4. Engineering Assessment

4.1 Alignment Design Standards

Design Standards

4.1.1 The proposed scheme (Design Manual for Roads and Bridges (DMRB) Stage 3 outline design) has been developed in accordance with current design standards and good practice. Reference is made to relevant sections of the DMRB and other standards within each section of this chapter.

Dual Carriageway Design Standards

4.1.2 The new dual carriageway component of the proposed scheme has been designed in accordance with the following design standards:

- DMRB CD 109 'Highway Link Design' (hereafter referred to as CD 109) (DMRB, 2020c);
- DMRB CD 127 'Cross-sections and headrooms' (hereafter referred to as CD 127) (DMRB, 2021c); and
- DMRB CD 169 'The design of lay-bys, maintenance hardstandings, rest areas, service areas and observation platforms' (hereafter referred to as CD 169) (DMRB, 2022d).

Grade Separated and At-Grade Junction Design Standards

4.1.3 The two grade separated junctions within the proposed scheme have been designed in accordance with DMRB CD 122 'Geometric design of grade separated junctions' (hereafter referred to as CD 122) (DMRB, 2022a).

4.1.4 The three isolated left-in, left-out at-grade junctions connecting onto the proposed A9 within the proposed scheme have been designed in accordance with DMRB CD 123 'Geometric design of at-grade priority and signal-controlled junctions' (hereafter referred to as CD 123) (DMRB, 2021d).

Roundabout Design Standards

4.1.5 There is one at-grade roundabout within the proposed scheme which has been designed in accordance with DMRB CD 116 'Geometric design of roundabouts' (hereafter referred to as CD 116) (DMRB, 2023).

Side Road and Access Track Design Standards

4.1.6 Side roads within the proposed scheme have generally been designed in accordance with CD 109 where they link into the proposed A9 junctions. In other locations, side roads and access tracks have been designed in accordance with the following standards:

- National Roads Development Guide (hereafter referred to as NRDG) (SCOTS, 2015);
- Designing Streets: A Policy Statement for Scotland (Scottish Government, 2010); and
- Transport Scotland's Roads for All: Good Practice Guide for Roads (Transport Scotland,2013).

Lay-by Design Standards

4.1.7 The four lay-bys included within the proposed scheme have been designed in accordance with:

- CD169: The design of lay-bys, maintenance hardstandings, rest areas, service areas and observation platform; and
- Transport Scotland's Roads for All: Good Practice Guide for Roads.

Maintenance Crossovers Standards

4.1.8 The four maintenance crossovers within the proposed scheme have been designed in accordance with DMRB CD 192 'The design of crossovers and changeovers' (hereafter referred to as CD 192) (DMRB, 2020b).

Walking, Wheeling, Cycling and Horse-riding Standards

4.1.9 The facilities for WCH users have been developed and designed in accordance with DMRB CD 143 'Designing for walking, cycling, and horse-riding' (hereafter referred to as CD 143) (DMRB, 2021b). The Scotland National Application Annex to CD 143 for walking, cycling and horse-riding notes that Cycling by Design (Transport Scotland, 2021) and Transport Scotland's Roads for All: Good Practice Guide for Roads should be used for the design of routes and facilities for walking, cycling and shared use.

4.2 Engineering Description – Design Speed Related Parameters

A9 Dual Carriageway

4.2.1 As identified in Paragraph 1.3.2 of Chapter 1, in September 2012, a Preliminary Engineering Services (PES) study for the dualling of the A9 between Perth and Inverness was commissioned by Transport Scotland. The PES commission delivered a route-wide assessment, identifying and collating engineering constraints, issues, risks and opportunities to inform later, more detailed design. The PES Study was undertaken in accordance with the requirements of a DMRB Stage 1 Engineering Assessment, and the output of the PES Study was the A9 Dualling Programme, Preliminary Engineering Services, DMRB Stage 1 Assessment Report (hereafter referred to as the DMRB Stage 1 Assessment Report) (Jacobs, 2014).

4.2.2 A key recommendation of the A9 PES commission was that the proposed A9 should be a Dual 2-lane All Purpose (D2AP) subcategory C (formerly referred to as Category 7A) carriageway in accordance with the CD 109.

4.2.3 As a result, the design speed (which shall be consistent with the anticipated vehicle speeds on the road), for the proposed dual carriageway is 120A kph (70mph). There will be no gaps in the central reserve and no at-grade minor junctions. It is also recommended that grade separated junctions are provided on the route, with isolated left-in, left-out access provided in exceptional circumstances for isolated existing accesses. Use of design standard criteria lower than the "desirable minimum" for the given Design Speed necessitates either a Relaxation or Departure from Standards. Further details for departures can be found in Section 4.10. For all other areas desirable minimum criteria has been achieved.

4.2.4 Geometric design parameters are set out in CD 109. A summary of the desirable minimum standards for a 120kph design speed are shown in Table 4-1.

	Design Speed (kph)	Horizontal Curvature (Radius, m)	Vertical Curvature (K Value)		Stopping Sight Distance (m)
		Desirable Minimum Radius	Desirable Minimum Crest	Desirable Minimum Sag	Desirable Minimum
A9 Mainline	120	1020	182	37	295

Table 4-1: A9 Dual Carriageway Geometric Parameters

4.2.5 The proposed A9 dual carriageway geometry is shown on Drawings A9P02-JAC-HML-D_ML000_ML-DR-RD-0001, A9P02-JAC-HML-D_ML015_ML-DR-RD-0002, A9P02-JAC-HML-D_ML030_ML-DR-RD-0003, A9P02-JAC-HML-D_ML045_ML-DR-RD-0004, A9P02-JAC-HML-D_ML060_ML-DR-RD-0005 and A9P02-JAC-HML-D_ML075_ML-DR-RD-0006 included in Volume 2: Engineering Drawings.

Grade Separated Junctions

4.2.6 Access to and from a D2AP subcategory C dual carriageway should be provided via a full grade separated junction, as detailed in CD 109 Table A.2. The layout of the grade separated junctions on the proposed scheme have been developed in accordance with the DMRB standards listed in Section 4.1 of this report, and have taken consideration of the various local constraints and issues.

4.2.7 There are two grade separated junctions within the proposed scheme; Birnam Junction and Dalguise Junction. Both junctions adhere to the design standards given in CD 109, and CD 122 and summarised in Table 4-2. Use of design standard criteria lower than the desirable minimum necessitates either a Relaxation or Departure from Standards. These standards are only applicable from the back of the diverging connector road nosing to the back of the merging connector road nosing. Mainline dual carriageway parameters become applicable prior to / beyond these points respectively, and side roads parameters become applicable where the connector roads join a side road via a junction.

	Design Speed (kph)	Horizontal Curvature (Radius, m)	Vertical Curvature (K Value)		Stopping Sight Distance (m)
		Desirable Minimum Radius	Desirable Minimum Crest	Desirable Minimum Sag	Desirable Minimum
Birnam Junction					
Northbound Diverge Loop	70	50	30	20	120
Northbound Merge Loop	70	30	30	20	120
Southbound Merge Slip Road	70	360	30	20	120
B867/Perth Road	70	360	30	20	120
Dalguise Junction					
Northbound Diverge Loop	70	50	30	20	120
Northbound Merge Loop	70	30	30	20	120
Southbound Diverge Slip Road	70	360	30	20	120
Southbound Merge Slip Road	70	360	30	20	120
B898	70	360	30	20	120

Table 4-2: Grade Separated Junction Geometric Parameters

4.2.8 The proposed grade separated junctions' geometry is shown on Drawings A9P02-JAC-HML-D_JC01A_JC-DR-RD-0001 and A9P02-JAC-HML-D_JC04A_JC-DR-RD-0001 included in Volume 2: Engineering Drawings.

Roundabout

4.2.9 An at-grade roundabout at Dunkeld is included in the design, resulting from the assessment described in the A9 Dualling Programme: Pass of Birnam to Tay Crossing DMRB Stage 2 Scheme Assessment Report (hereafter referred to as the DMRB Stage 2 Assessment Report) (Jacobs, 2023). The Dunkeld Roundabout should adhere to the design standards given in CD 116 and summarised in Table 4-3. The side roads connecting to the roundabout should adhere to the design standards given in CD 109 and summarised in Table 4-4. Use of design standard criteria lower than the Desirable Minimum necessitates either a Relaxation or Departure from Standards.

	Maximum Inscribed Circle Diameter (m)	Carriageway	Minimum Central Island Diameter (m)	Verge (m)
Dunkeld Junction				
Dunkeld Roundabout	100	3 lanes	4	2.5

Table 4-3: At-grade Roundabout Geometric Parameters

	Design Speed (kph)	Horizontal Curvature (Radius, m)	Vertical Curvature (K Value)		Stopping Sight Distance (m)
		Desirable Minimum Radius	Desirable Minimum Crest	Desirable Minimum Sag	Desirable Minimum
Dunkeld Junction					
A822 (Old Military Road)	85A	510	55	20	160
Unclassified Road (Road to Inver)	70B	360	30	20	120
A923	50A *See Note 1*	180	10	9	70

Table 4-4: Side roads connecting to the at-grade Roundabout Geometric Parameters

Note:

1. *The A923 has posted speed limits of 30mph and a calculated design speed of 70kph. As the road will be adopted back to the posted speed limit, a design speed of 50kph has been used in the design.*

4.2.10 The proposed roundabout geometry is shown on Drawing A9P02-JAC-HML-D_JC02A_JC-DR-RD-0001 in Volume 2: Engineering Drawings.

4.3 Engineering Description – Proposed Cross-section

Cross Sections

4.3.1 The mainline D2AP (Dual 2 lane all-purpose) cross-section was determined by the Scottish Government who committed to a D2AP provision. However, the selection of appropriate carriageway cross-sections at other locations is in accordance with CD 127. This requires predicted traffic flows in the Design Year, which is fifteen years after the assumed first full year of programme operation in accordance with DMRB guidelines.

4.3.2 The forecasted 24 hour, 7-day Annual Average Daily Traffic (AADT) in the Opening Year (2036) and the Design Year (2051) for key roads within the proposed scheme are further discussed in Chapter 5: Traffic and Economic Assessment of this report.

A9 Dual Carriageway

4.3.3 Technical Advice note TA 46/97 'Traffic Flow Ranges for use in Assessment of New Rural Roads' sets out potential carriageway cross-section standards, related to opening year flow ranges, that are most likely to be economically and operationally acceptable. The traffic flow range for a D2AP carriageway is outlined in Table 2.1 of TA 46/97 as an opening year AADT of between 11,000 and 39,000. The opening year traffic flow forecasts on the A9 within the study area, as presented in Chapter 5, fall within this range. The cross-section parameters for the D2AP carriageway can be found in Table 4-5.

	Type of Road	Carriageway Width (m)	Hardstrip / Hardshoulder Width (m)		Minimum Verge Width (m)	Minimum Central Reserve Width (m)
			Nearside	Offside		
A9 Mainline	D2AP	7.3 See Note 1	1.0	1.0	2.5 See Note 2	2.5

Table 4-5: A9 Dual Carriageway Cross-section Parameters (CD 127)

Note:

1. *It should be noted that the 7.3m carriageway width consists of two 3.65m lanes in either direction.*
2. *It should be noted that a minimum verge width of 3m is proposed for the A9. This is to accommodate the necessary road furniture, including road restraint system and filter drains, as well as longitudinal ducts for the intelligent transport system and other communication equipment.*

4.3.4 The proposed A9 dual carriageway layout is shown on Drawings A9P02-JAC-HML-D_ML000_ML-DR-RD-0001, A9P02-JAC-HML-D_ML015_ML-DR-RD-0002, A9P02-JAC-HML-D_ML030_ML-DR-RD-0003, A9P02-JAC-HML-D_ML045_ML-DR-RD-0004, A9P02-JAC-HML-D_ML060_ML-DR-RD-0005 and A9P02-JAC-HML-D_ML075_ML-DR-RD-0006 included in Volume 2: Engineering Drawings.

