.6.31 If the tunnel is to be advanced by a sequential drill-and-blast method, the design will comprise typically a top heading, bench and invert construction, with each stage being supported by sprayed concrete, rock bolts and perhaps steel arches in extreme ground conditions. Typically a number of alternative support designs, giving different concrete thicknesses, different rock bolt arrangements etc will be prepared to deal with conditions that will not be fully known until they are encountered.

4.6.32 If the tunnel is to be advanced by a Tunnel Boring Machine (TBM), transport of a large TBM to the relatively remote drive portal location will be a logistical challenge in itself and considerably more space will be required at the driving portal to position the TBM and start the advance. The design of a hard rock TBM is a specialist subject in its own right, requiring the design of cutting wheels and picks on the cutter head which are designed to deal with the anticipated rock conditions encountered.

4.6.33 Several aspects of construction are implied in the section on design above.

4.6.34 Construction by drill and blast methods can be advanced simultaneously from both portals, but a TBM construction would be from one portal only.

Pink Route Option

4.6.35 The principal structures in this possible route option are:

- A tunnel approximately 2.9km in length as shown in Figure 4.9 and Figure 4.10.

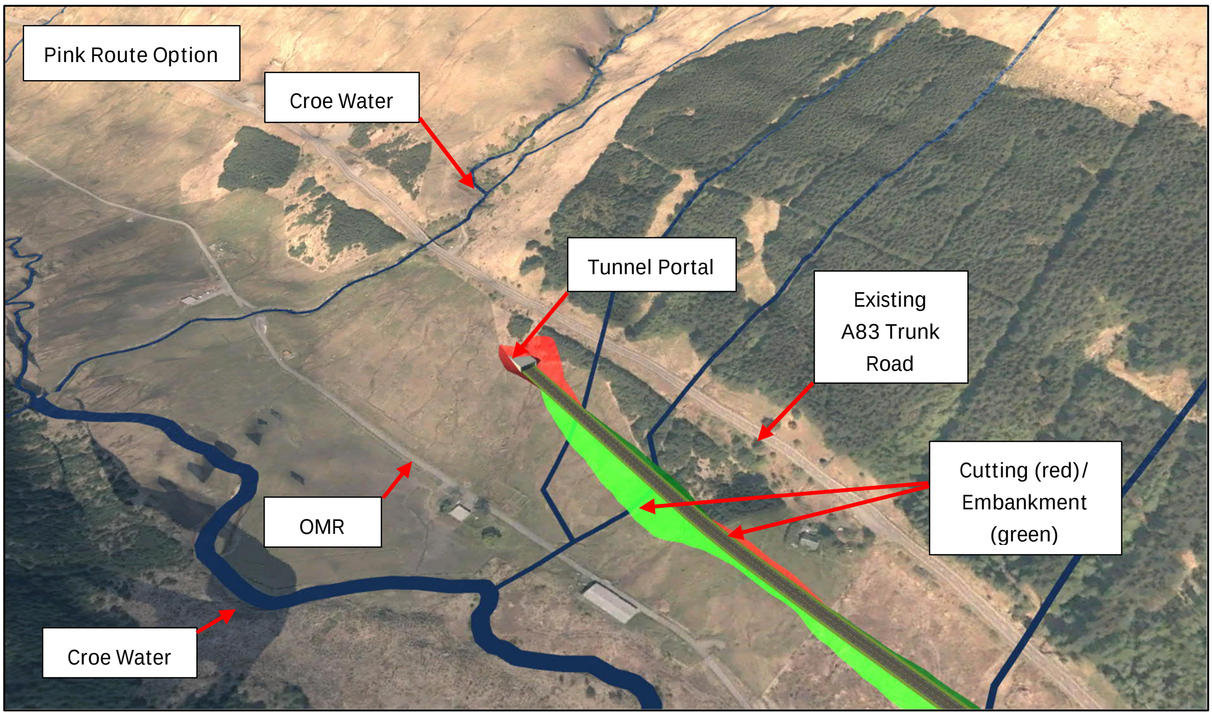


Figure 4.9: Southern Portal of Tunnel South of Croe Water

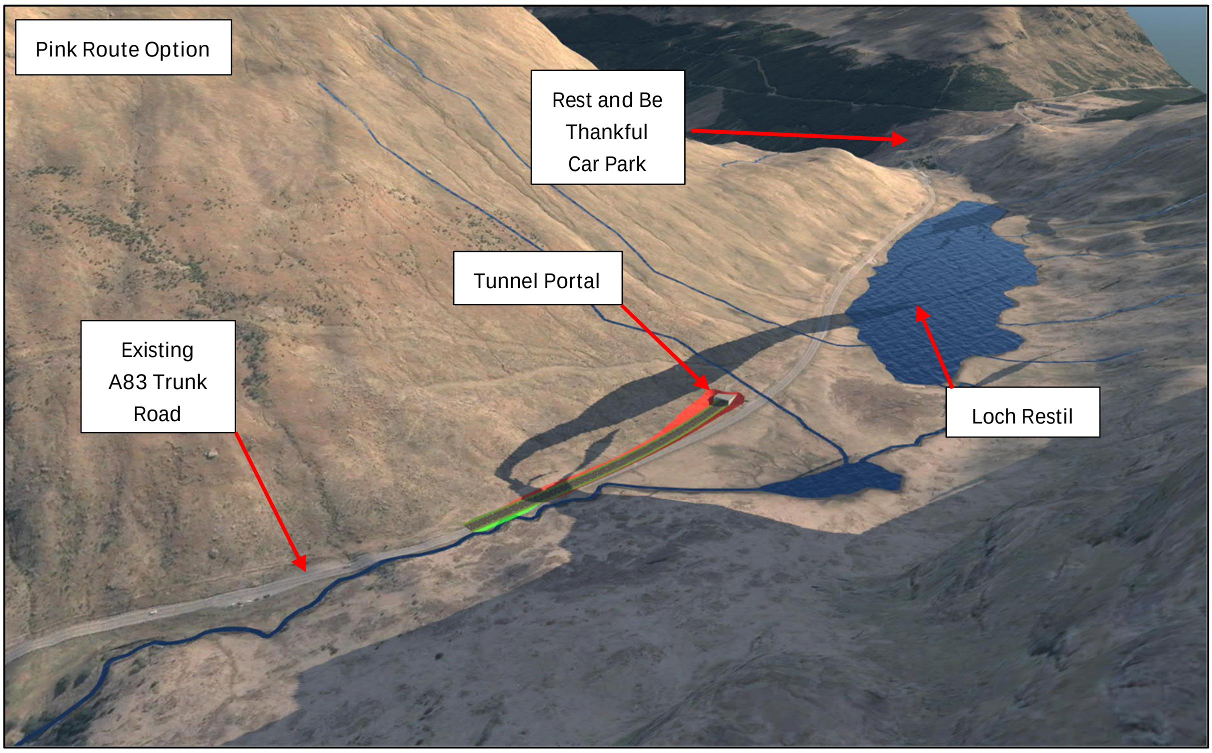


Figure 4.10: Northern Portal of Tunnel

Tunnel Design and Construction Considerations

4.6.36 The tunnel will provide for a 7.3m wide single carriageway with 1.2m wide hardened verge/emergency egress footway each side. Cyclist access to the tunnel will not be permitted, and an alternative routing for cyclists would need to be considered The cross-section will allow for ducts over the roadway for the provision of semi-transverse ventilation, as well as a fire-protected low-pressurised passageway at one side for the emergency evacuation in the case of fire, with typically doorways for access to the passageway at 150m intervals. The use of the tunnel by vehicles carrying potentially hazardous materials or dangerous goods (such as fuel tankers) is largely dependent on fire safety and ventilation, and may require a tunnel ventilation system that allows for a larger design fire size. The gradient in the tunnel upwards from south to north is approximately a constant 3.6% over approximately 2.9km total length, with a compliant horizontal alignment, allowing for stopping sight distances. Overtaking should not be permitted for a 7.3m wide carriageway due to changed perceptions by drivers in a tunnel.

4.6.37 A considerable amount of excavation and ground support is anticipated at each of the portals, to stabilise the loose scree and boulder material, and to provide access to a vertical or sub-vertical rock face from which the tunnelling can be advanced. In addition the portal face may need to be stabilised and catch fences added to ensure that the portal and personnel entering the portal are protected.

4.6.38 Due to the greater length of this tunnel, compared with the Purple Option an intermediate shaft or adit is recommended to be provided near the mid-point of the tunnel to facilitate evacuation in an emergency. Due to the depth of such a shaft if constructed vertically, and the difficulties both getting evacuees to the top of the shaft and caring for them once they reach free air, the design of an adit to connect to the existing A83 Trunk Road or the OMR is an option that could be further evaluated.

4.6.39 If the tunnel is to be advanced by a sequential drill-and-blast method, the design will comprise typically a top heading, bench and invert construction, with each stage being supported by sprayed concrete, rock bolts and perhaps steel arches in extreme ground conditions. Typically a number of alternative support designs, giving different concrete thicknesses, different rock bolt arrangements etc will be prepared to deal with conditions that will not be fully known until they are encountered.

4.6.40 If the tunnel is to be advanced by TBM, transport of a large TBM to the relatively remote drive portal location will be a logistical challenge in itself and considerably more space will be required at the driving portal to position the TBM and start the advance. The design of a hard rock TBM is a specialist subject in its own right, requiring the design of cutting wheels and picks on the cutter head which are designed to deal with the anticipated rock conditions encountered.

4.6.41 Several aspects of construction are implied in the section on design above.

4.6.42 Construction by drill and blast methods can be advanced simultaneously from both portals, but a TBM construction would be from one portal only.

4.7 Pavements

4.7.1 Pavement construction will generally fall into two approaches across the five possible route options within the preferred route corridor:

- For open cut/fill sections of carriageway, it is anticipated that it will consist of full depth, flexible or flexible composite construction using bituminous materials, generally in line with the wider Scottish trunk road network; and,
- For structures, viaducts and tunnels, it is anticipated that partial depth construction will be used with a bituminous surface layer directly on top of the deck structure.

4.7.2 All possible route options will require tie ins at either end to the existing alignment of the A83 Trunk Road, with some possible route options potentially making greater use of the existing carriageway than others. Accordingly, further pavement surveys and analysis will be required in subsequent stages of design development and assessment to determine whether it is of suitable condition and can be accepted into the permanent works or if improvements are required. Transport Scotland’s current standards permit the use of existing pavements to be incorporated within foundation layers of new roads, therefore, where suitable this can be considered.

4.7.3 The B828 local road which connects to the A83 Trunk Road at the Rest and Be Thankful car park is owned and maintained by Argyll and Bute Council. It is expected that there will be interaction with the B828 local road for all possible route options, albeit to varying degrees. Generally, local authorities have different pavement material specifications for their roads compared to trunk roads managed by Transport Scotland. As such, consultations with Argyll and Bute Council will be necessary to confirm their requirements with respect to pavement construction.

4.8 Vehicle Restraint Systems

4.8.1 Vehicle Restraint Systems (VRS) and structural parapets shall be specified in line with DMRB design standard CD377 – '*Requirements for Road Restraint Systems*'.

4.8.2 At this early stage of design development and assessment it is not possible to identify specific hazards and thus define the exact extents of provision required. However, given the nature of the alignments of possible route options within the preferred route corridor and using the existing A83 Trunk Road as a reference, it is anticipated that the majority of the possible route options will require significant lengths of VRS.

4.8.3 Generally, the open cut/ fill road alignments on all five possible route options are elevated above the floor of Glen Croe with steep side slopes adjacent, posing a risk for drivers. It is expected that VRS would be required on the down slope side in most instances, and where positioned on an embankment, may be required on both sides of the carriageway.

4.8.4 The structures/viaducts in the Green, Yellow and Brown Route Options result in sheer drops either side which will require structural parapets. If retaining walls and other structures are identified as the scheme design development and assessment progresses, appropriate provision of VRS will likely be necessary.

4.8.5 For the Pink and Purple options, it is not anticipated that the provision of VRS will likely be required within the tunnels based on recent examples around the United Kingdom. However, for the debris flow shelter in the Brown option it may be required.

4.8.6 In line with DMRB design standard CD377 – 'Requirements for Road Restraint Systems', for options that involve long downhill gradients, assessment at future design stages will consider whether there could be potential for problems associated with runaway vehicles and any mitigation necessary within the design.

4.9 Public Utilities

4.9.1 This section will explain the process that has commenced to establish the presence of utility apparatus before summarising the key impacts.

4.9.2 Public utility information is currently being collected in accordance with the C2 Preliminary Inquiries stage of the '*New Roads and Street Works Act 1991, Measures Necessary where Apparatus is Affected by Major Works (Diversionary Works), A Code of Practice*'.

4.9.3 Utility impacts are critical factors in future alignment development, due to both community and economic risk factors. Their impacts will be avoided whenever feasible. However, if unavoidable utility impacts arise, strong consideration will be given to construction methods for either protection or relocation, depending upon which option is the most effective in terms of cost and programme.

4.9.4 As the project progresses, engagement with all Statutory Undertakers is expected. However, as four of the possible route options within the preferred route corridor are offline from the existing A83 Trunk Road, existing utilities may not be directly impacted by the scheme. Nonetheless, access to the utilities in the verge of the A83 Trunk Road may be lost as a consequence as there is no definitive strategy at this point with regard to the existing trunk road post-construction and whether it will be retained should an offline route option be taken forward. Therefore, it may be necessary for Statutory Undertakers to relocate their apparatus to a new route in their entirety.

BT Openreach

4.9.5 BT Openreach currently has existing apparatus in the form of underground cables and chambers which run parallel and in close proximity to both the A83 Trunk Road and the OMR for the extents of the project. The key potential impacts on each possible route option are as follows:

- The Green, Yellow, Pink and Purple Options have potential impacts at both tie-in locations between the A83 Trunk Road and proposed offline alignment sections.
- The Brown Option is likely to impact this utility for the full length of the debris shelter structure and where the offline section ties into the existing A83 Trunk Road, south of the Rest and Be Thankful car park.

Mobile Broadband Network Limited

4.9.6 Mobile Broadband Network Limited (MBNL) currently has existing apparatus in the form of a mast which is located on the B828 local road, approximately 200m south-west of the Rest and Be Thankful car park. There are no potential impacts envisaged as a result of the possible route options, however, future design development and assessment stages should take into consideration the potential for impacts as a consequence of any realignment required of the B828 local road.

Unknown Statutory Undertaker

4.9.7 Identified through photography, there is an existing overhead cable running in parallel with the B828 local road between Lochgoilhead and the Rest and be Thankful car park. To date, none of the C2 inquiries have identified the owner of this apparatus. It is likely that the Green Option will have impact on this existing apparatus; however, future design development and assessment stages should take into consideration the potential for impacts as a consequence of any realignment required of the B828 local road.

4.10 Non-motorised Users (NMUs)

Possible Route Corridor Option Impacts on Existing NMU Routes

4.10.1 Within the extents of the preferred route corridor and within proximity of the possible route options, there are four NMU routes consisting of one Core Path and three undesignated local paths. Table 4-7 summarises which of these may be impacted by the various possible route options. Details of the four NMU routes are included below.

Table 4-7: Existing NMU Provision Potentially Impacted by Possible Route Options

NMU Route	Green Option	Yellow Option	Brown Option	Pink Option	Purple Option
Core Path	X				
Undesignated Local Path 1	X				
Undesignated Local Path 2	X	X	X		X

Undesignated Local Path 3		X	X		X

4.10.2 There are no existing formal NMU facilities within the cross-section of the A83 Trunk Road within the extents of the preferred route corridor, and the nearest identified sections are east of Ardgartan Holiday Park and at the top of Loch Shira.

Core Path

4.10.3 The Core Path is included in the Core Paths Plan for the Loch Lomond & The Trossachs National Park by the National Park Authority. Located on the western side of Glen Croe, it runs from Ardgartan along the forestry tracks to approximately 430m south-west of the Rest and Be Thankful car park where it then turns south-west towards Gleann Mor and to Lochgoilhead. A short branch of the Core Path links from a parking area adjacent to the B828 local road to the main route of the Core Path. This Core Path connects to a wider network of Core Paths within the national park, providing NMU access.

4.10.4 Given the strategic importance of this section of Core Path to link the wider network in an area where there is limited other provision, the impact of any potential route options should be considered to maintain this NMU route.

Undesignated Local Path 1

4.10.5 An undesignated local path is located on the existing forestry track which is located between the Core Path, described above, and Croe Water. It provides a link between A83 Trunk Road/OMR junction to the Core Path towards High Glencroe.

Undesignated Local Path 2

4.10.6 An undesignated local path is located on the OMR from the A83 Trunk Road /OMR junction to High Glencroe.

Undesignated Local Path 3

4.10.7 An undesignated local path is located to the east of the A83 Trunk Road and this generally runs parallel to Croe Water and is approximately 900 metres in length. It is known from consultation with SSE that they use this path as a means of foot access to their infrastructure within the area, while it has also understood to be used by walkers accessing the adjacent hills, particularly Beinn Luibhean.

4.10.8 The potential impacts and maintenance of each of these NMU routes should be considered in combination with the future provision of Junctions and Accesses within the preferred route corridor, as outlined in Section 4.3 of this report. Access to the SSE infrastructure using undesignated local path 3 will need to be maintained or alternative access provision agreed with through further consultation as the design development and assessment progresses.