Grade Separated Junctions

4.3.5 For the grade separated junctions at Birnam and Dalguise, the projected traffic flows on the connector roads were used to determine the cross-section. The available traffic data indicates, in accordance with CD 122, that a single lane carriageway with nearside hardshoulder should be used for both diverge and merge interchange links and slip roads. Therefore, as defined within CD 127, a DG1C cross-section has been chosen for diverge slip roads and a MG1C for the merge slip roads for Birnam Junction and Dalguise Junction. Details for all cross-sections are detailed in Table 4-6.

	Type of Road	Carriageway Width (m)	Hardstrip / Hardshoulder Width (m)		Minimum Verge Width (m)	Minimum Central Reserve Width (m)
			Nearside	Offside		
Birnam Junction						
Northbound Diverge Loop	DG1C	3.7	3.3	0.7	2.0 (Nearside) 2.8 (Offside)	N/A
Northbound Merge Loop	MG1C	3.7	3.3	0.7	2.0 (Nearside) 2.8 (Offside)	N/A
Southbound Merge Slip	MG1C	3.7	3.3	0.7	2.0 (Nearside) 2.8 (Offside)	N/A
B867/Perth Road	S2	6 *See Note 1*	1.0	N/A	2.5	N/A
Dalguise Junction						
Northbound Diverge Loop	DG1C	3.7	3.3	0.7	2.0 (Nearside) 2.8 (Offside)	N/A
Northbound Merge Loop	MG1C	3.7	3.3	0.7	2.0 (Nearside) 2.8 (Offside)	N/A
Southbound Diverge Slip Road	DG1C	3.7	3.3	0.7	2.0 (Nearside) 2.8 (Offside)	N/A
Southbound Merge Slip Road	MG1C	3.7	3.3	0.7	2.0 (Nearside) 2.8 (Offside)	N/A
B898	S2	6 *See Note 1*	1.0	N/A	2.5	N/A

Table 4-6: Grade Separated Junction Cross-section Parameters (CD 127)

Note:

1. *On side roads with a traffic flow of 5,000 AADT or less, carriageway widths have been set to 6m with 1m hardstrips in order to provide a better tie-in to the existing carriageway widths on the local side road network, as permitted within the CD 127 Clause S/1.1.*

4.3.6 The proposed grade separated junction layouts are shown on Drawings A9P02-JAC-HML-D_JC01A_JC-DR-RD-0001 and A9P02-JAC-HML-D_JC04A_JC-DR-RD-0001 included in Volume 2: Engineering Drawings.

At-grade Roundabout

4.3.7 For the at-grade roundabout at Dunkeld, the proposed cross-section used for each arm has been selected in accordance with CD 127. A Rural Single Carriageway (S2) cross-section with 7.3m carriageway should be used for these connecting side roads. However, as stated within the CD 127 Clause S/1.1, a minimum carriageway width of 6 metres shall be permitted for rural all-purpose single carriageway (S2) roads with design year flows of 5,000 AADT or less. The cross-section parameters are detailed in Table 4-7.

	Type of Road	Carriageway Width (m)	Hardstrip / Hardshoulder Width (m)		Minimum Verge Width (m)	Minimum Central Reserve Width (m)
			Nearside	Offside		
Dunkeld Junction						
At-grade Roundabout	N/A	12 (3x4m lanes)	N/A	N/A	2.5	N/A
A822 (Old Military Road)	S2	6 *See Note 1*	1.0	N/A	2.5	N/A
Unclassified Road (Road to Inver)	S2	6 *See Note 1*	1.0	N/A	2.5	N/A
A923	S2	6 *See Note 1*	1.0	N/A	2.5	N/A

Table 4-7: At-Grade Roundabout Cross-section Parameters (CD 127)

Note:

1. *On side roads with a traffic flow of 5,000 AADT or less carriageway widths have been set to 6m with 1m hardstrips in order to provide a better tie-in to the existing carriageway widths on the local side road network, as permitted within the CD 127 Clause S/1.1.*

4.4 Engineering Description – Roundabout Parameters

4.4.1 The at-grade roundabout has been designed in accordance with CD 116 and developed to maximise the size of roundabout whilst minimising its impact in terms of engineering, environment, social and economic considerations. The cross-section parameters for the roundabout can be found in Table 4-8.

	Standard Provided (m)		
	Inscribed Circle Diameter	Carriageway	Verge
At-grade Roundabout	90m	3x 4m lanes	2.5m

Table 4-8: At-grade Roundabout Cross-section Parameters

4.4.2 The proposed at-grade roundabout layout is shown on Drawing A9P02-JAC-HML-D_JC02A_JC-DR-RD-0001 in Volume 2: Engineering Drawings.

4.5 Engineering Description – Grade Separated Junction Parameters

Slip Roads

4.5.1 The geometric design parameters of the merge and diverge layouts have been developed to the Rural All-Purpose 120kph design speed requirements, as detailed in CD 122 (Tables 3.21 and 3.32). An assessment was undertaken to determine the merge and diverge layouts, this was determined using the mainline and slip roads traffic flow data for maximum vehicles per hour per lane. A summary of the key merge and diverge design parameters are shown below in Table 4-9.

Design Standard	Length of Taper (m)	Nose Ration (min)	Nose Length (m)	Minimum Auxiliary Lane Length (m)	Length of Auxiliary Lane Taper (m)
Merge	150	1:30	85	190	55
Diverge	150	1:15	70	170	55

Table 4-9: Merge/Diverge Design Standards (CD 122)

4.5.2 In accordance with CD 122 (Clause 5.8), a near straight at least equal in length to the nose length is to be provided upstream and downstream of the back of the nose for both the merge and diverge tapers respectively. There are two locations within the proposed scheme where this has not been achieved, the Dalguise Junction northbound merge slip and Dalguise Junction southbound merge slip. This is due to the location of the proposed Dalguise Junction being constrained by the Highland Main Line railway, existing steep topography, River Tay Crossing and Inch Rail and Inver Rail Bridge structures. This non-compliance with the design standards has been included in the Departures from Standards application. Refer to Section 4.10 for further details.

4.5.3 The proposed grade separated junction slip road layouts are shown on Drawings A9P02-JAC-HML-D_JC01A_JC-DR-RD-0001 and A9P02-JAC-HML-D_JC04A_JC-DR-RD-0001 included in Volume 2: Engineering Drawings.

Weaving Distance

4.5.4 In accordance with CD 122, for rural all-purpose roads the Desirable Minimum weaving length to be provided between a grade separated junction and an at-grade junction, lay-by or direct access is 1 km.

4.5.5 There are two instances within the proposed scheme where this has not been achieved. One instance is between the Birnam Junction Northbound Merge and the direct access for Dunkeld & Birnam Station. The second is between the Dalguise Junction Southbound Diverge and the left-in, left-out junction for the Inver Maintenance Access Track (North). In both cases, the inclusion of a link road between the junctions was not provided due to being constrained by the Highland Main Line railway, existing steep topography, residential properties, and Inver Rail Bridge structure. In addition, the left-in, left-out accesses are estimated to have low traffic flows. This non-compliance with the design standards has been included in the Departures from Standards application. Refer to Section 4.10 for further details.

4.6 Engineering Description – Left-in, Left-out At-Grade Junction Parameters

4.6.1 As described in Chapter 3 (Proposed Scheme), there are three left-in, left-out at-grade junctions within the proposed scheme. Two of these junctions are located on the northbound carriageway at the Network Rail Maintenance Access Track and The Hermitage, with the third located on the southbound carriageway at the Inver Maintenance Access Track (North).

At-Grade Major/ Minor Junction Standard

4.6.2 The left-in, left-out junctions have been designed in accordance with CD 123. The typical junction layout is shown in Figure 4.1.

4.6.3 The proposed junction at the Network Rail Maintenance Access Track contains a diverge taper, rather than a diverge auxiliary lane as shown in Figure 4.1, and the junctions at both the Network Rail Maintenance Access Track and Inver Maintenance Access Track (North) do not contain a merge taper. The desirable minimum geometric design parameters from CD 123, and the proposed design parameters for each junction are shown in Table 4-10.

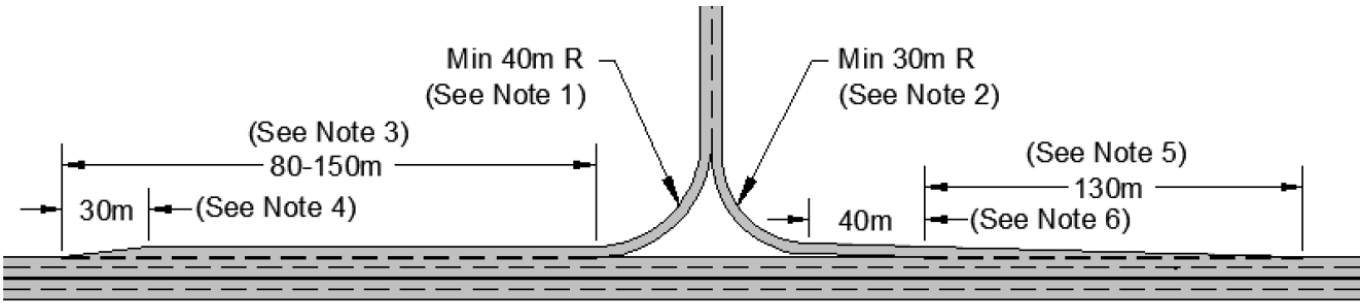

Figure 4.1: Layout of Proposed Nearside Auxiliary Diverge Lane for Left-in, Left-out At-grade Junctions.

Notes:

1. *The radius connecting the diverge taper to the minor road is at least 40m where the Design Speed of the major road is greater than 85kph. (CD 123, Paragraph 5.6.4).*
2. *The radius connecting the merge taper to the minor road is at least 30m where the Design Speed of the major road is greater than 85kph. (CD 123, Paragraph 5.6.6).*
3. *The deceleration length for a dual carriageway with 120kph Design Speed varies depending on the gradient on the major road at the junction. Appropriate lengths are given below. (CD 123, Table 5.22)*
   a. *Up Gradient (0 - 4%) - 110m;*
   b. *Up Gradient (Above 4%) - 80m;*
   c. *Down Gradient (0 - 4%) - 110m; and*
   d. *Down Gradient (Above 4%) - 150m.*
4. *The merging length for a Design Speed of 120kph is 130m. (CD 123, Table 5.26)*
5. *On dual carriageways with a Design Speed of 120kph the merging taper may be preceded by a short nose of 40m length. (CD 123, Paragraph 5.26.1)*
6. *Drivers approaching a major / minor priority junction from both the major road and the minor road will have unobstructed visibility in accordance with the relevant Design Speed and in accordance CD 109. Verge widening, to accommodate SSD, may be required.*

Design Standard	Desirable Minimum (m) above 85kph	Standard Provided (m)		
		Network Rail Maintenance Access Track	The Hermitage	Inver Maintenance Access Track (North)
Auxiliary Diverge Lane				
Deceleration Length (Up Gradient 0-4%)	110	-	110	110
Direct Taper Length	30	-	30	30

Design Standard	Desirable Minimum (m) above 85kph	Standard Provided (m)		
		Network Rail Maintenance Access Track	The Hermitage	Inver Maintenance Access Track (North)
Corner Radius into the Minor Road	40	-	40	15
Diverge Taper				
Deceleration Length (Gradient 0-4%)	110	110	-	-
Corner Radius into the Minor Road	40	9.9	-	-
Merge Taper				
Merge Taper Length (where the minor road is not a through Route)	11	-	110	-
Merge Taper Nose Length	40	-	48	-
Corner Radius into the Mainline (if merge taper included)	30	-	17	-
Corner Radius into the Mainline (if no merge taper included)	20	11.3	-	18.5

Table 4-10: Diverge and Merge Design Standard (CD 123)

4.6.4 The left-in, left-out at-grade junction layouts are shown on Drawings A9P02-JAC-HSR-D_SR034_AC-DR-RD-0001, A9P02-JAC-HSR-D_SR050_AC-DR-RD-0001, and A9P02-JAC-HML-D_JC03A_JC-DR-RD-0001 included in Volume 2: Engineering Drawings.

4.7 Engineering Description – Other Design Parameters

Transitions

4.7.1 To comply with CD 109 (Clause 4.12) transition curves have been provided on all horizontal curves in the A9 dual carriageway where the horizontal radius is less than the minimum radius. The length of the transition has predominantly used a 'q value' of 0.3m/sec3, however in difficult circumstances a value of 0.6 m/sec3 has been utilised.