Future Considerations

4.10.9 Future stages of design development and assessment will consider the potential impacts on NMU routes and also opportunities in greater detail as well as develop possible alternative designs or improvements where required.

4.10.10 There is currently no existing dedicated NMU infrastructure within the cross-section of the A83 Trunk Road between Ardgartan Holiday Park and the top of Loch Shira. As the scheme progresses, this should be taken into consideration as any proposed NMU improvements adjacent to the carriageway within the preferred route corridor could be isolated and provide little benefit with regard to connectivity in the wider NMU network within Loch Lomond & The Trossachs National Park, and greater Argyll and Bute.

4.10.11 As noted above, the existing Core Path provides connectivity to the wider area and ultimately forms part of a much larger network. Therefore, future stages of design development and assessment should consider this Core Path, ensuring connectivity and accessibility are maintained, and where possible improved.

4.11 Constructability Considerations

4.11.1 This section summarises the key constructability considerations related to the major structures and tunnels that are proposed to be included for the possible route options within the preferred route corridor, along with general observations for construction.

Yellow Route Option

4.11.2 The Yellow Route Option includes an extensive viaduct constructed to the west of the existing A83 Trunk Road on the valley slope. Below are some of the key construction considerations.

- Construction of the pier and abutment foundations is on the sloped valley face, which will require significant temporary access and working platforms to allow plant and materials supply, as well as operational working areas. This would likely be accessed from the OMR, but should seek to limit impacts to it in case of the need to use the OMR for A83 Trunk Road traffic.
- Abutment construction at the tie in points with the existing alignment of the A83 Trunk Road could have notable impacts to traffic management. It would be recommended to locate the abutments away from the existing A83 Trunk Road where possible to minimise disruption. The use of a solution such as reinforced earth walls may be required to prevent the earthworks at the abutments from encroaching on the existing A83 Trunk Road as well. At the northern end of the Yellow Route Option the abutment is constructed close to the A83 Trunk Road and OMR, so the final location will need to be determined to optimise the reduction of impacts to both.
- There would be notable challenges to utilising cranes to lift in deck components due to the highly sloped ground in most areas. The construction of the bridge deck of the viaducts could be achieved using several approaches, including post-tensioned segmental construction by balanced cantilever, incremental segmental span launching by gantry system or segmental or insitu launching from one end. For smaller structures, other methods such as use of precast deck sections of insitu concrete pours may be appropriate. The selection of deck construction method will inform the access requirements at the pier locations depending whether elements are installed from the advancing deck (e.g launch) or lifted from the ground (e.g balanced cantilever).
- As an off-line option with access from the valley floor and a span-by-span or launched deck construction, the viaduct's construction is likely to have only limited disruption to the A83 Trunk Road.

4.11.3 Piers at the northern end of the structure will have to be set away from the OMR alignment to maintain availability in the event of a landslip. The construction of the piers in general may be best achieved using a separate dedicated haul route where possible but, in this location, some use of the road could be preferred. If the OMR is in use by the public certain construction operations could be impacted such as lifting in if deck sections for the crossing span.

Brown Route Option

4.11.4 This option includes construction of a Debris Flow Shelter which is online for approximately 1.34km of the A83 Trunk Road, presenting a number of challenges along with other considerations as summarised below:

- The available working area is extremely constrained due to the topography on either side of the A83 Trunk Road and the relatively narrow width of the existing road.

- Construction will be highly disruptive to traffic on the A83 Trunk Road, requiring extended periods of single lane operation for two-way traffic under signal control to enable activities including construction of the widened sections of road, foundations and widening into the hillside. There would also need to be numerous road closures during overnight or off-peak periods to complete major works that could not be accommodated whilst live traffic is on the carriageway, for example crane lifts or large-scale piling.
- Construction of the Debris Flow Shelter would likely be best achieved in shorter sections to minimise impacts of the lane closures. This may impact efficiency of construction if linear activities cannot be continuous along the length of the road, so would require careful planning to ensure an optimal balance.
- Construction itself would be vulnerable to pre-existing and ongoing landslide hazard, and will be challenging to mitigate this.
- Construction access to the site is severely limited and it is assumed that materials delivery will be by road almost exclusively from the south via the A82 Trunk Road. This will inform the size and weight of precast components to be used.
- Throughout the construction, watercourses would have to be managed by temporarily diversion or over-pumping to enable the structure to be completed where it crosses them.

4.11.5 The option also has an interface between the Debris Flow Shelter and a short viaduct at the northern end. For that reason, it would be likely that completion of the Debris Flow Shelter would proceed from the southern end whilst the abutments and bridge are constructed. These works will also require some lane and full road closures to complete which will increase the impact to the A83 Trunk Road and should be coordinated with debris shelter construction activities. The likely construction sequence would see the completion of the new viaduct and diversion of traffic onto the structure before the Debris Flow Shelter construction is continued over and adjacent to the live trafficked road.

4.11.6 Viaduct construction at the northern end will share some of the same considerations as the Yellow Route Option for working near the OMR and construction on the valley slope.

Purple Route Option

4.11.7 The Purple Route Option includes a new offline surface road or viaduct west of the existing A83 Trunk Road leading to a short tunnel under the Rest and Be Thankful. The main tunnel considerations are summarised below.

- A tunnel could be advanced by drill and blast techniques or by using a large Tunnel Boring Machine (TBM).
- For a drill-and-blast advance the flat-bottomed “horseshoe”-shaped excavation of newly cut rock would be evaluated by a geologist and strengthened using a combination of rock bolts and sprayed concrete lining (SCL), to form a stable primary lining before the next advance is drilled and charged with explosive. Although this may seem a slow and laborious process it can be an economic method to construct tunnels in rock. The tunnel can be completed more quickly if the drill-and-blast sequence can be repeated at the opposite portal, or even from intermediate shafts. Once the tunnel is completed an in-situ cast secondary lining can be installed to form a durable final structure.
- Alternatively, the tunnel can be bored using a large TBM, starting at one end and boring the length of tunnel consecutively. Although this involves a large capital investment in a TBM, large site set-up at the portal locations as well as challenging logistics to transport to TBM to site, when compared with drill-and-blast, the final circular structural lining of pre-cast segments can be formed as the tunnel advances.
- Whichever method is used, short sections of cut and cover tunnel would be required at each

portal location to form a vertical face in reasonably competent rock from which the bored tunnel can be advanced. At these locations the construction of portals would be a significant challenge, given the potential for landslide events near the south portal. Construction in these areas would likely require a relatively substantial temporary and permanent works solution to stabilise the portal and protect the work site from potential landslips.

- Given the difficulties associated with the landslides near the south portal and the shortage of useable space, it is likely that the main tunnel driving site would be at the northern portal. It is also unlikely that a TBM-mined tunnel would be economic and practical at this southern location.
- It would be advisable to locate tunnel portals as far from the existing A83 Trunk Road and OMR as practicable, to minimise traffic disruption on the roads during construction.

4.11.8 The approach at the southern end of the tunnel crosses the OMR and the embankment potentially extends across it in some places. This would necessitate a bridge or portal tunnel being constructed to maintain the road under the new A83 Trunk Road, which could have a relatively long span and high skew with abutment structures to be set back sufficiently to allow the road to be used whilst the bridge is constructed. The OMR will remain open during the works but the construction of the bridge deck would require the OMR to be closed during this stage of the works to install beams, permanent formwork or precast sections. Retaining walls or Mechanically Stabilised Earth (MSE) slopes could be employed to reduce the embankment footprint where it passes close to the road.

4.11.9 The extensive embankment works at the southern approach could provide a potential opportunity to use tunnelling arising as a fill, provided the material is suitable. This would reduce the amount of material being removed from site considerably.

Pink Route Option

4.11.10 The Pink Route Option includes an extended tunnel under Beinn Luibhean with a short section of surface road to the west of the existing A83 Trunk Road at the southern approach. The tunnelling operations share many similar construction considerations to the Purple Route Option tunnel with the following specific considerations.

- Whichever method is used, short sections of cut and cover tunnel would be required at each portal location to form a vertical face in reasonably competent rock from which the bored tunnel can be advanced. Construction in these areas would likely require a relatively substantial temporary and permanent works solution to stabilise the portal and protect the work site from potential landslips.
- For the longer tunnel proposed for the Pink Route Option , the provision of an intermediate ventilation/escape shaft or adit is a significant additional item, posing the problems of sinking a shaft from an area that is difficult to access, and the difficulties of providing personnel transport to the top of the shaft and well as evacuation from that location. For this reason, an intermediate ventilation/evacuation adit connection to the existing A83 Trunk Road should be further considered, as an alternative to a shaft.
- Construction of the tunnel could likely be achieved from either or both ends due to the marginally improved access at the southern portal compared with the purple option, as well as location away from the primary landslip risk zones.

4.11.11 Earthworks volumes for the tunnel in the Pink Route Option are likely to be high as there is limited opportunity to reuse the material in the works, as would be possible in the Purple Route Option for example.

Green Route Option

4.11.12 The green Route Option is located to the west side of the valley with potential access along the existing forestry track. Subject to further investigation, the option may need to incorporate a Debris Flow Shelter similar to the Brown Route Option. Construction of this structure would be easier because of the offline working area.

4.11.13 The viaduct proposed at the northern end of the valley in the Green Route Option crosses a very steep gully which will add to the challenges for construction access detailed above, possibly requiring a solution such as a cable crane to lift in materials and small plant to the foundation locations. If possible, it would be advisable to avoid major piling works at the areas to reduce the amount of heavy plant required to construct.

4.11.14 At the northern tie in, there will be a significant impact to the Rest and Be Thankful car park to construct the new cutting through the hillside, requiring closure to the public. This could present an opportunity to use the area as a compound for construction at the northern end.

4.11.15 At the southern end of the route, the viaduct is constructed offline at the abutments although the proximity to the existing A83 Trunk Road will mean construction space will need to be managed carefully to maintain segregation of the works. The existing landscape is also rocky and will require a notable amount of work to provide suitable access for construction plant.

4.11.16 Where the viaduct crosses the A83 Trunk Road, there will need to be some road closures with diversions onto the OMR to construct the bridge deck. The piers will need to be located so as to provide sufficient offset from the road to allow construction with minimal impact to the A83 Trunk Road.

4.11.17 There is potential for impacts to construction activities from flooding of Croe Water, particularly relating to the construction of the piers on the southern viaduct, where flooding could affect the foundation works and available areas to situate plant. Piers would be advised to be located out of the flood zone where practicable to achieve and some work could be carried out seasonally to reduce risk. There may also be a need to build up a suitable working platform to raise the ground level above the flood risk level.

4.11.18 The river may also mean that a temporary haul road bridge is required to enable crossing by plant and vehicles from the south end.

4.11.19 Substantial tree clearance will be required for construction of the route compared to the other proposed options.

General Considerations

4.11.20 At tie in locations in general, it would be advisable to align the road so the it transitions offline at existing road level before changing levels or crossing a new structure, providing sufficient space to construct without disruption to the existing A83 Trunk Road.

4.11.21 Many of the options in this route corridor are constructed within the existing debris flow zone which presents a potential hazard for the workforce during construction over a potentially extended period. As a result, and subject to risk assessment, there may be a requirement to provide additional protection to mitigate the hazard and protect the workforce during the construction period.

4.11.22 The valley floor at the southern end offers areas that could be used for main construction compounds and laydown areas to support construction, particularly at the junction with the OMR. Locations would need to be cognisant of flood zones from the watercourse in the base of the valley, but an ideal location might be between the OMR and the A83 Trunk Road.

4.11.23 Construction in the route corridor would require notable amounts of construction traffic on the public roads for earthworks import and removal as well as delivery of materials including major precast bridge elements.

5. Environmental Assessment

5.1 Introduction

5.1.1 The Strategic Environmental Assessment (SEA) has been undertaken as an equivalent of a DMRB Stage 1 Environmental Assessment. In relation to the environmental assessment:

- SEA is a means of systematically assessing the likely impact of a public plan, programme or strategy on the environment. The Environmental Assessment (Scotland) Act 2005 transposes the requirements of the European Community SEA Directive (2001/42/EC). Under the Environmental Assessment (Scotland) Act 2005, those bodies preparing qualifying Scottish plans are required to undertake a SEA of plans that are likely to have significant environmental effects, if implemented.

- The SEA aims to offer greater protection to the environment by ensuring public bodies (in this case, Transport Scotland) and those organisations preparing plans of a 'public character' consider and address the likely significant environmental effects. The SEA also offers a foundation for future DMRB stages of a project assisting an environmentally led design.

5.1.2 The SEA Directive topics, to be considered at all SEA stages, are listed below in **Table** 5.1 in relation to the topics listed in Highways England *et al*. (2019).[1]

Table 5.1: SEA topics / DMRB environmental topics

SEA Topic	DMRB Equivalent Topic, as listed in LA101
Climatic Factors	Climate
Air Quality	Air
Population and Human Health	Population and Human Health
Material Assets	Material Assets, Land
Water	Water
Biodiversity, Fauna and Flora	Biodiversity
Soil	Soil
Cultural Heritage	Cultural Heritage
Landscape and Visual Amenity	Landscape

[1] Highways England, Transport Scotland, Welsh Government, Department for Infrastructure (2019) LA 101 Introduction to environmental assessment. Available from https://www.standardsforhighways.co.uk/prod/attachments/54b0eb69-fd65-4fa5-a86b-7313f70b3649?inline=true [Accessed 23 March 2021].

5.1.3 The SEA also describes the interaction between these topics, and potential cumulative effects from the project alone and acting in combination with other plans and projects.

5.2 General Principles and Environmental Approach

5.2.1 Following confirmation through a screening process that an SEA would be undertaken, the next stage in the process was scoping. The purpose of the scoping stage was to describe the environmental context, by establishing the relevant baseline information, reviewing other relevant PPS and identifying environmental problems and opportunities. The scoping stage was informed by environmental workshops and engagement.

5.2.2 The Scoping Report was intended to provide sufficient information about the Access to Argyll and Bute (A83) project and its potential environmental effects to allow the Consultation Authorities to provide an informed view regarding the environmental topics to be included in the SEA. The Scoping Report also provided a proposed methodology to be used for assessing these potential environmental effects.

5.2.3 The study area for the SEA Scoping Report included the 11 original route corridor options which have undergone Preliminary Assessment, before four additional route corridors were added through the public consultation process. After scoping, the next stage of the SEA was the Environmental Report stage. Following the identification of a preferred route corridor, the study area for the SEA Environmental Report was reduced to the 2km wide area for Route Corridor 1 which is the preferred route corridor.

5.2.4 For the Environmental Report stage of the SEA, a desk-based assessment approach was used for all SEA topics (stated above in paragraph 5.1.2 / Table 5.1). This focussed on the 2km route corridor area, based on the SEA Objectives (Table 5.2) and scoring criteria set out in Table 5.3.

5.2.5 The baseline and assessment for the SEA was supported by the use of ProjectMapper, a Geographic Information Systems (GIS) tool developed by Jacobs. This is an interactive mapping tool which shows a wide range of environmental constraints, such as designated and undesignated sites, in relation to the preferred route corridor.

Table 5.2: SEA Objectives for each SEA topic

SEA Topic	SEA Objective
Climatic Factors	Reduce emissions from Scotland's transport sector by reducing the need to travel and encouraging modal shift and help meet Scotland's wider targets to reduce greenhouse gas emissions.
	Adapt the transport network to the predicted effects of climate change.
Air Quality	Reduce all forms of transport-related air pollution and improve air quality.
Population and Human Health	Improve quality of life and human health and increase sustainable access to essential services, employment, recreation and the natural environment.
	Reduce noise and vibration associated with the transport network.
	Promote, invest in, build and maintain infrastructure to support the development of high-quality places.

SEA Topic	SEA Objective
	Improve safety on the transport network.
Material Assets	Promote and improve the sustainable use of the transport network.
	Reduce use of natural resources.
Water Environment	Protect, maintain and improve the quality of water bodies, wetlands and the marine environment from any direct or indirect impacts from the project, and protect against the risk of flooding.
Biodiversity, Fauna and Flora	Protect, maintain and enhance biodiversity and ecosystem services, avoiding damage to or loss of designated and undesignated wildlife or geological sites.
Soil	Safeguard and improve soil quality in Scotland, particularly high value agricultural land and carbon-rich soil.
Cultural Heritage	Protect and enhance (where appropriate) cultural heritage resources and their settings.
Landscape and Visual Amenity	Safeguard and enhance the character and diversity of the Scottish landscape, areas of valuable landscape.

5.2.6 The SEA used colour-coded Red Amber Green (RAG) scoring to categorise the likely environmental impacts and this is shown in Table 5.3.

Table 5.3: Assessment Scoring Criteria for the Preferred Route Corridor and its Possible Route Options

Score	Description	Colour Coding and Symbol
Minor positive effect	The route corridor* has potential for positive environmental effects, for example by providing opportunities for enhancement.	+
Minor negative or uncertain effect	The route corridor* has potential for a minor negative or uncertain environmental effect.	-
Significant negative effect	The route corridor* has potential for significant negative environmental effects.	--
*Or possible route option within it		

5.3 Key Findings Identified by the Strategic Environmental Assessment

5.3.1 This section sets out the key findings identified by the SEA, with environmental constraints and opportunities identified for each of the key topics discussed in paragraph 5.1.2. The main Environmental Report of the SEA includes a more detailed narrative on the assessment methodology, key findings and proposed mitigation, monitoring and enhancement recommendations.