Crossfall and Superelevation

4.7.2 On straight sections of road, the superelevation or camber has been set to 3% from the central reserve of dual carriageways to the outer channels. This has been increased from 2.5% due to the use of surface type TS2010 used across the A9 Dualling Perth to Inverness project to aid runoff and increase watershed. On horizontal curves the crossfall is dictated by the relevant design speed and is stipulated in CD 109 (Equation 4.2). On straight sections of the local road network, the superelevation or camber has been set to 2.5% from the centre of the single carriageway to the outer channels. Superelevation on all roads does not exceed 7%.

4.7.3 Use of design standard criteria lower than the "desirable minimum" described above necessitates either a Relaxation or Departure from Standards. Further details on the proposed departures and relaxations on the proposed scheme can be found in Section 4.10 of this report.

Vertical Gradients

4.7.4 The desirable minimum and maximum gradients, stipulated in CD 109 for the roads within the proposed scheme are given in Table 4-11. However, to reduce construction costs and impact on the environment by better following existing topography, gradients steeper than the desirable maximum gradient for side roads have been used in the proposed design.

Design Standard	Desirable Maximum Gradient (%)	Minimum Gradient (%)	Absolute Maximum Gradient (%)
Mainline (All-purpose Dual Carriageway)	4	0.5 See Note 1	8 (in hilly terrain)
Side Roads (All-purpose Single Carriageways)	6 See Note 2	0.5 See Note 1	
Slip Roads	6	0.5 See Note 1	
Access Tracks	5	0.8	8

Table 4-11: Vertical Gradients

Note:

1. *To assist with carriageway runoff a minimum of 0.8% has been provided when the crossfall is 2.5%, where possible.*
2. *For Local Roads with bus provisions, the recommended maximum gradient is 6.7% where possible.*

4.7.5 The transition lengths, crossfall/superelevation and vertical gradients are shown on the Plan and Profile Drawings included in Volume 2: Engineering Drawings.

4.8 Engineering Description – Lay-bys

4.8.1 Lay-bys shall be designed in accordance with CD 169. Each lay-by shall also be designed in accordance with Roads for All: Good Practice Guide for Roads which requires a 2 metre wide footway to the rear of the 3.6 metre wide parking lane.

4.8.2 The upgrade of two existing lay-bys has been incorporated into the design which provide drivers with a suitable place to stop for a short time or in emergencies for broken down vehicles. Two lay-bys which provide buses with a suitable place to stop for a short time, have also been incorporated into the proposed scheme, as described in Paragraph 4.8.8.

4.8.3 While accidents involving vehicles which are entering or leaving lay-bys are low, their severity can be significant. As a result, and in accordance with CD 169, there are a number of factors that need to be taken into account when considering where to site a lay-by including:

- Lay-bys should not be sited on the inside of a left-hand horizontal curve of radius less than 2,040 metres (for a 70mph dual carriageway) as this can compromise forward visibility;
- Lay-bys should not be sited on the outside of a right-hand horizontal curve of radius less than 2,040 metres (for a 70mph dual carriageway) as there is an increased risk that a fatigued driver may unintentionally enter the lay-by at high speed;
- Suitable forward visibility for the mainline speed should be available on approach to and through the lay-by;
- The separation (weaving length) between a lay-by and a grade separated junction must be 1 km;
- The separation (weaving length) between a lay-by and an at-grade junction must be 3.75V (450m);
- Lay-bys must not be combined with a junction or access as this may increase accidents; and
- Where practical, lay-bys should be sited away from housing to avoid noise and visual intrusion and reduce the possibility of trespass.

Type A Lay-bys

4.8.4 As a result of the factors detailed above, as well as environmental constraints, there are limited locations available within the extents of the proposed scheme where a lay-by could be safely provided. As described in Chapter 3 (Description of the Proposed Scheme) two lay-bys are proposed to be upgraded to a type A lay-by as part of the scheme. These are located to the

immediate south of the southern extent of the current single carriageway section (Ch. -500 to Ch. 0). The layout of a type A lay-by is shown in Figure 4.2.

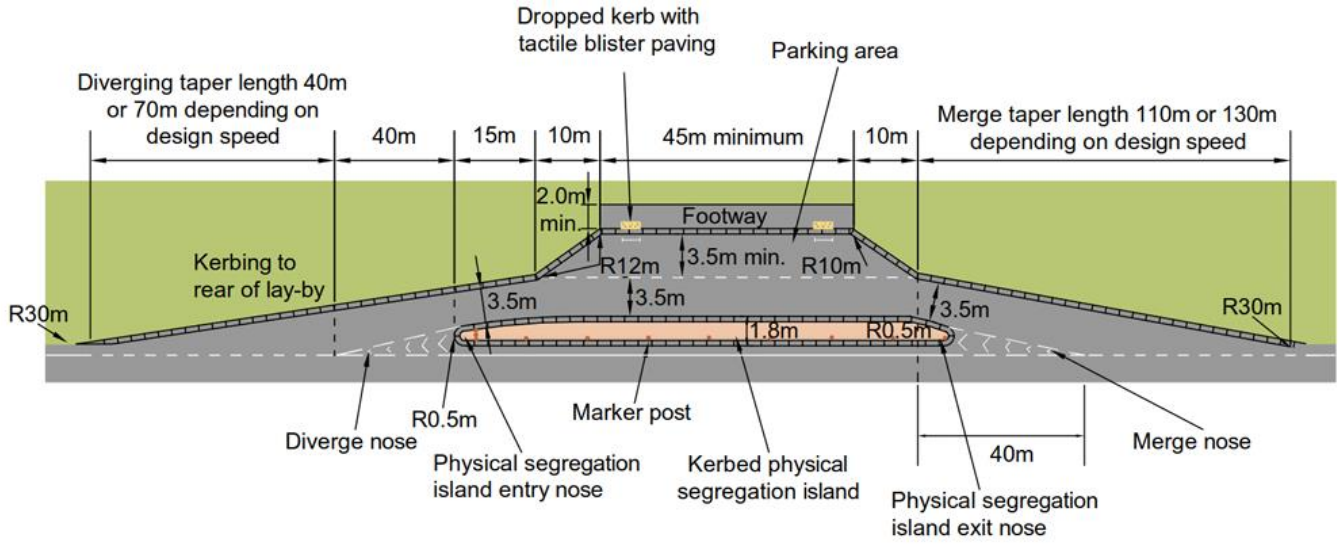

Figure 4.2: Layout of Type A Lay-by (CD 169)

4.8.5 In accordance with CD 169, lay-by spacing is recommended every 2.5km on sections of new dual carriageway, however local factors should be taken into consideration. This is not achieved in the proposed scheme as only 1 lay-by is proposed in each the northbound and southbound carriageways along the 8.4km scheme length, as described in Paragraph 4.8.4. This is due to a number of factors, for example the spacing of junctions along the carriageways prevent any suitable gaps being available for lay-bys that fit within recommended guidelines.

4.8.6 Although spacing requirements have not been met, the design follows the Lay-by Strategy in the DRMB Stage 1 Assessment Report. Also, it is expected that Birnam and Dunkeld will be used in cases where drivers need to stop and use facilities.

4.8.7 The proposed lay-bys are shown on Drawing A9P02-JAC-HML-D_ML000_ML-DR-RD-0001 included in Volume 2: Engineering Drawings.

Bus Lay-bys

4.8.8 The proposed scheme will close both existing bus lay-bys in the locality of The Hermitage, with two new bus lay-bys to be provided at Inver on the A9 northbound carriageway at Ch. 4600 and on the A9 southbound carriageway at Ch. 4700. The proposed bus lay-bys will not have a segregation island in accordance with Roads for All: Good Practice Guide for Roads as shown in Figure 4.3.

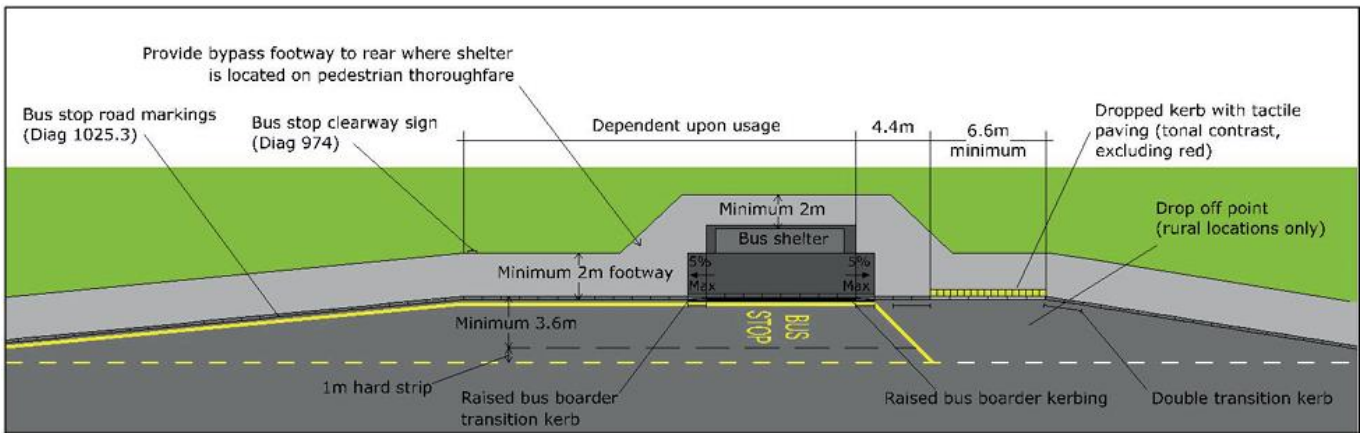

Figure 4.3: Layout of Bus Lay-by (Transport Scotland, 2013)

4.8.9 The separation between a lay-by (other than a maintenance hardstanding) and an at-grade junction or access, both upstream and downstream, must be at least 3.75V, where V is the design speed in km/h. This has not been achieved within the proposed scheme between the proposed at-grade roundabout at Dunkeld and the proposed bus lay-by on the northbound carriageway. Therefore, a departure from standard has been incorporated into the design, as described in Paragraph 4.10.4.

4.8.10 This is due to a number of factors which have been explained in detail within the Departures from Standards Report but are summarised below:

- To allow connectivity with public transport to be maintained;
- Favourable SSD compared to other proposed locations;
- To minimise the walking distances for the communities that the bus stop is being provided for;
- To reduce impacts on properties at Inver; and
- The location of other proposed junctions.

4.8.11 Although weaving length requirements have not been achieved, the design follows the Lay-by Strategy in Appendix M of the DMRB Stage 1 Assessment Report (Jacobs, 2014).

4.8.12 The proposed lay-bys are shown on Drawing A9P02-JAC-HML-D_ML045_ML-DR-RD-0004 included in Volume 2: Engineering Drawings.

4.9 Engineering Description – Access Tracks

4.9.1 A sifting exercise was undertaken early in the DMRB Stage 3 assessment to identify the preferred access solution to address the closure of a number of existing direct accesses onto the A9, which were classified as Tier 3 with respect to the Junction and Access Strategy in Appendix J of the

DMRB Stage 1 Assessment Report (Jacobs, 2014). A number of options for each access were identified and considered against a number of criteria including:

- Property;
- Severance;
- Water Environment;
- Biodiversity;
- Heritage;
- Woodland on Ancient Woodland Inventory;
- Landscape and Visual;
- Length of Diversionary Route / Journey Time; and
- Economic Assessment.

4.9.2 Following the sifting exercise and consultation with land/property owners, the access options outlined in Table 4-12 have been identified. In a number of instances, the land / property owners suggested refinements to the design, and these were incorporated where technically feasible through an iterative design process, and are reflected in the proposed scheme. The proposed DMRB Stage 3 design has assumed full surfacing for all proposed accesses. This will be refined during the Specimen Design and Detailed Design stages.

Existing Access Name	Proposed Access Option Treatment	Proposed Surfacing	Sifting Justification
Murthly Estate Access	Via a new Murthly Estate Access Track from the B867.	Surfaced	The proposed access avoids additional access onto the A9.
Dalpowie Plantation Access	Closed.	N/A	The access is no longer required due to the new Murthly Estate Access Track.

Existing Access Name	Proposed Access Option Treatment	Proposed Surfacing	Sifting Justification
Station Access	Network Rail private access via Network Rail Maintenance Access Track. Public access via proposed Dunkeld & Birnam Station Pedestrian Underpass from Dunkeld & Birnam Station Replacement Car Park on Station Road.	Surfaced	The proposed access is the only viable alternative route.
Forestry Access 1	Via the proposed Inver Maintenance Access Track (South).	Surfaced	The proposed access is the only viable alternative route.
Auchlou Cottage Access	Closed.	N/A	Property to be demolished as part of the scheme.
Field Access 1	Via the proposed Inver Maintenance Access Track (North).	Surfaced	The proposed access rationalises the number of accesses onto the A9, and has the least impact on the River Tay floodplain.
The Hermitage Access	Replaced with the proposed Hermitage Left-in, Left-out Junction	Surfaced	The proposed access retains a similar access regime that is currently in place.
Forestry Access 2	Via the proposed Inver Maintenance Access Track (North).	Surfaced	The proposed access rationalises the number of accesses onto the A9, and has the least impact on the River Tay floodplain.
Forestry Access 3	Via the proposed Inverwood Access Track (South).	Surfaced	The proposed access avoids additional access onto the A9.
Forestry Access 4 (Tay Forest Park)	Via the access to Douglas Fir Wood off the B898.	Surfaced	The proposed access avoids additional access onto the A9.

Existing Access Name	Proposed Access Option Treatment	Proposed Surfacing	Sifting Justification
Forestry Access 5	Via the proposed Inverwood Access Track (North)	Surfaced	The proposed access avoids additional access onto the A9.
Forestry Access 6	Via the access to Douglas Fir Wood off the B898.	Surfaced	The proposed access avoids additional access onto the A9.
Field and Utility Maintenance Access	Via the proposed Inverwood Access Track (North)	Surfaced	The proposed access avoids additional access onto the A9.

Table 4-12: Junction and Access Preferred Options

4.9.3 Given the rural setting of the proposed scheme, new lengths of access tracks providing access to private land, business/residential properties and field accesses have been designed in accordance with the NRDG. These requirements are shown below in Table 4-13.

	Design Speed (kph)	Horizontal Curvature (Radius, m)	Vertical Curvature (K Value) Stopping Sight Distance (m)		Stopping Sight Distance (m)
		Desirable Minimum Radius	Desirable Minimum Crest	Desirable Minimum Sag	Desirable Minimum
Access Tracks	16	10	2	2	20

Table 4-13: NRDG Design Standards

4.9.4 The proposed access tracks' geometric parameters and layouts are shown on the Plan and Profile Drawings included in Volume 2: Engineering Drawings.

4.10 Departure from Standards

4.10.1 The proposed scheme has been designed, as far as practicable, to be compliant with DMRB. However, the adjacent physical constraints make it difficult to design to Desirable Minimum standards without resulting in disproportionate engineering and environmental, social and economic impacts. As a result, where safety is not adversely affected or can be acceptably mitigated, Departures from Standards have been incorporated into the design. A procedure exists whereby such departures from DMRB standards are applied for by the Designer, to the Overseeing Roads Authority, and the application is independently scrutinised and due diligence applied in approving or rejecting the application. For the proposed Scheme, Transport Scotland is the Roads Authority for the trunk road and associated junctions which form part of the trunk road network.

4.10.2 In addition to the mainline trunk road and junction departures, there are Departures from Standards associated with side roads and local roads and accesses along the proposed scheme.

4.10.3 There are three categories of side road Departure which have been identified for the A9 Dualling Programme. The category under which each Departure from Standard falls, determines which authority is responsible for the Departure determination as outlined below:

- Category 1 – where side roads are improved along the length of the existing road, the Local Authority determines any Departure from Standards as local roads authority for that road. Transport Scotland to be kept informed of progress for awareness;

- Category 2 – where new side roads/lengths of side roads are provided, Transport Scotland determine the Departures from Standards given the likely scenario that the new road will be a Scottish Ministers' asset for a period of time. Local Authority agreement is however required prior to determination, as it is expected that the road will be transferred to them in due course. A copy of their agreement is provided with the departures application; and

- Category 3 – where side road junctions are provided onto the A9, Transport Scotland determine the Departures from Standards given the interaction of the junction with the trunk road. Local Authority agreement is however required prior to determination as it is expected that some or all of the road will be transferred to them in due course.

A9 Dual Carriageway Departures from Standards

4.10.4 There is a total of 22 Departure from Standards for the A9 dual carriageway. These are outlined in Table 4-14.

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
DEPM02	A9 Trunk Road, Northbound Carriageway Ch. 2300 -2924.4	Weaving Length (Birnam Junction to Network Rail Maintenance Access Track Left-in, Left-out Junction)	CD 122: Geometric Design of Grade Separated Junctions, Clause 4.1	For all-purpose roads, the minimum length between a full grade separated junction and an at-grade junction shall be 1km	624.4m
DEPM04	A9 Trunk Road, Northbound Carriageway Ch. 2480 – 2720	Stopping Sight Distance (SSD) on Junction Approach (Network Rail Maintenance Access Track Left-in, Left-out Junction)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	295m	Lane 1 LOH = 252 (min) Lane 1 HOH = 256m (min)

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
DEPM06	A9 Trunk Road, Northbound Carriageway Ch. 4161 – 4550	Lay-by spacing (Dunkeld Junction to Bus Lay-by)	CD 169: The design of lay-bys, maintenance hardstanding, rest areas, service areas and observation platforms. Clause: 3.7	450m	389m
DEPM08	A9 Trunk Road, Northbound Carriageway Ch. 5748 – 6090	Combination of Stopping Sight Distance (SSD) and Horizontal Alignment	CD 109: Highway Link Design, Table 2.10, Clause 2.12	Except for stopping sight distance relaxations of up to 1 design speed step below desirable minimum coincident with horizontal curvature relaxations of up to 1 design speed step below desirable minimum, relaxations shall not be used in combination.	Lane 2 LOH = 200m (min) Lane 2 HOH = 295m (min) R=726m
DEPM09	A9 Trunk Road, Northbound Carriageway Ch. 5987.5 – 6790	Stopping Sight Distance (SSD) on Junction Approach (Dalguise Junction Northbound Diverge and Merge)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	295m	Lane 1 LOH= 269m (min) Lane 1 HOH= 295m (min) Lane 2 LOH= 201m (min) Lane 2 HOH= 295m (min)
DEPM10	A9 Trunk Road, Northbound Carriageway Ch. 7430 – 7790	Carriageway Cross-Section (on the existing River Tay structure)	CD 127: Cross Sections and Headroom, Figure 2.1.1N1e, Clause 3.1	- 1m offside hardstrip - 1m nearside hardstrip - 2.5m verge	- 0.7m offside hardstrip - 0.7m nearside hardstrip - 2m verge

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
DEPM11	A9 Trunk Road, Northbound Carriageway Ch. 7150 – 7230	Stopping Sight Distance (SSD) on Junction Approach (Dalguise Junction Northbound Merge)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	295m	Lane 1 LOH = 246m (min) Lane 1 HOH = 295m (min) Lane 2 LOH = 268m (min) Lane 2 HOH = 295m (min)
DEPM12	A9 Trunk Road, Southbound Carriageway Ch. 6430 – 6112	Stopping Sight Distance (SSD) on Junction Approach (Dalguise Junction Southbound Merge)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	295m	Lane 1 LOH = 220m (min) Lane 1 HOH = 225m (min) Lane 2 LOH = 268m (min) Lane 2 HOH = 268m (min)
DEPM15	A9 Trunk Road, Southbound Carriageway Ch. 7383 – 7744.1	Application of Superelevation (on the existing River Tay structure)	CD 109: Highway link design, Clause 4.1	2.5% Superelevation (3% for TS2010 Pavement requirement)	2.5% Crown
DEPM16	A9 Trunk Road, Ch. 3004.2 – 3299.2 Ch. 3359.2 – 3544.9 Ch. 4161 – 4940.8	Application of Superelevation	CD 109: Highway Link Design, Table 2.10, Clause 4.1	For radius = 2040m to 2880m, or >2880m, 2.5% superelevation	For radius = 2040 to 2880, and >2880m, 3% superelevation
DEPM24	A9 Trunk Road, Southbound Carriageway Ch. 6883 – 6810	Stopping Sight Distance (SSD) on Junction Approach (Dalguise Junction)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	295m	Lane 1 LOH = 218m (min) Lane 1 HOH = 295m (min)
DEPM29	A9 Trunk Road, Southbound Carriageway Ch. 6207 – 5640	Weaving Length (Junction spacing between full grade separated Dalguise junction and at-grade Inver Maintenance Access Track (North) left-in, left-out junction).	CD 122: Geometric design of grade separated junctions, Clause 4.1	1km distance	567m separation provided

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
DEPM30	A9 Trunk Road, Southbound Carriageway Ch. 6090 – 5820	Stopping Sight Distance (SSD) on Junction Approach (Inver Maintenance Access Track (North) left-in, left-out)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	295m	Lane 1 LOH = 199m (min) Lane 1 HOH = 229m (min) Lane 2 LOH = 257m (min) Lane 2 HOH = 273m (min)
DEPM31	A9 Trunk Road, Southbound Carriageway Ch. 5769 – 5510	Junction Visibility (Inver Maintenance Access Track (North) left-in, left-out)	CD 123: Geometric design of at-grade priority and signal-controlled junctions, Clause 3.4	x = 2.0m Y = 295m	X = 2.0m Y = 256m LOH (right/North) Y = 288m HOH (right/North) Y = 295m LOH (left/South) Y = 295m HOH (left/South)
DEPM41	A9 Trunk Road, Southbound Carriageway Ch. 7438.6 – 7355.4	Vertical Alignment on Junction Approach (Dalguise Northbound Merge)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	K (crest) = 182	K (crest) = 100
DEPM35	A9 Trunk Road, Northbound Carriageway Existing lay-by Ch. -770m – 30	Stopping Sight Distance (SSD) on approach to a lay-by	CD169: The design of lay-bys, maintenance hardstanding, rest areas, service areas and observation platforms. Clause 3.4	295m	Lane 1 LOH = 287m Lane 1 HOH = 295m Lane 2 LOH = 208m Lane 2 HOH = 295m
DEPM36	A9 Trunk Road, Northbound Carriageway Existing lay-by Ch. -344 – 30	Lay-by – outside of curve	CD169: The design of lay-bys, maintenance hardstanding, rest areas, service areas and observation platforms. Clause 3.2	Lay-bys shall not be sited on the outside of a RH curve with R less than Table 3.2.1 (R = 2040m)	R=1032.089m R=1615.845m

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
DEPM37	A9 Trunk Road, Southbound Carriageway Existing lay-by Ch. -575.8 – 238.4	Stopping Sight Distance (SSD) on approach to a lay-by	CD169: The design of lay-bys, maintenance hardstanding, rest areas, service areas and observation platforms. Clause 3.4	295m	Lane 1 LOH = 202m Lane 1 HOH = 218m Lane 2 LOH = 258m Lane 2 HOH = 295m
DEPM38	A9 Trunk Road, Southbound Carriageway Existing lay-by Ch. -575.8 – (-204.1)	Lay-by – outside of curve	CD169: The design of lay-bys, maintenance hardstanding, rest areas, service areas and observation platforms. Clause 3.2	Lay-bys shall not be sited on the outside of a RH curve with R less than Table 3.2.1 (R = 2040m)	R=1615.845m R=1032.089m
DEPM43	A9 Trunk Road, Northbound Carriageway Ch. 7566.3 – 7605.1	Combination of Stopping Sight Distance (SSD) and Vertical Alignment	CD 109: Highway Link Design, Table 2.10, Clause 2.12	K (crest) = 182 SSD = 295m	K (crest) = 100 Lane 1 SSD LOH = 273m (min) Lane 1 SSD HOH = 295m (min) Lane 2 SSD LOH = 295m (min) Lane 2 SSD HOH = 295m (min)
DEPM44	A9 Trunk Road, Northbound Carriageway Ch. 8155.5 – 8390	Stopping Sight Distance (SSD) on Junction Approach (P03 Fishing Bothy Access 1)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	295m	Lane 1 LOH = 209m (min) Lane 1 HOH = 209m (min) Lane 2 LOH = 295m (min) Lane 2 HOH = 295m (min)
DEP/JCT/30-01	A9 Trunk Road, Northbound Carriageway Ch. 3055 - 2810	Junction Visibility (Network Rail Maintenance Access Track Left-in, Left-out)	CD 123: Geometric design of at-grade priority and signal-controlled junctions, Clause 3.4	x = 2.0m Y = 295m	X=2.0m Y = 241m LOH (left/South) Y = 277m LOH (left/South) Y= 295m LOH (right/North) Y = 295m HOH (right/North)

Table 4-14: A9 Dual Carriageway, Departures from Standards

A9 Dual Carriageway Relaxations from Standards

4.10.5 In addition to Departures from Standards, there are 12 design components which fall within the permitted steps below the Desirable Minimum design criteria, which can be introduced at the discretion of the design organisation in accordance with CD 109 and are therefore categorised as permitted Relaxations from Standards. These are provided Table 4-15.