5.3.2 Table 5.4 discusses the key findings for each SEA topic and states the effect duration and scoring as shown in Table 5.3.

Table 5.4: Summary of Key findings for SEA topics

SEA Topic	Key Findings – Environmental Constraints and Opportunities
Climatic Factors	▪ Loss of forestry and peat lands during construction and operation has the potential for permanent, minor negative or uncertain effects on Climate. Manufacture of materials and construction activities would release emissions which would add the atmospheric concentration of greenhouse gases. Mitigation could be successful in carbon off-setting but this would be considered in further assessment. ▪ Construction of the project would improve the resilience of the A83 Trunk Road to the anticipated impacts of climate change and reduce the need for closures during adverse weather, resulting in long-term, minor positive effects during operation.
Air Quality	▪ There is potential for a future increase in traffic volumes during operation of the project, as a result of improved connectivity and resilience, though this is unlikely to have a significant effect on air quality in the route corridor and in the Argyll and Bute region as a whole. ▪ There are opportunities for improvements to green infrastructure as a result of the project, though any effects this would have on air quality would be unlikely to be significant. ▪ There is potential for short-term, minor negative air quality effects during construction where works occur in close proximity to sensitive receptors. However, these effects would be largely mitigated through construction best practice. During operation a minor negative or uncertain effect is anticipated.
Population and Human Health	▪ There is potential for a slight increase in traffic levels during operation of the project, which could result in an increase in noise and vibration and air quality effects at a localised level. ▪ It is expected that the project would generally improve quality of life and increase sustainable access to essential services, employment and the natural environment within the route corridor through improved resilience of the A83 Trunk Road, more reliable and frequent public transport services, and the provision of enhanced Non-Motorised User (NMU) and parking facilities, including linkages to walking and cycling routes and core paths. ▪ It is also anticipated that the route corridor would generally improve connectivity between the central belt and Argyll and Bute, and it is expected that it would provide greater accessibility to active travel routes, including the Loch Lomond and The Trossachs National Park core path network in and around the area, and hill walking routes such as The Cobbler. ▪ There is potential that the project could result in short-term, negative effects on air quality and noise and vibration for local residents resulting from traffic and activities associated with construction works. Short-term negative effects on access to and the amenity of NMU facilities within the route corridor could also result from increases in noise levels, dust and

SEA Topic	Key Findings – Environmental Constraints and Opportunities
	emissions and temporary changes to views during the construction phase. However, through the implementation of best practice methods, it is not anticipated that these effects would be significant. ▪ During operation a permanent, minor positive effect is anticipated on population and human health.
Material Assets	▪ Loss of forestry and peat during construction and operation has the potential for permanent, long-term, minor negative or uncertain effects on natural material assets. Land-use within the route corridor would change as a result of the project. The scale of these effects would be determined by the footprint of the project and the success of mitigation. ▪ Construction of the project would consume energy and finite resources, as well as generate demolition and construction waste, resulting in long-term, minor negative or uncertain effects on built material assets. ▪ Provision of resilient infrastructure would positively contribute towards adapting the road network to climate change impacts, resulting in a permanent, minor positive effect on built material assets.
Biodiversity, Fauna and Flora	▪ There is potential for significant negative effects on designated sites during construction, as a result of disturbance and generation of dust and airborne pollutants from construction activities. Negative effects as a result of habitat loss or alteration during construction and operation could also occur. Refinement of the project design and implementation of appropriate mitigation could reduce these effects, but it is not possible to determine whether all negative effects can be mitigated. ▪ There is potential for minor negative and significant negative effects on habitats and species of conservation interest as a result of habitat loss or alteration during construction and operation of the project. Refinement of the project design and implementation of appropriate mitigation could reduce these effects, but it is not possible to determine whether all negative effects can be mitigated. Minor negative and significant negative effects as a result of construction activities are expected to be reduced through implementation of best practice construction methods and typical mitigation methods. ▪ There may be opportunities for improving biodiversity in the long-term, with adoption of the principle of Biodiversity Net Gain throughout the project lifecycle to ensure compliance with government policy and DMRB guidance. The project should seek to minimise overall land-take and ensure permeability for wildlife.
Water Environment	▪ There is potential for negative effects on surface water bodies during construction and operation of the project, as a result in changes to their water quality or hydromorphology. Through the implementation of appropriate mitigation, it is considered unlikely these effects will be significant However at this stage it is not possible to determine whether all negative effects on hydromorphology can be mitigated. ▪ Effects on groundwater bodies are dependent on existing groundwater levels, which are not known at this stage. There is potential for negative effects on groundwater bodies during construction and operation of the project due to potential changes in groundwater quality, flow direction or levels. These effects will likely be localised and temporary in nature during construction, however there is potential for longer term effects during the operation, dependent on the design of the project.

SEA Topic	Key Findings – Environmental Constraints and Opportunities
	▪ There is potential for the project to have negative effects on flood risk to not only existing receptors, but also to the construction site or carriageway during operation. It is anticipated any negative effects will be addressed through appropriate mitigation and are unlikely to be significant. ▪ Opportunities may exist to improve the water quality in surface water and groundwater bodies, through upgrading existing drainage networks in line with current standards. There may also be opportunities to improve channel hydromorphology where watercourses have existing modifications and reduce the likelihood of fluvial flood risk through upgrading watercourse crossings with insufficient capacity in line with current design standards.
Soils	▪ There is potential for the project to result in reversible and irreversible, minor negative or uncertain effect on soils. This recognises the potential irreversible loss and disturbance of superficial and bedrock geology and the potential irreversible sealing of and reversible medium-term disturbance (loss of organic matter, change in soil biodiversity, contamination, compaction and structural degradation) to soils (including carbon-rich soils), peat, land capable of use for agriculture and land capable of use for forestry. ▪ Mitigation and enhancement opportunities have been identified where possible for the project that have the potential to reduce the effect on soils. These include reducing irreversible soil sealing through design development, reducing reversible disturbance of peat and carbon-rich soils through development of a Peat Management Plan, and considering opportunities for peatland habitat restoration and enhancement.
Cultural Heritage	▪ No positive or significant negative effects on cultural heritage have been predicted as a result of the construction and operation of any of the possible route options. Minor negative or uncertain effects on cultural heritage were predicted. ▪ There is potential for construction of all five possible route options to physically alter the setting of the 'Rest and Be Thankful' Stone during construction, including construction activities associated with the Rest and Be Thankful car park. There will also be a potential change to its setting during operation, due to the presence of new infrastructure. ▪ The Green, Purple and Yellow Route Options, which are generally offline from the existing A83 Trunk Road, may require more new land-take. They would therefore have a higher potential to impact on cultural heritage, in comparison to the Pink Route Option, which is largely proposed to be within a tunnel, or the Brown Route Option which is generally on the line of the existing A83 Trunk Road.
Landscape and Visual Amenity	▪ There is potential for significant negative effects on the Special Landscape Qualities of the Loch Lomond and The Trossachs National Park (LLTNP), the LLTNP core wildness areas around the summits of The Cobbler and Beinn Luibhean, the Upland Glens and Highland Summits Landscape Character Types and local landscape elements and features such as Loch Restil, woodland, forestry and distinct landform. ▪ There is also potential for significant negative effects on residential receptors, the Rest and Be Thankful viewpoint, nearby hill walking routes, core paths and the Old Military Road. ▪ There is potential for minor negative or uncertain, or positive effects on the people travelling along the Argyll Coastal Route within the route corridor, depending on the route alignment and design of structures.

SEA Topic	Key Findings – Environmental Constraints and Opportunities
	▪ There is potential for delivering high-quality design and placemaking within the route corridor, although the details cannot be confirmed at this stage.

5.3.3 The key constraints and opportunities are identified for the SEA topics in Table 5.4. The SEA has reported the following topics have no significant effects at SEA level:

- Climatic Factors;
- Air Quality;
- Population and Human Health;
- Soils; and
- Cultural Heritage.

5.3.4 The SEA reported that there would be likely significant (negative) environmental effects in the following SEA topics and sub-topics :

- Biodiversity, Fauna and Flora (designated sites, other habitats, species of conservation interest);
- Water Environment (hydrogeology, hydromorphology); and
- Landscape and Visual Amenity (National Park, various landscape and visual receptors, including landscape character and viewpoints).

5.3.5 The effects identified are at a strategic level and it is expected that through design development and mitigation measures at subsequent DMRB assessment stages it would be possible to reduce these effects. The SEA also identified a number of key opportunities, under the following general themes:

- Decarbonise construction, through innovation in design, procurement and construction methods;
- Promote active travel;
- Provide green infrastructure;
- Improve road safety;
- Promote positive effects for biodiversity;
- Improve watercourse hydromorphology;
- Reduce the likelihood of fluvial flood risk; and
- Design viaducts and other structures to fit in with the local environment and contribute to placemaking

5.3.6 Further detail on the SEA, including the findings and opportunities, is provided in the main Environmental Report of the SEA and the SEA digital non-technical summary.