Reference	Location & Chainage	Relaxation Type	DMRB Reference	Required Standard	Standard Provided
RLXM01	A9 Trunk Road, Northbound Carriageway Ch. 30 – 830	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	295m	Lane 2 LOH = 228 (min) Lane 2 HOH = 295m (min)
RLXM02	A9 Trunk Road, Northbound Carriageway Ch. 2360 – 2482	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	295m	Lane 1 LOH = 259m (min) Lane 1 HOH = 295m (min)
RLXM18	A9 Trunk Road, Ch. 2560 – 2840	Horizontal Alignment	CD 109: Highway link design: Table 2.10 and Clause 4.5	1020m	720m
RLXM03	A9 Trunk Road, Northbound Carriageway Ch. 5460 – 5748	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	295m	Lane 1 LOH = 263m (min) Lane 1 HOH = 295m (min) Lane 2 LOH = 216m (min) Lane 2 HOH = 295m (min)
RLXM06	A9 Trunk Road, Ch. 5690 – 6940	Horizontal Alignment	CD 109: Highway link design: Table 2.10 and Clause 4.5	1020m	726m
RLXM14	A9 Trunk Road, Ch. 7355.4 – 7438.6	Vertical Alignment	CD 109: Highway link design: Table 2.10 and Clause 5.7	K (Crest) = 182	K (Crest) = 100
RLXM19	A9 Trunk Road, Northbound Carriageway Ch. 7440 – 7800	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	295m	Lane 1 LOH = 248m (min) Lane 1 HOH = 276m (min) Lane 2 LOH = 264m (min) Lane 2 HOH = 295m (min)

Reference	Location & Chainage	Relaxation Type	DMRB Reference	Required Standard	Standard Provided
RLXM07	A9 Trunk Road, Southbound Carriageway Ch. 1150m – 238.4m	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	295m	Lane 1 LOH = 231m (min) Lane 1 HOH = 295m (min)
RLXM10	A9 Trunk Road, Southbound Carriageway Ch. 3030 - 2630	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	295m	Lane 1 LOH = 279m (min) Lane 1 HOH = 295m (min) Lane 2 LOH = 231m (min) Lane 2 HOH = 295m (min)
RLXM11	A9 Trunk Road, Southbound Carriageway Ch. 6112 – 6090	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	295m	Lane 1 LOH = 219m (min) Lane 1 HOH = 295m (min) Lane 2 LOH = 273m (min) Lane 2 HOH = 295m (min)
RLXM17	A9 Trunk Road, Southbound Carriageway Ch. 7000 – 6883	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	295m	Lane 1 LOH = 218m (min) Lane 1 HOH = 295m (min)
RLXM20	A9 Trunk Road, Northbound Carriageway Ch. 7830m - 8155.5	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	295m	Lane 1 LOH = 248m (min) Lane 1 HOH = 295m

Table 4-15: A9 Dual Carriageway, Relaxations from Standards

Junction and Side Road Departures from Standards

4.10.6 There is a total of 28 Departure from Standards for grade separated junctions, left-in, left-out junctions, at-grade roundabouts, and side roads. These are outlined in Table 4-16.

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
Birnam Junction					
DEP/JCT/21-01	Birnam Junction Northbound Diverge ML Ch. 1432 – 1755	Stopping Sight Distance (SSD)	On diverges, mainline SSD (295m) shall be provided: 2)	295m to be achieved up to the back of nose	LOH = 178m (min) HOH = 192m (min)

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
			to a 0.26 metre object height at the 'give way' line or 'stop' line from a distance equal to the mainline SSD, where the length of the connector road is equal to or less than the mainline SSD, as illustrated in Figure 3.34b.		
DEP/JCT/2/1-16	Private Access, Ballincrieff (Connection with B867) Ch. 773 – 847	Junction Visibility	CD 123 Geometric design of at-grade priority and signal-controlled junctions: Clause 3.6, Clause 3.7, Clause 3.8 (Point 3) CD 109: Highway Link Design, Table 2.10	X = 2.0m Y = 120m	X=2.0m Y LOH & HOH = 74m North/to the left Y LOH & HOH = 120m (min) South/to the right
Dunkeld Junction					
DEP/JCT/41-02	A822 (Old Military Road), Westbound and Eastbound Carriageway Ch. 0 – 17.2	Horizontal Alignment	CD 109: Highway link design, Table 2.10, Clause 2.12	HA = 510m	HA = 45m
DEP/JCT/41-04	A822 (Old Military Road), Westbound Carriageway Ch. 121.5 – (-118.5)	Stopping Sight Distance (SSD) on Junction Approach (Ladywell Access Junction)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	160m	LOH = 29m (min) HOH = 51m (min)
DEP/JCT/41-20	A822 (Old Military Road), Westbound	Visibility on approach to Dunkeld Roundabout	CD 109: Highway Link Design, Table	a = 160m	Visible sight line to give way = 109m

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
	and Eastbound Carriageway Ch. 0 – 121.5		2.10, Clause 2.13		
DEP/JCT/41-15	A822 (Old Military Road) Westbound and Eastbound Carriageway Ch. 5.3 – 79.1	Vertical Alignment on Junction Approach	CD 109: Highway link design: Table 2.10 and Clause 2.13	K55 Crest	K38 Crest
DEP/JCT/41-05	A923, Westbound and Eastbound Carriageway Ch. 19.7 – 63.7	Horizontal Alignment	CD 109: Highway link design: Table 2.10 and Clause 4.5	180m	38m
DEP/JCT/41-06	A923, Westbound Carriageway Ch. 0 – 40	Stopping Sight Distance (SSD) on Junction Approach (Little Dunkeld Road & Perth Road)	CD 109: Highway Link Design Table 2.10 and Clause 2.13	70m	LOH = 53m (min) HOH = 53m (min)
DEP/JCT/41-13	Segregated Left Turning Lane (A923 to Mainline Ch. 46.5 – 112.1	Vertical Alignment on Junction Approach	CD 116: Geometric design of roundabouts Clause 6.28	SLTLs shall not be used at junctions where the approach road gradient is in excess of 4%.	Gradient = 6%%
DEP/JCT/41-31	A923, Eastbound Carriageway Ch. 40 – 110	Stopping Sight Distance on Junction Approach (Perth Road & Little Dunkeld Road)	CD 109: Highway Link Design Table 2.10 and Clause 2.13	70m	LOH = 35m (min) HOH = 35m (min)
DEP/JCT/41-07	Segregated Left Turning Lane (A923 to Mainline) Ch. 0 – 110	Stopping Sight Distance (SSD)	CD 116: Geometric Design of Roundabouts, Clause 6.24 and Table 6.27	SSD = 70m	LOH = 32m (min) HOH = 37m (min)
DEP/JCT/41-12	Little Dunkeld Road (Connection with A923) Ch. (-9) - 40	Junction Visibility	CD 123 Geometric design of at-grade priority and signal-controlled junctions: Clause 3.6, Clause 3.7,	X = 2.4m Y = 70m	X = 2.4m Y LOH & HOH = 29m South/to the right Y LOH & HOH = 20m North/to the left

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
			Clause 3.8 (Point 2) CD 109: Highway Link Design Table 2.10		
DEP/JCT/41-09	Unclassified Road to Inver, Eastbound Carriageway Ch. 49.9 – 169.9	Visibility on approach to Dunkeld Roundabout	CD 116: Clause 3.45 and Clause 3.46	a = 120m	Visible sight line to give way = 32m
DEP/JCT/41-25	Unclassified Road to Inver, Westbound Carriageway Ch. 90 – (-15)	Stopping Sight Distance (SSD) on Junction Approach (SuDS Pond D)	CD 109: Highway link design: Table 2.10 and Clause 3.5	120m	LOH = 30m (min) HOH = 35m (min)
DEP/JCT/41-33	Unclassified Road to Inver, Eastbound Carriageway Ch. (-130.1) – 49.9	Stopping Sight Distance (SSD) on Junction Approach (Dunkeld Roundabout)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	120m	LOH = 47m (min) HOH = 47m (min)
DEP/JCT/41-34	Unclassified Road to Inver Ch. (-64) - 66	Junction Visibility	CD123 Geometric design of at-grade priority and signal-controlled junctions: Clause 3.6, Clause 3.7, Clause 3.8 (Point 1) CD109: Highway Link Design Table 2.10	X = 2.0m Y = 120m	X = 2.0m Y LOH= 49m (West/to the right) Y HOH = 81m (East/to the left)
The Hermitage Left-In, Left-Out Junction					
No departures from standard					
Dalguise Junction					
DEP/JCT/69-01	Northbound Diverge Slip Road ML Ch. 6430 – 6651.9	Stopping Sight Distance (SSD) up to the back of nose.	CD 122: Geometric Design of Grade Separated Junctions,	295m	LOH = 160m (min) HOH = 214m (min)

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
			Clause 3.34, Figure 3.34a		
DEP/JCT/69-02	Northbound Diverge Slip Road Ch. 20 – 90	Near Straight Horizontal Alignment	CD 122: Geometric Design of Grade Separated Junctions, Clause: 5.8	Connector roads shall include a near straight (1020m) at the back of nose, at least equal in length to the nose.	735.2m
DEP/JCT/69-03	Southbound Diverge Slip Road ML Ch. 7552 – 7257	Stopping Sight Distance (SSD) up to the back of nose.	CD 122: Geometric Design of Grade Separated Junctions, Clause 3.34, Figure 3.34a	295m	LOH = 216m (min) HOH = 266m (min)
DEP/JCT/69-04	Southbound Merge Slip Road Ch. 20 – 105	Near Straight Horizontal Alignment	CD 122: Geometric Design of Grade Separated Junctions, Clause: 5.8	Connector roads shall include a near straight (1020m) at the back of nose, at least equal in length to the nose.	638.9m
DEP/JCT/69-06	B898, Northbound Carriageway Ch. 846 - 930	Stopping Sight Distance (SSD) on Junction Approach (Douglas Fir Wood Access)	CD 109: Highway Link Design, Table 2.10, Clause 2.12	120m	LOH = 90m (min) HOH = 105m (min)
DEP/JCT/69-08	B898, Southbound Carriageway Ch. 1206 - 1026	Stopping Sight Distance (SSD) on Junction Approach (Douglas Fir Wood Access)	CD 109: Highway Link Design, Table 2.10, Clause 2.13	120m	LOH = 33.7m (min) HOH = 33.7m (min)
DEP/JCT/69-09	B898, Southbound Carriageway Ch. 1010 - 930	Combination: Horizontal Alignment and Stopping Sight Distance (SSD)	CD 109: Highway Link Design, Table 2.10, Clause 2.12	SSD = 120m HA = 510m	SSD LOH = 112m (min) SSD HOH = 120m (min) HA = 180m

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
DEP/JCT/69-22	Northbound Merge Slip Road ML. Ch. 7130 – 7210m	Stopping Sight Distance (SSD) from the back of nose	CD 122: Geometric Design of Grade Separated Junctions, Clause 3.24	295m	LOH = 246m (min) HOH = 295m (min)
DEP/JCT/69-23	Southbound Merge Slip Road ML. Ch. 6340 – 6112	Stopping Sight Distance (SSD) from the back of nose	CD 122: Geometric Design of Grade Separated Junctions, Clause 3.24	295m	LOH = 195m (min) HOH = 206m (min)
DEP/JCT/69-19	B898, Northbound Carriageway Ch. 1120 - 1140	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	120m	LOH = 53m (min) HOH = 75m (min)
DEP/JCT/69-26	B898 Northbound Carriageway Ch. 1080 - 1120	Combination: Horizontal Alignment and Stopping Sight Distance (SSD)	CD109: Highway Link Design, Table 2.10, Clause 2.12	SSD = 120m HA = 360m	SSD LOH = 73m (min) SSD HOH = 96m (min) HA = 128m

Table 4-16: A9 Junctions, Departures from Standards

Junction and Side Road Relaxations from Standards

4.10.7 In addition to junction and side road Departures from Standards there are 7 design components which fall within the permitted steps below the Desirable Minimum design criteria, which can be introduced at the discretion of the design organisation in accordance with CD 109 and are therefore categorised as permitted Relaxations from Standards. These are provided Table 4-17.

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
Birnam Junction					
No relaxations from standards					
Dunkeld Junction					
RLX/JCT/41-02	Unclassified Road to Inver Ch. 5.9 – 99.9	Horizontal Alignment	CD 109: Highway link design: Table 2.10 Clause 4.5	360m	255m

Reference	Location & Chainage	Departure Type	DMRB Reference	Required Standard	Standard Provided
RLX/JCT/41-03	Unclassified Road to Inver, Westbound Carriageway Ch. 169.6 – 160.4	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 Clause 3.5	120m	LOH = 103m (min) HOH = 120m (min)
RLX/JCT/41-10	A923, Eastbound Carriageway Ch. 167.4 - 160	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 Clause 3.5	70m	LOH = 54m (min) HOH = 70m (min)
Dalguise Junction					
RLX/JCT/69-04	B898, Northbound Carriageway Ch. 760 - 846	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 Clause 3.5	120m	LOH = 90m (min) HOH = 105m (min)
RLX/JCT/69 - 05	B898, Ch. 830 – 1030	Horizontal Alignment	CD 109: Highway link design: Table 2.10 Clause 4.5	360m	180m
RLX/JCT/69-08	B898, Southbound Carriageway Ch. 1026 – 1010	Stopping Sight Distance (SSD)	CD 109: Highway link design: Table 2.10 and Clause 3.5	120m	LOH = 112m (min) HOH = 126m (min)
RLX/JCT/69 - 09	B898 Ch. 1060 - 1140	Horizontal Alignment	CD 109: Highway link design: Table 2.10 and Clause 4.5	360m	128m

Table 4-17: A9 Junctions, Relaxations from Standards

4.11 Design Development since DMRB Stage 2

4.11.1 The DMRB Stage 3 design for the proposed scheme, as assessed in this DMRB Stage 3 Scheme Assessment report, is the result of design development to the Preferred Route Option that was identified and recommended in the DMRB Stage 2 Assessment Report.

General Design Development

4.11.2 The development of the dual carriageway, grade separated junctions and side roads design was undertaken based on the Preferred Route Option identified in the DMRB Stage 2 Assessment Report using the standards set out in DMRB.

4.11.3 The alignment design was developed to be cognisant of the identified constraints including topography; the existing ground and water features; potential drainage outfalls; existing roads and infrastructure; properties, land/farm boundaries; and the environmental constraints identified during the PES and DMRB Stage 2 Assessments, and further assessed and reported in the A9 Dualling Pass of Birnam to Tay Crossing EIAR. Road design standards, safety and cost are also key factors in the development of the design.

4.11.4 The drainage design has been prepared in accordance with the relevant road design and appropriate best practice guidance, which considers the inclusion of Sustainable Drainage Systems (SuDS). The design has also been prepared in consultation with the Scottish Environmental Protection Agency (SEPA). Further details of the drainage design are included in Section 4.14.

4.11.5 In addition, the design of the structures required for the scheme is in accordance with the standards in Volume 2 of the DMRB and are discussed in more detail in Section 4.16.

4.11.6 In accordance with DMRB GG 119 'Road Safety Audit guidance' (DMRB, 2020a), a Stage 1 Road Safety Audit was undertaken by Stewart Paton Associates and the recommendations identified by this audit have been considered and addressed in the proposed scheme design.

4.11.7 The proposed scheme design as presented in this report evolved through ongoing collaboration within the multi-disciplinary design team, the client team, stakeholders and through consultation with affected landowners and the public. The collaboration resulted in multiple design iterations, with the design evolving through these iterations into the optimum design as presented in this report. Examples of this iterative design process which have resulted in changes from the DMRB Stage 2 design are summarised in the following paragraphs, with further details provided in Chapter 6 (Iterative Design Development) of the EIAR.

Design Development – Removal of a Roundabout at Dalguise Junction

4.11.8 The Preferred Route included a proposed roundabout connecting the southbound diverge and merge slip roads with the realigned B898 connector road to the east of the mainline at Ch. 6800. The earthworks footprint created by the roundabout at this location encroached into the Network Rail land boundary. The design has been refined to include a priority junction instead of a roundabout and to relocate the alignment further away from the Network Rail land. This has minimised the impact and provided sufficient space to accommodate the Inverwood Access Track (North). The traffic flows using the slip road are not significant, therefore have no bearing on the junction form.

Design Development – Dalguise Junction Vertical Alignment Redesign

4.11.9 Further assessment was undertaken to identify a highways design that would allow for the removal of the drainage pumping station which was deemed necessary on the realigned B898. Consideration was required to maintain existing levels at the Inver Rail Tunnel (Ch. 5750) and Inch Rail Tunnel (Ch. 7370), to the respective south and north of the Dalguise Junction, to allow the existing structures to be retained. A solution was found which involved lifting the mainline by

approximately 1.4m at the location of the Dalguise Junction Bridge (Ch. 6950). The lifting of the mainline alignment subsequently allowed the realigned B898 through the structure to be lifted and the gradient to be reversed to fall from west to south. The changes in the gradient ultimately allowed for a gravity fed drainage system to be proposed.

4.11.10 Raising the mainline and junction profile also reduced the size of the rock cutting to the west and increased fill requirements – reducing the surplus earthworks materials produced by the scheme.

Design Development – Provision of WCH User Routes

4.11.11 Consideration of provisions for walkers, wheelers, cyclists and horse-riders has formed a large part of the DMRB Stage 3 design development, with the aim of providing replacements or enhancements for the existing WCH routes impacted by the scheme, and further enhancements to the wider WCH network surrounding the proposed scheme, where feasible. All WCH routes have been considered in conjunction with all other elements of the DMRB Stage 3 design, and have been developed with input from relevant local and national bodies to best accommodate the needs of all users. The proposed routes are described in Table 3-7 in Chapter 3 (Proposed Scheme).

Design Development – Inver Parallel Access Track Removal

4.11.12 A parallel access track was previously provided connecting Inver to the SuDS located to the east of the A9 mainline at Ch. 5650. This required complex retaining walls, with sections of cantilever to support the parallel access track, extensions to culverts and increased embankment widths. This increased design footprint increased the flood risk within the area. To minimise the impact in this area a left-in, left-out junction was provided at Ch. 5500 to remove the need for the parallel access track.

Design Development – Flood Relief Culverts

4.11.13 At DMRB Stage 3, the guidance from SEPA on climate change allowance to be included in the design was revised - increasing the peak river flow allowances (used in the river flood modelling) to 53%. The effect of this increase required the mainline carriageway to be raised by approximately 1.7 metres from the DMRB Stage 2 design (this equates to 3.5m above the existing) between approximately Ch. 4100 – 4800 to allow for flood relief culverts to be provided through the carriageway embankment. These culverts were required to mitigate against the increased flood risk from the River Braan to the surrounding properties in Inver, and to prevent the flood water overtopping the proposed carriageway.

Design Development - Murthly Estate Access Track

4.11.14 The location of the Murthly Estate Access Track was updated to move the track closer to the A9 and follow the approximate route of the existing access to reduce the impact on existing planting.

4.11.15 A SuDS feature was originally sited between the A9 and the access track, with the access looping around it. To improve the landscape and visuals for those using the track, the SuDS feature was moved to the north-eastern side of the access track.

Design Development – Birnam Glen Bridge

4.11.16 In recognition of the complexities of maintaining access along Birnam Glen during construction, the form of the structure proposed was reconsidered to provide a single span arrangement. This would allow demolition and construction to be completed through a series of night time closures minimising the impact on the residents along Birnam Glen.

4.11.17 A number of alterative access roads, including through Ladywell Landfill Site, were considered during the DMRB Stage 3 Assessment. These were not progressed due to construction complexities and impact on the landfill site and associated environmental consents

Design Development – Birnam Junction Bridge Structure Form

4.11.18 In recognition of the proximity of rock to the existing ground level, in the area of the proposed Birnam Junction, the form of the structure proposed for the junction was reconsidered to make better use of the rock as a footing medium. This provided a more structurally efficient deck design to be adopted, using steel girders for the superstructure rather than concrete beams. The intermediate supports were switched from vertical concrete columns to inclined steel legs, with their footing positioned at the top of the rock cut. This has reduced rock excavation and length of supports. The overall impact is to create a more open crossing area for users passing below the structure, including the widening of the northbound verge to accommodate a 2.5m shared footway provision. This has reduced rock excavation and the length of the structural supports. It also creates a thinner overall deck construction, which has allowed a lowering of the mainline alignment in the junction area, achieving wider project benefits such as reduced earthworks and lower cost. The updated structural form is shown on Drawing A9P02-JAC-SBR-D_ML022_ST-DR-ST-0001 included in Volume 2: Engineering Drawings.

4.12 Climate, Topography and Land Use

4.12.1 The proposed scheme constitutes mainly online widening of the existing single carriageway A9 to facilitate the dual carriageway cross-section. The climate, topography and land use has negligible variation from that of the existing, which is described in greater detail in Chapter 2 (Existing Conditions), Section 2.2 (Scheme Location and Environment).

4.13 Ground Conditions, Geology and Geomorphology

General

4.13.1 The assessment of ground conditions underlying the route has been developed following completion of two principal phases of Ground Investigation (GI); a Detailed GI and a Supplementary GI, with the site works completed in February 2015 and September 2021 respectively. Further localised ground investigation works were also carried out at the site during this time, to build upon the findings from the Detailed GI and further inform ongoing and future design and assessment works.

4.13.2 The findings from the various ground investigations are contained in the following reports. Due to the proximity to the Tay Crossing to Ballinluig scheme to the north, and the consequential overlap of the boundaries for the projects, there are a number of exploratory positions undertaken as part of the latter scheme which are within the proposed scheme boundary, hence why these reports are included in the list below.

- Report on a Ground Investigation for the A9 Dualling: Birnam to Tay Crossing. Soil Engineering Geoservices Ltd, Project No. TA7397, November 2015.
- A9 Dualling Southern Section, Pass of Birnam to Tay Crossing, Report on Ground Investigation without Geotechnical Evaluation. Fugro Engineering Services, Contract No. G151043UA, June 2016.
- A9 Dualling Southern Section, Tay Crossing to Ballinluig, Report on Ground Investigation without Geotechnical Evaluation. Fugro Engineering Services, Contract No. G151043UB, June 2016.
- A9 Dualling, Tay Crossing to Killiecrankie, Preliminary Ground Investigation, Tay Crossing to Ballinluig, Report on a Ground Investigation without Geotechnical Evaluation. Fugro Engineering Services, Contract No. G161021UA, October 2018.
- Report on Ground Investigation without Geotechnical Evaluation, A9 Dualling Tay Crossing to Ballinluig, Detailed GI. Fugro GeoServices Limited, Document No. G181001U, April 2019.
- Report on the A9 Dualling, Project 2, Birnam Additional Boreholes. Soil Engineering Geoservices Ltd, Project No. TC8191A, August 2019.
- Report on the A9 Dualling: Tay Crossing to Ballinluig, Supplementary Ground Investigation. Soil Engineering Geoservices Ltd, Project No. TC8191, March 2021.
- Report on a Ground Investigation for A9 Dualling – Birnam to Tay Crossing Supplementary Ground Investigation. Soil Engineering Geoservices Ltd, Project No. TE8258, March 2023.