6. Traffic and Economic Assessment

6.1 Introduction

6.1.1 The A83 Trunk Road is a key route providing access to the rural parts of Argyll and Bute, including the Cowal and Kintyre peninsulas. An assessment of baseline traffic conditions for the route is reported in Chapter 2 of this report. The A83 Trunk Road is the main transport link in Kintyre, carrying goods, traffic and public transport services to/from and between the peninsula's main settlements, including Lochgilphead, Tarbert and Campbeltown. The A83 Trunk Road also links to ferry services to Islay and Jura from Kennacraig.

6.1.2 The A83 Trunk Road is also a key route for tourism in Argyll and Bute, an industry which is worth in the region of £300m to the Argyll and Bute economy each year. The road provides access to Inveraray Castle, one of the region's foremost tourist attractions.

6.1.3 Network resilience is a key issue in the corridor, the A83 Trunk Road being one of only two strategic east west links in the region. As a result of the region's geography, closures due to landslides are a key issue, particularly at the Rest and Be Thankful, to the north of the corridor. Closures of the route result in severance impacts and lengthy diversions for communities, visitors and businesses along the route at a substantial cost to the local economy.

6.1.4 Traffic data for 2019 collected at the permanent traffic count sites of Transport Scotland's National Traffic Database System (NTDS) indicates that Average Annual Daily Traffic (AADT) is highest at the north-east section of the A83 Trunk Road, with traffic flows in the region of 4,400 vehicles per day recorded near the junction with the A82 Trunk Road at Tarbet. Travelling south along the A83 Trunk Road traffic flows gradually decrease to levels in the region of 2,300 vehicles per day at its south-west end. In some locations, local traffic adds to these volumes as the road passes near settlements. Higher traffic levels are observed in the summer months, during the main tourist season. In August, the busiest month, traffic flows exceeded AADT by between 12% and 25%, depending on location.

6.1.5 At the Rest and Be Thankful, the HGV percentage is around 9%, suggesting that, on average, around 400 HGVs pass through Glen Croe, on a daily basis. Additionally, around 17% of average daily traffic in 2019, on the A83 within Glen Croe (approximately 800 vehicles) was a light goods vehicle. Approximately 100 buses and coaches per day passed through Glen Croe via the A83 Trunk Road, in 2019.

6.1.6 This chapter outlines likely future traffic conditions along the corridor, and provides a brief discussion of the benefits to result from delivering upgraded road infrastructure to address the transport issues affecting network performance on the A83 Trunk Road at the Rest and Be Thankful. A high-level analysis of economic benefits is provided, based on the assumption that the corridor will be improved through implementation of one of the possible route options introduced in Chapter 3.

6.2 Future Traffic Growth

6.2.1 Based on observed traffic trends in recent years (2015 – 19), reported in Chapter 2 of this report, traffic growth in the A83 Trunk Road corridor has been relatively modest, with annual increases in traffic levels of 2% at most.

6.2.2 Future growth has been examined based on traffic forecasts from the Transport Model for Scotland (TMfS18). Traffic growth estimates have been derived for the period between 2019, the most recent year when traffic count data was available and 2030, the prospective opening year for the scheme. Growth to 2045, the design year have also been estimated.

6.2.3 It should be noted that 2045 is beyond the last forecast year assessed by the currently available TMfS18 forecast, which has a final forecast year of 2042. Annual traffic growth for the years between 2042 and 2045 has therefore been estimated based on compound annual growth calculated from the last two modelled years in TMfS18, 2037 and 2042.

6.2.4 Forecast traffic growth for a range of locations in the A83 Trunk Road corridor is shown in Table 6.1.

Table 6.1: Modelled Traffic Growth, 2019 to Opening Year (2030) and Design Year (2045), Source: TMfS18

Location	Traffic Growth (2019-2030)	Traffic Growth (2019-2045)
Tarbet to Arrochar	10%	16%
A83 Rest and Be Thankful	10%	19%
A815 local road to Inveraray	5%	7%
Inveraray to Lochgilphead	9%	12%
Lochgilphead to Tarbert	6%	10%
Tarbert to Kennacraig	4%	12%

6.2.5 As shown in Table 6.1 traffic levels are expected to increase along the route, by 4-10% over the period 2019-2030 and 7-19% over the period 2019-2045, depending on geographic location. It should be noted that TMfS18 substantially under-represents base traffic levels in the A83 Trunk Road corridor and that there is therefore some doubt around the robustness of these forecasts.

6.3 Effects of Improvement Strategies

6.3.1 The possible route options assessed concentrate on the preferred route corridor through Glen Croe. In the subsequent sections, impacts are outlined in broad terms. Further design detail will be added as improvement options are developed further during Stage 2 of the DMRB assessment process. Possible wider consideration of measures that may be considered in the wider network would form part of future scheme developments.

Impacts on Safety

6.3.2 Improvement options may result in minor reductions in transport related casualties due to the upgrade of the road to modern single carriageway standards. Moreover, the improvement strategies would be targeted at reducing the impact of closures due to landslides. As a result, they are likely to reduce additional vehicle km on lower standard roads, and hence transport related casualties, incurred due to the additional travel distances associated with available diversionary routes.

Impacts on Resilience

6.3.3 Improving network resilience through reducing road closures due to incidents, including landslides, is a key objective for improvements in the A83 Trunk Road corridor. Due to the close proximity of the Old Military Road (OMR), the diversionary route used during closures of the A83 Trunk Road at the Rest and Be Thankful, landslides in this location often impact on both roads.

6.3.4 Lack of route choice in the area, means that when both the A83 Trunk Road and the OMR are closed, the nearest available east-west connection requires diverting from the A83 Trunk Road between Tarbet and Inveraray via the A82 Trunk Road, A85 Trunk Road and A819 local road. The length and journey time of the diversion depends on the destination. If the traveller is going to Inveraray, or destinations to the west, the diversion is approximately an additional 30 minutes (25 miles). If, however, the traveller is accessing the Cowal peninsula via the A815, the diversion adds approximately 60 minutes (47 miles) to the journey.

6.3.5 Even when the OMR is unaffected, this route is a single track access and convoy working is required to manage the traffic that would normally use the A83 Trunk Road, resulting in delays to journeys.

6.3.6 The improvements would therefore result in greater network resilience, though will not introduce significant journey time or distance savings during normal operation, when the A83 is fully open to traffic in both directions.

6.4 Economics

6.4.1 This section presents a high level cost benefit analysis for improvement within the preferred route corridor, Glen Croe. The analysis is based on the assumption that under normal unimpeded operation of the A83, traffic flows, journey times and vehicle operating costs in the corridor will remain largely unchanged compared with a Do Nothing scenario, so the scheme does not provide significant benefit under this measure. Benefits were derived from improved resilience, i.e. from the journey times and vehicle operating cost savings made through eliminating road closures in this location, and hence the need to re-route traffic using the road.

6.4.2 Within Chapter 2 of this report, historic closures due to landslides affecting the A83 Trunk Road at the Rest and Be Thankful are outlined. The information presented in that section highlighted a high degree of variability both in the number of days the A83 Trunk Road at the Rest and Be Thankful was closed each year and in the proportion of such closure events when disruption caused by landslides also extended to the OMR, necessitating traffic to re-route via the A82 Trunk Road, A85 Trunk Road and A819 local road.

6.4.3 No sound analysis forecasting future closures, through assessing ground conditions and the resilience of the existing asset is available at present. Based on data on historic closures, the three scenarios reflecting different closure assumptions were therefore developed to account for the aforementioned variability. The scenarios are summarised in Table 6.2.

Table 6.2: A83 Trunk Road at the Rest and Be Thankful Closure Scenarios

	Description	A83 Trunk Road Closure	A83 Trunk Road & OMR Closure	A83 Trunk Road Closure but OMR Open
Scenario 1	Average number of days of closure per year over a five year period (2015-2019)	3	2	1
Scenario 2	Average number of days of closure per year over a ten year period (2010-2019)	4	2	2
Scenario 3	Total number of days of closure during 2020	112	13	99

6.4.4 Monetised benefits associated with each scenario were estimated using the following assumptions:

- The opening year is 2030;
- Traffic levels for each year during the assessment period were calculated based on observed AADT on the A83 Trunk Road at the Rest and Be Thankful in the TMfS18 base year, i.e. 4,300 vehicles per day under the application of growth factors derived from TMfS18 projected traffic growth. For years after the last modelled year (2042) traffic was assumed to remain constant.

- Journey times for the A83 Trunk Road, and existing diversion routes via either the A82 Trunk Road, A85Trunk Road and A819 local road route, or the route which uses the OMR were extracted from Google maps. It was assumed that journey times remain unchanged during the 60 year assessment period.
- All other parameters required for the analysis, including economic trip purpose proportions, values of time and fuel cost parameters were extracted from the TAG databook v1.14 (July 2020).
- Quantified safety benefits from the reduction in diversions are not included. These will be in the range of negligible to extremely minor.

6.4.5 In line with guidance, all costs and benefits are expressed in 2010 values and prices, allowing a consistent comparison to be made.

6.4.6 The estimated present value of benefits accrued through avoidance of closures at the A83 Trunk Road at the Rest and Be Thankful for each scenario is shown in Table 6.3.

Table 6.3: A83 Rest and Be Thankful : Indicative Present Value of Resilience Benefits

Scenario	PVB (£2010m)
Scenario 1	2.8
Scenario 2	3.0
Scenario 3	44.4

6.4.7 Scheme cost estimates have been prepared for a range of possible route options in the preferred route corridor, in order to reflect the uncertainties regarding the final form of the preferred option at this early stage of the process. These were presented in Chapter 3. High and low estimates for the scheme costs have been included in £171m and £549m (2010 values and prices).£171m and £549m (2010 values and prices).

6.4.8 Table 6.4, with an adjustment for forecast construction price inflation, conversion into 2010 prices, and discounting to 2010 values. The present value of the cost of implementing the possible route options in the preferred route corridor has been estimated to fall in the range between £171m and £549m (2010 values and prices).

Table 6.4: A83 Rest and Be Thankful : Scheme Cost Estimates

	PVC (£2010m)
Low Costs Scenario	171.3
High Costs Scenario	549.3

6.4.9 An indicative Value for Money assessment has been carried out based on the scheme costs and benefit estimates outlined above. The results of this assessment are summarised in Table 6.5.

6.4.10 It should be noted that these results are highly indicative, and that more robust forecasting of future closures, taking into account ground conditions and the resilience of the existing asset and diversionary route is required to confirm these results. Moreover, the results presented in Table 6.5 do not account for the costs incurred to maintain the existing asset including the cost of mitigation and repairs associated with landslide events.

Table 6.5: A83 Rest and Be Thankful : Indicative Economic Results [1]

Item	Value (£2010m)
Present Value of Resilience Benefits	2.8 – 44.4
Total Present Value of Benefits	2.8 – 44.4
Present Value of Costs (PVC)	171.3-549.3
Benefit to Cost Ratio (BCR)	0.01-0.26

6.5 Wider Economic Impacts

6.5.1 As a result of the enhanced resilience provided through mitigating landslide induced closures and, subsequently, increased business confidence and associated inward investment, the possible route options within the preferred route corridor have the potential to provide a positive contribution towards wider economic impacts within the wider Argyll & Bute region. The level of benefits associated with enhanced resilience are dependent, however, on the level of future closures that would otherwise be required.

6.5.2 The level of disruption caused by the major landslides occurring at the Rest and Be Thankful, in 2020, is estimated to cost the economy of Argyll & Bute, and its residents, over £2m[3], on an annualised basis. While the largest impacts are likely to have been felt by the Kintyre Peninsula, particularly for the road haulage industry, impacts in the tourism sector, and by commuters, are likely to have been experienced in areas such as Inveraray. Improvements at the Rest and Be Thankful, therefore, could make a substantial contribution to the acceptability of working arrangements that require commuting via the A83 Trunk Road. They could also substantially reduce the costs to business that are intensive users of the route.

6.5.3 Wider economic impacts will be considered further at DMRB Stage 2.

[1] Since current timetables varied from normal service provision due to the impact of the COVID-19 pandemic, bus frequencies have been extracted from historic Traveline data. Since the Traveline FTP site does not retain historic data, this was taken from FTP data for September 2018, which was available from the development of Transport Model for Scotland. Journey time data is taken from travelinescotland.com and traveline.info.

[3] Costs in 2018 Prices

7. Risk

7.1 Introduction

7.1.1 Summarised below are key challenges and risks associated with constructing a route through the preferred route corridor and how they will need to be managed.

7.2 Challenges and Risks

7.2.1 There are a range of challenges and risks in providing a route within Glen Croe. Some of these occur regularly on major road projects, including those that have been previously delivered by Transport Scotland, whilst others are specific to this project due to the nature of the preferred route corridor and possible route options.

7.2.2 Challenges and risks similar to those seen on major road projects include:

- Construction on steep sections of hillside which could present some challenges for plant access, requiring significant temporary works solutions.
- Ground conditions including those affecting possible route options that involve structures, tunnels and major earthworks.
- Flood risks from surface water flows and from the Croe Water.
- Pollution impacts during construction and operation on watercourses including the Croe Water and Loch Restil.
- Ecological impacts, mainly relating to the Beinn an Lochan SSSI which lies to the west of the A83 Trunk Road at the Rest and Be Thankful car park and Loch Restil and also due to the Glen Etive and Glen Fyne Special Protection Area which lies to the north of the preferred route corridor.
- Managing impacts on the landscape of the Loch Lomond and The Trossachs National Park due to the proposed scheme.
- Addressing impact on privately owned land and property.
- Cost effectiveness of the proposed scheme due to the need for various structures and geotechnical measures within the different possible route options.

7.2.3 Challenges and risks specific to this project include:

- Addressing the risk posed by landslide, debris flow and boulder fall hazards (landslide used as a generic term hereafter) which may affect the design, construction and operation of the proposed scheme.
- Addressing the wider landslide and debris flow hazard along the existing A83 Trunk Road, particularly between Tarbet and Inveraray which may affect future route resilience.
- Construction of a route within the corridor at the same time as the existing A83 Trunk Road or OMR are being used by trunk road traffic and whilst continued maintenance and resilience work on these roads may be ongoing.
- Topography within the corridor which includes sidelong ground within Glen Croe and a significant difference in level between the foot of Glen Croe and the Rest and Be Thankful car park of over 160m that affects the design standards of the possible route options.
- Tunnel standards and safety for options including tunnels.

7.3 Risk Management

7.3.1 Route option development and selection of the preferred route will give detailed consideration to these challenges and risks, including following Transport Scotland's Value for Money and Risk governance procedures. For any risks identified, the route selection process will give full consideration to the degree to which the different route options address the various challenges and risks to ensure the preferred route option is deliverable.

7.3.2 Management of risks that are similar to those seen on other major road projects has been achieved to ensure successful project delivery by employing normal design and risk management procedures practice that would also apply on this project, including:

- Construction challenges requiring significant temporary works solutions – managed through construction planning as part of scheme development.
- Ground conditions – managed through ground investigation, design and certification procedures, as is normal practice.
- Flood risks – managed through flood model development and overland flow assessments to ensure the scheme design addresses flood risk.
- Run-off and pollution of existing watercourses – addressed through scheme design and construction planning.
- Ecological impacts – managed with ecological surveys and assessments informing scheme design and construction.
- Landscape impacts within the Loch Lomond and The Trossachs National Park – managed through landscape and visual surveys and assessments informing scheme design, and consultation with the National Park Authority and Environmental Steering Group formed for the project.
- Compulsory acquisition of private land – managed by ensuring the minimum land necessary is identified and that the landowner's continued use of their remaining land within the glen is possible. Sensitive engagement with the main landowner who owns the majority of the Old Military Road will be undertaken.
- Scheme costs – managed through normal design and value engineering procedures, with scrutiny of costs in line with Transport Scotland's governance procedures.

7.3.3 The ability to manage risks specific to this project has been a key consideration in scheme development and the preferred corridor recommendation. This includes:

- Landslide hazard – this will affect the possible route options in different ways depending on their location within Glen Croe. Various solutions are deliverable and will be assessed as part of route option development. This may include option routing, structures such as viaducts, debris flow shelters, or geotechnical measures. Risks are more significant on the Brown and Yellow Route Options, although landslide hazards are also present on the south side of Glen Croe where the Green Route Option is located and debris flows can extend, albeit less significantly, into Glen Croe. For the Purple and Pink Route Options, landslide hazard would only affect the siting of tunnel portals and any intermediate shafts.
- Landslide risk affecting construction – will also affect the possible route options in different ways depending on their location within Glen Croe. Various solutions are deliverable through construction phasing and temporary works/protection measures. Construction planning as part of scheme development will consider the extent measures that may be necessary to facilitate safe construction and protection of the works.

- Landslide hazard along wider extents of the existing A83 Trunk Road between Tarbet and Inveraray – will be managed by building on previous work by the Trunk Road Operating Company to set out any measures necessary as part of the routine network management strategies.