4.13.3 The information obtained through these investigations supplements the review of the published geology and historic GI records made during the DMRB Stage 2 assessment and enables an improved understanding of the site geology and geotechnical risks.

4.13.4 The findings from the above ground investigations have been used to inform the preparation of the Design for the proposed scheme.

Summary of Ground Conditions

4.13.5 The GI information for the site confirms the superficial deposits underlying the proposed route to comprise predominantly granular soils. These deposits typically comprise gravelly sand or sandy gravel but are often described as silty and occasionally clayey, with a variable cobble and boulder content. This correlates with the units identified by the published geology, namely Alluvium, River Terrace Deposits and Glacial Deposits.

4.13.6 Granular Alluvium was recorded in areas of lower elevations throughout the site and is associated with the floodplains of the Rivers Tay and Braan, Inchewan Burn and Mill Stream as well as some minor watercourses. A concentrated area of Cohesive Alluvium was recorded at the location of the proposed Dalguise Junction between Ch. 6900 to Ch. 7200, which supports the published geology in this area.

4.13.7 River Terrace Deposits (RTD) were typically encountered from Ch. 2400 northwards and often located at higher elevations associated with raised terraces (approximately 7 to 10 m above low water level of the River Tay). A channel of RTD was encountered between the current A9 and Perth Road at approximately Ch. 2500 where the deposits were loose predominantly sands and silts and contained pockets of peat. RTD were also encountered around the Inver area associated with a historical fan system.

4.13.8 Granular Glacial Deposits were encountered throughout the proposed route and were often encountered underlying the Alluvium and RTD but were on occasions encountered from ground level. These deposits were typically denser than the overlying materials. Cohesive Glacial Deposits were rarely encountered and were generally found in layers within the granular deposits.

4.13.9 Peat was encountered locally in a relatively small number of exploratory holes across the site. The most noticeable concentration of peat was recorded between the current A9 and Perth Road at approximate mainline Ch. 2500; however, no extensive areas of peat were recorded. The peat was typically encountered between ground level and 7.70m below ground level (bgl), varying in thickness from 0.10m to 2.60m.

4.13.10 Made Ground with anthropogenic material was encountered locally across the site, notably where exploratory holes were undertaken in areas adjacent to the existing A9 carriageway, other roads or areas of development (e.g. near the railway line, residential properties, farms, etc.). Typical anthropogenic material recorded includes brick, ash, glass, timber, wood, metal, concrete and tarmac.

4.13.11 Bedrock was encountered across the site and the lithology was generally found to be consistent with the published geology. Where encountered, the depth to rockhead was found to vary significantly throughout the site and was recorded between ground level and 79.50m bgl.

4.13.12 Bedrock was not encountered within the boreholes between Ch. 3900 to Ch. 5500 which encompasses the Inver area, suggesting bedrock is deeper within this section of the proposed route. This is in keeping with the published geology which suggests a possible infilled valley around this location.

4.13.13 Bedrock was proven between around 14 m and 36 m AOD at the southern end of the Tay Crossing, suggesting bedrock level is variable in this area. At the northern end of the Tay Crossing bedrock was encountered at -25.15m AOD.

4.13.14 The bedrock lithology is dominated by meta-sedimentary strata, particularly Psammite and Semi-pelite which are commonly interbedded. Schist was also commonly intersected during the ground investigation, particularly in the location of Birnam Junction and Dunkeld & Birnam Station.

4.13.15 Groundwater levels were monitored during the various investigations and did not show significant variations to what could be expected. Generally shallow groundwater was noted throughout the scheme, particularly in areas of the A9 floodplain.

General Earthworks Design Issues

4.13.16 It is considered that the superficial deposits excavated to form the cuttings will be largely re-usable as general earthworks fill material. This may require processing due to the high cobble and boulder content recorded in some of the deposits. Those deposits with high fines content with the potential to retain moisture, e.g. Cohesive Alluvium, may not be suitable for re-use as excavated and may require processing and/or treatment, or disposal off site.

4.13.17 Excavation of bedrock is anticipated in order to construct the proposed scheme. Rock cuttings are expected around Birnam Junction between Ch. 2000 and Ch. 2400 for the realigned B867 (Perth Road) and southbound merge to the mainline, and for the mainline widening between Ch. 6200 and Ch. 6500. The majority of excavated bedrock is likely to be defined as argillaceous due to the presence of semi-pelites and pelites with significant mica content within the interbedded strata. As a result, the material won from the rock cuttings is unlikely to be permissible for use as selected granular fill (Class 6) but may be suitable as a general granular fill (Class 1) for re-use within the proposed embankments or landscaping at the site.

4.13.18 Rock blasting is expected to be required to form the rock cuttings at the site. Blasting using pre-split techniques may reduce the potential for future slope instability. The extent of rock blasting required, and the appropriate techniques, will be assessed as part of the Specimen Design.

4.13.19 It is anticipated that the embankments will predominantly be constructed on competent River Terrace Deposits or Glacial Deposits. In areas where cohesive alluvial soils are recorded to be present, i.e. soft silts and clays, the earthworks are likely to require formation preparation in the form of excavation and replacement. Similarly, any peat deposits or Made Ground with anthropogenic material present either at surface or at depth shall require similar treatment.

4.13.20 Several reinforced earth embankments are proposed at the site to minimise the impact of the earthworks on the surrounding infrastructure and residential properties. Availability of acceptable materials should be considered within the design and earthworks management plan to minimise or avoid the need to import selected granular fill (Class 6) for the reinforced earth embankments.

4.13.21 The Scottish Road Network Landslides Study (Winter et al. 2008) identified a landslide hazard between Ch. 7600 and Ch. 8400, which encompasses the historic landslide event detailed in the Preliminary Sources Study Report. Detailed assessment of slope stability will be required to determine the appropriate slope angle for cutting and strengthening design taking cognisance of the geotechnical hazard.

Earthworks Volumes / Balance

4.13.22 The design shall aim to utilise a high proportion of site won material for the construction of embankments and for landscaping purposes. However, it is possible that selected granular fill shall require to be imported to site, for example for fill to structures. A summary of the estimated earthwork quantities for the construction of the proposed scheme is provided in Table 4-18.

Import / Export (Disposal)	Volume (m^3)
Estimated total fill required	779,306
Estimated bulk earthworks material excavated (acceptable and unacceptable topsoil, acceptable and unacceptable cut [including rock])	1,262,357
Estimated bulk unacceptable earthworks material for disposal	126,236
Re-used acceptable material (acceptable topsoil and cut [including rock])	779,305
Estimated earthworks materials import (topsoil and fill)	0
Estimated bulk earthworks material for disposal (acceptable and unacceptable topsoil, acceptable and unacceptable cut [including rock])	356,816

Table 4-18: Estimated Earthworks Quantities

4.14 Drainage, Hydrology and Hydrogeology

General

4.14.1 The proposed scheme drainage design has been designed in accordance with current design standards and good practice. The design standards are:

- DMRB CG 501 Design of highway drainage systems (hereafter referred to as CG 501) (DMRB, 2022b);
- DMRB CD 522 Drainage of runoff from natural catchments (hereafter referred to as CD 522) (DMRB, 2020f);
- DMRB CD 529 Design of outfall and culvert details (hereafter referred to as CD 529) (DMRB, 2021f); and
- DMRB CD 532 Vegetated drainage systems for highway runoff (hereafter referred to as CD 532) (DMRB, 2021e).

4.14.2 Other standards and guidance used include:

- Building Research Establishment (BRE) Digest 365 Soakaway design (BRE, 2003);
- Flood Estimation Handbook (FEH) (CEH, 2009);

- Flood Studied Report (FSR) (NERC, 1975);
- Institute of Hydrology Report No. 124 Method (Marshall DCW & Bayliss AC, 1994);
- Planning Advice Note (PAN) 79: Water and Drainage (Scottish Executive, 2006);
- Guidance for Transport Infrastructure Projects (Wat-SG-93) (SEPA, 2018);
- SEPA Guidance Note 2: Planning advice on Sustainable Drainage Systems (SEPA, 2010);
- SEPA Climate change allowances for flood risk assessment in land use planning (Version 5) (SEPA, 2024);
- SEPA Regulatory Method (WAT-RM-08) Sustainable Urban Drainage Systems (SUDS or SUD Systems) (SEPA, 2019);
- SuDS for Roads (SuDS Working Party, 2010);
- The SuDS Manual C753 (CIRIA, 2015);
- Technical Flood Risk Guidance for Stakeholders (SEPA, 2022); and
- The Water Environment (Controlled Activities) (Scotland) Regulations, 2011 (UK Government, 2011).

4.14.3 The following key stakeholders were consulted as part of the drainage design process:

- SEPA; and
- Perth & Kinross Council (PKC).

4.14.4 The proposed drainage design provides two levels of treatment for the A9 carriageways and junctions and one level of treatment for side roads within each catchment. This approach was agreed with SEPA. In general, this has been achieved through the use of SuDS features such as filter drains, ponds, detention basins, and swales, or proprietary SuDS comprising of geocellular storage units with hydrodynamic vortex separators, in order to meet the required water quality criteria.

4.14.5 SuDS ponds, basins and wetlands are anticipated to require an impermeable liner in order to retain a volume of water where appropriate.

4.14.6 The proposed trunk road networks and associated side road networks have separate drainage systems where feasible; this has not always been possible due to the topography and proximity to receiving watercourses. In general the drainage systems for the trunk road network will be maintained by Transport Scotland as the trunk road authority. The side road networks, where separated from the trunk road network, will be owned and maintained by PKC as the local road authority.

Drainage Features

4.14.7 The following provides a summary of the general drainage components that are proposed to manage surface water runoff in the proposed scheme drainage design.

Pre-earthwork Drainage System

4.14.8 Pre-earthwork drainage will take the form of ditches which will be constructed at the top of cuttings and the base of embankments where the adjacent natural catchment falls towards the earthworks, thus allowing the flow to be intercepted. Where natural catchments fall away from the carriageway and the proposed earthworks fall towards the carriageway, the flow from the earthworks slope is captured by the filter drains. The purpose of the pre-earthworks drainage is to collect runoff from the natural catchments and convey overland flow to the nearest watercourse and where possible maintain the existing hydrological regime of the natural catchment. Once operational, this system does not require treatment or attenuation prior to discharge as it drains the natural catchment and is predominantly kept separate from any of the potentially polluted carriageway runoff. The pre-earthworks drainage has been designed in accordance with CD 522. The ditches are designed to a 1 in 100-year (1% AEP) rainfall event.

4.14.9 During the construction of the works, drainage situated at the base of embankments will potentially contain sediment and will require careful management and appropriate mitigation measures to be installed prior to any runoff being discharged into the receiving watercourse. These measures are provided in Chapter 19 (Road Drainage and the Water Environment) in the EIAR and include:

- Avoiding stockpiling of materials and exposure of bare surfaces, limiting topsoil stripping and phasing stripping to areas where bulk earthworks are immediately programmed;
- Installation of temporary drainage systems/SuDS including pre-earthworks drainage;
- Treatment facilities to be scheduled prior to any works which may generate site run-off and sedimentation, to allow settlement and treatment of any pollutants contained in site runoff and to control the rate of flow before water is discharged into a receiving watercourse;
- Adoption of silt fences, check dams, settlement lagoons, soakaways and other sediment trap structures as appropriate;
- Maintenance and regrading of haulage route surfaces where issues are encountered with the breakdown of existing surface and generation of fine sediment;
- Provision of wheel washes at appropriate locations;
- Protection of soil stockpiles using bunds, silt fencing and peripheral cut-off ditches; and
- Restoration of bare surfaces throughout the construction period as soon as possible after the work has been completed.

Carriageway Drainage Systems

4.14.10 All new road surface and hardstanding areas will be drained by a positive drainage system, which will convey water from all impermeable areas to carriageway drainage systems.