8. Conclusions

8.1.1 The outcome of the Preliminary Assessment and the baseline information, scheme development and assessment described in this report have identified a range of possible route options for the project within the preferred route corridor and numerous engineering and environmental constraints, challenges, risks and opportunities.

8.1.2 The possible route options include:

- Green Route Option - an offline route which looks to position a new section of single carriageway road, likely including sections of open cut/fill, structures and geotechnical measures, on the western side of Glen Croe, opposite the existing A83 Trunk Road. The approximate total length of the option is 4.4km.
- Yellow Route Option - an offline route which looks to position a new section of single carriageway road, predominantly on viaduct, between the OMR and A83 Trunk Road on the lower eastern slope of the glen. The approximate total length of the option is 2.1km.
- Brown Route Option – a predominately online route which looks to introduce a debris flow shelter over the alignment of the existing A83 Trunk Road, with a short offline section of viaduct at the northern end. The approximate total length of the option is 1.3km.
- Purple Route Option – an offline route which looks to use a combination of cut/fill road through Glen Croe and a tunnel from High Glencroe to north of Loch Restil. A length of this option in Glen Croe on approach to the tunnel portal may either be on embankment or viaduct subject to further design development and assessment. The approximate total length of the option is 3.2km.
- Pink Route Option – an offline option which looks to introduce a tunnel south of Croe Water to north of Loch Restil. The approximate total length of the option is 4.1km.

8.1.3 Challenges and risks associated with providing a route within the preferred route corridor include:

- Generally steep topography, which is susceptible to landslides;
- Numerous watercourse crossings, with Croe Water experiencing regular flood events;
- Tie-in to the existing alignment of the A83 Trunk Road and northern and southern extents of route, including horizontal and vertical alignment, and continuation of A83 Trunk Road traffic during construction;
- Requirement for geotechnical and structural solutions potentially including viaducts, rock cuttings, debris flow shelters, retaining walls and tunnels;
- Tunnel portals may be susceptible to geohazards depending on their location; and,
- Viaduct alignment requires careful consideration due to relatively steep vertical geometry anticipated along the length and the impact on pier heights.

8.1.4 The traffic and economic assessment in Chapter 6 describes the challenges posed by the effects that landslides and debris flow events have on the existing A83 Trunk Road in terms of closures in recent times and diversion routes. The cost of these closures in traditional transport economic efficiency terms is significant as indicated by the scenarios examined. The cost of the possible route options is also likely to be significant and as such it is unlikely that the scheme will deliver a positive economic return.

8.1.5 Notwithstanding the challenges and risk, each of the possible route options offers potential to provide a resilient route to address the issues faced by the existing A83 Trunk Road at the Rest and Be Thankful and no options are recommended to be discounted on the basis of the assessments described in this report. The possible route options should therefore be considered for further development and assessment at the DMRB Stage 2 route options assessment, building on the findings of this report to support identifying a preferred route option for the project to provide the long term resilient route within the preferred route corridor.

Appendix A. Figures

Figure Number	Figure Title	BIM Number
Figure 1	ROUTE CORRIDOR 1 OVERVIEW	A83AAB-JAC-GEN-COR_01-DR-CX-0001
Figure 2	Not Used	Not Used
Figure 3A	EXISTING CONDITIONS FOR ROUTE CORRIDOR 1, SHEET 1 0F 8	A83AAB-JAC-GEN-COR_01-DR-CX-0003
Figure 3B	EXISTING CONDITIONS FOR ROUTE CORRIDOR 1, SHEET 2 0F 8	A83AAB-JAC-GEN-COR_01-DR-CX-0004
Figure 3C	EXISTING CONDITIONS FOR ROUTE CORRIDOR 1, SHEET 3 0F 8	A83AAB-JAC-GEN-COR_01-DR-CX-0005
Figure 3D	EXISTING CONDITIONS FOR ROUTE CORRIDOR 1, SHEET 4 0F 8	A83AAB-JAC-GEN-COR_01-DR-CX-0006
Figure 3E	EXISTING CONDITIONS FOR ROUTE CORRIDOR 1, SHEET 5 0F 8	A83AAB-JAC-GEN-COR_01-DR-CX-0007
Figure 3F	EXISTING CONDITIONS FOR ROUTE CORRIDOR 1, SHEET 6 0F 8	A83AAB-JAC-GEN-COR_01-DR-CX-0008
Figure 3G	EXISTING CONDITIONS FOR ROUTE CORRIDOR 1, SHEET 7 0F 8	A83AAB-JAC-GEN-COR_01-DR-CX-0009
Figure 3H	EXISTING CONDITIONS FOR ROUTE CORRIDOR 1, SHEET 8 0F 8	A83AAB-JAC-GEN-COR_01-DR-CX-0010
Figure 4	GLEN CROE ROAD CLOSURE AND ASSOCIATED DIVERSION ROUTE	A83AAB-JAC-GEN-COR_01-DR-CX-0011
Figure 5	BUS AND NMU ROUTES IN AND AROUND ROUTE CORRIDOR 1	A83AAB-JAC-GEN-COR_01-DR-CX-0012
Figure 6	GEOTECHNICAL STUDY AREA	A83AAB-JAC-HGT-COR_01-DR-CE-0001
Figure 7	GEOTECHNICAL STUDY AREA, SLOPE ANGLE	A83AAB-JAC-HGT-COR_01-DR-CE-0002
Figure 8	GEOTECHNICAL STUDY AREA, TERRAIN ZONES	A83AAB-JAC-HGT-COR_01-DR-CE-0003
Figure 9A	GEOTECHNICAL CONSTRAINTS PLAN, SHEET 1 OF 6	A83AAB-JAC-HGT-COR_01-DR-CE-0004
Figure 9B	GEOTECHNICAL CONSTRAINTS PLAN, SHEET 2 OF 6	A83AAB-JAC-HGT-COR_01-DR-CE-0005
Figure 9C	GEOTECHNICAL CONSTRAINTS PLAN, SHEET 3 OF 6	A83AAB-JAC-HGT-COR_01-DR-CE-0006
Figure 9D	GEOTECHNICAL CONSTRAINTS PLAN, SHEET 4 OF 6	A83AAB-JAC-HGT-COR_01-DR-CE-0007
Figure 9E	GEOTECHNICAL CONSTRAINTS PLAN, SHEET 5 OF 6	A83AAB-JAC-HGT-COR_01-DR-CE-0008
Figure 9F	GEOTECHNICAL CONSTRAINTS PLAN, SHEET 6 OF 6	A83AAB-JAC-HGT-COR_01-DR-CE-0009
Figure 9	GEOTECHNICAL CONSTRAINTS PLAN, KEY SHEET	A83AAB-JAC-HGT-COR_01-DR-CE-0010

Appendix B. Drawings

Drawing Title	BIM Number
GREEN ROUTE OPTION, PLAN AND PROFILE, SHEET 1 OF 3	A83AAB-JAC-HML-COR_01-DR-CH-9241
GREEN ROUTE OPTION, PLAN AND PROFILE, SHEET 2 OF 3	A83AAB-JAC-HML-COR_01-DR-CH-9242
GREEN ROUTE OPTION, PLAN AND PROFILE, SHEET 3 OF 3	A83AAB-JAC-HML-COR_01-DR-CH-9243
YELLOW ROUTE OPTION, PLAN AND PROFILE, SHEET 1 OF 2	A83AAB-JAC-HML-COR_01-DR-CH-9251
YELLOW ROUTE OPTION, PLAN AND PROFILE, SHEET 2 OF 2	A83AAB-JAC-HML-COR_01-DR-CH-9252
BROWN ROUTE OPTION, PLAN AND PROFILE, SHEET 1 OF 2	A83AAB-JAC-HML-COR_01-DR-CH-9261
BROWN ROUTE OPTION, PLAN AND PROFILE, SHEET 2 OF 2	A83AAB-JAC-HML-COR_01-DR-CH-9262
PINK ROUTE OPTION, PLAN AND PROFILE, SHEET 1 OF 3	A83AAB-JAC-HML-COR_01-DR-CH-9291
PINK ROUTE OPTION, PLAN AND PROFILE, SHEET 2 OF 3	A83AAB-JAC-HML-COR_01-DR-CH-9292
PINK ROUTE OPTION, PLAN AND PROFILE, SHEET 3 OF 3	A83AAB-JAC-HML-COR_01-DR-CH-9293
PURPLE ROUTE OPTION, PLAN AND PROFILE, SHEET 1 OF 3	A83AAB-JAC-HML-COR_01-DR-CH-9331
PURPLE ROUTE OPTION, PLAN AND PROFILE, SHEET 2 OF 3	A83AAB-JAC-HML-COR_01-DR-CH-9332
PURPLE ROUTE OPTION, PLAN AND PROFILE, SHEET 3 OF 3	A83AAB-JAC-HML-COR_01-DR-CH-9333