4.14.11 The drainage pipe networks developed for the proposed scheme drainage design have been designed to accommodate a (100% Annual Exceedance Probability (AEP)) 1 in 1 year return period rainfall event in-bore without surcharging, and a (20% AEP) 1 in 5 year return period rainfall event where the surcharge levels do not encroach on the formation level, or sub-formation level where a capping layer is present. This also takes into account an allowance for climate change which is carried out by increasing peak rainfall intensities of the design storm by 39%, as outlined in SEPA 'climate change allowances for flood risk assessment in land use planning' and CG 501.

4.14.12 Filter drains are typically proposed to collect surface water runoff from the main carriageway together with surface water runoff from verges / cut slopes and any sub-surface draining of the pavement layers. These systems typically comprise of perforated pipes placed at the base of free draining filter stone material, through which the surface water percolates prior to entering the pipe. This filtration process provides an effective first level of treatment at source for removing sediment arising from the surface water runoff.

4.14.13 Gullies will be provided where the road is kerbed, typically where there are footways parallel to side roads. The gully connection pipes discharge to outfalls generally via longitudinal carrier pipes in the verge.

4.14.14 In constrained locations where it is not feasible to install a piped drainage system due to conflicts with the road infrastructure, particularly over bridge decks, at lay-bys and where flood relief culverts are proposed, a combined kerb drainage system will be used to collect and convey carriageway runoff. The combined kerb unit comprises of an edge of carriageway kerb unit with a number of inlet holes to the face and a hollow construction to create a channel for the conveyance of runoff. The unit also comprises of inlet holes to the base below the finished road surface which allow for the draining of pavement layers where required. The combined kerb and drainage systems will only be specified over short lengths of carriageway where it is not feasible to provide a filter drain as these units do not offer a level of treatment to carriageway runoff. Due to the short length within the overall drainage catchments, the absence of any treatment provision is not considered to be a significant issue and any potential influx of pollution will be addressed in a latter part of the treatment train. The water quality assessment which forms part of the environmental impact assessment has been undertaken with cognisance to the inclusion of combined kerb drainage.

Sustainable Drainage Systems (SuDS)

4.14.15 All runoff from the proposed scheme carriageways will typically be collected and conveyed to SuDS comprising of filter drains, ponds, detention basins, wetlands, swales or proprietary SuDS consisting of geocellular storage units with hydrodynamic vortex separators, which shall treat and attenuate runoff prior to it being discharged into the receiving watercourse.

4.14.16 During the design development, engineering and environmental factors were considered to confirm the design of each SuDS feature, including whether or not treatment and attenuation should be achieved through the use of a dry detention basin or wet retention ponds. The decision was based on a number of key factors contained within the CIRIA guidance which sets out the four pillars of SuDS design, which are water quantity, water quality, amenity and biodiversity. As such, the following was considered;

- Highways Agency Water Risk Assessment Tool (HAWRAT) assessment which shows the treatment levels of a retention pond are typically higher than a detention basin;
- Size and topography of the catchment area;
- Potential issues with seepage into any structural embankment;
- Integrating the SuDS feature within the surrounding landscape character and topography;
- Potential to contribute to visual amenity; and
- Potential to contribute to biodiversity including areas of potential habitat.

4.14.17 Chapter 19 (Road Drainage and the Water Environment) of the EIAR provides the outcomes of the process, while further details on the SuDS design principles to be adopted as part of the detailed design and construction of the proposed scheme are set out in Appendix A19-4 (SuDS and Water Quality) of the EIAR.

Detention Basin (Dry Pond)

4.14.18 Detention basins are depressions in the ground which, unlike ponds, remain dry except during, and immediately after, rainfall events. Surface water runoff is collected and conveyed from the carriageway pipe network where it then enters the basin for an additional form of treatment and subsequent attenuation. A flow control system in the form of a Hydro-Brake is installed at the basin outlet in order to control the rate of discharge into the receiving watercourse at a predetermined rate, to avoid an increase in flood risk which influences the required site-specific storage volume of the basin. Detention basins have been designed to attenuate runoff flows for a 1 in 200-year return period (0.5% AEP), with an additional 39% allowance to take account of climate change, and discharge at the equivalent 1 in 2 year (50% AEP or QMED) greenfield runoff rate. The detention basins will be lined with an impermeable liner to prevent ground water contamination.

Retention Pond (Wet Pond)

4.14.19 Wet retention ponds are features with a permanent pool of water (treatment volume) that provide both attenuation and treatment of surface water runoff. These are generally constructed as depressions in the ground comprising of a permanent pool level with extra storage for attenuation above the permanent level. Surface water runoff is collected and conveyed from the carriageway pipe network where it then enters the pond for the second level of treatment and subsequent attenuation. A flow control system in the form of a Hydro-Brake is installed at the

pond outlet in order to control the rate of discharge into the receiving watercourse at a predetermined rate, which influences the required site-specific storage volume of each pond. The retention ponds have been designed to attenuate runoff flows for 1 in 200-year return period (0.5% AEP) with an additional 39% climate change allowance and discharge at the equivalent 1 in 2 year (50% AEP or QMED) greenfield runoff rate. Generally, wet retention ponds have been specified where a greater level of treatment is required in order to meet the required water quality criteria for a specific site. Any impurities such as suspended solids or debris will settle at the bottom of the pond and permanently remain in the pool of water which gives the greater level of water quality treatment. The retention pond will be lined with an impermeable liner to prevent potential ground water contamination.

Swales

4.14.20 Swales are shallow, flat bottomed, vegetated channels designed to convey runoff and provide attenuation and treatment. Berms can be installed perpendicular to the flow path to allow runoff to temporarily pond, thus increasing pollutant retention and infiltration, as well as further reducing flow velocity. It is proposed that dry swales are adopted in order to allow infiltration into groundwater, which will provide enhanced treatment and attenuation.

4.14.21 For the purposes of the A9 Dualling Pass of Birnam to Tay Crossing project swales will be used as a second level of treatment for mainline drainage where surface water runoff is collected and conveyed from the carriageway pipe network for treatment and subsequent attenuation. A flow control system in the form of a Hydro-Brake is installed at the swale outlet in order to control the rate of discharge into the receiving watercourse at a predetermined rate to avoid an increase in flood risk. This influences the required site-specific storage volume of each swale. Swales are vegetated which helps remove suspended solids providing some form of filtration.

4.14.22 Swales proposed for the A9 Dualling Pass of Birnam to Tay Crossing project have designed for inundation during the 1 in 30 year return period (3.33% AEP) with an additional 39% climate change allowance, and discharge at the equivalent 1 in 2 year (50% AEP or QMED) greenfield runoff rate.

Geocellular Storage

4.14.23 Geocellular storage is a system of modular plastic units with high porosity (95% void ratio) that can be used to efficiently create a sub-surface structure for the temporary storage of surface water runoff before controlled release into the receiving watercourse. Surface water runoff is collected and conveyed from the carriageway pipe network where it then enters the Geocellular storage system. The storage tank does not provide a secondary form of treatment. A flow control system in the form of an HVS is installed at the Geocellular storage system outlet in order to control the rate of discharge into the receiving watercourse at a predetermined rate to avoid an increase in flood risk which influences the required site specific storage volume of each storage tank. The Geocellular storage system has been designed to attenuate runoff flows for the 1 in 200 year return period (0.5% AEP) with an additional 39% allowance to take account of climate change and discharge at the equivalent 1 in 2 year (50% AEP or QMED) greenfield runoff rate.

Hydrodynamic Vortex Separator (HVS)

4.14.24 Hydrodynamic Vortex Separators are proprietary products designed to remove sediments in suspension and floatable debris in the flow of highways surface runoff.

4.14.25 Two levels of SuDS treatment have been identified as a minimum requirement for the proposed scheme mainline and junctions. On catchment C1 shown on Drawings A9P02-JAC-HDG-D_ML015_SU-DR-DE-0002 and A9P02-JAC-HDG-D_ML030_SU-DR-DE-0003 within Volume 2: Engineering Drawings, a second level of treatment has been achieved through the adoption of a proprietary system (HVS with a Geocellular storage unit) as opposed to conventional SuDS. This is due to the catchment being considered a 'constrained site' given the limited land available between the mainline carriageway, the proposed Dunkeld & Birnam Station car park and the surrounding properties where a SuDS feature cannot be accommodated due to spatial constraints.

Carriageway Drainage System – Proposed Networks

4.14.26 The new dual carriageway and side road catchments are generally defined by the high and low points along the vertical alignment of the road and the location of the existing watercourses. The SuDS proposals are summarised below:

- Minimum of two levels of treatment prior to outfalling to receiving watercourse;
- First level of treatment is achieved by utilising filter drains to capture runoff at source. Proposed filter drains will run parallel to the carriageway edge; and
- Next level of treatment is achieved by utilising a retention pond, detention basin, swale or geocellular storage system with hydrodynamic vortex separator to attenuate and treat surface water runoff prior to it being discharged to the receiving watercourse.

4.14.27 Table 4-19 details the 11 carriageway drainage networks on the proposed dual carriageway. The extent of each drainage network is shown on the Drainage Catchment Drawings included in Volume 2: Engineering Drawings. Further details on the proposed SuDS and forms of treatment can be found in Chapter 19 (Road Drainage and the Water Environment) of the EIAR.

Catchment Reference	Section	Approximate Catchment Length (m)		Indicative Treatment & Attenuation Measures	Receiving Watercourse
		Chainage Start	Chainage End		
Catchment A	Lay-by provision at Southern Extent of Scheme to Murthly Estate Bridge and section of the realigned Murthly Estate Access Track	-577	885	Filter Drain & Detention Basin	River Tay (SAC) (WF6)
Catchment B1	Murthly Estate Bridge to south of Birnam Junction Bridge and northbound slip roads	885	2,230	Filter Drain & Detention Pond (with wet pond)	River Tay (SAC) (WF6) via WF5A
Catchment B2	North of Birnam Junction to Ch. 2,650 and Realigned B867/Perth Road and Birnam Junction southbound merge	2,230	2,820	Filter Drain & Detention Basin	River Tay (SAC)(WF6)
Catchment C1	North of Birnam Junction to Dunkeld and Birnam Station Pedestrian Underpass	2,820	3,350	Filter Drain, Hydrodynamic Vortex Separator & Geocellular Storage	Inchewan Burn (WF8)
Catchment C2	Dunkeld and Birnam Station Pedestrian Underpass to Inchewan Burn Bridge	3,350	3,450	Filter Drain & Dry Swale	Inchewan Burn (WF8)

Catchment Reference	Section	Approximate Catchment Length (m)		Indicative Treatment & Attenuation Measures	Receiving Watercourse
		Chainage Start	Chainage End		
Catchment D	Inchewan Burn Bridge to the River Braan Bridge including Dunkeld Roundabout and realigned sections of A822 and Unclassified Road to Inver.	3,450	4,330	Filter Drain & Detention Basin	River Braan (WF11)
Catchment E	Realigned A923	-	-	Filter Drain & Dry Swale	Existing Drainage Network within A923
Catchment F	River Braan Bridge to north of the Hermitage Junction	4,330	5,490	Filter Drain, Detention Basin & Dry Swale	Mill Lade (WF12)
Catchment G	North of the Hermitage Junction to North of the Inver Rail Tunnel	5,490	6,150	Dry Swale & Detention Basin	River Tay (SAC) (WF6)
Catchment H	North of the Inver Rail Tunnel to Tay Crossing	6,150	7,450	Filter Drain & Detention Basin	River Tay (SAC) (WF6)
Catchment I	Tay Crossing to end of scheme	7,450	8,421	Filter Drain & Detention Basin	River Tay (SAC) (WF6)

Table 4-19: Dual Carriageway Drainage Networks

Side Road Drainage

4.14.28 As part of the drainage design of the proposed scheme there are a number of locations where the design shall tie-in with the local authority side road network. In this instance, where this section of the drainage design shall subsequently be adopted by PKC, it shall be designed to the appropriate design criteria as agreed by PKC for the adoption of assets. These design criteria are outlined in Flood Risk and Flood Risk Assessments, Developers Guidance Note on Flooding and Drainage (Perth and Kinross Council, 2014).

B867/Perth Road

4.14.29 The realigned B867/Perth Road passes under the A9 mainline carriageway forming part of the proposed Birnam Junction. The road will be kerbed and therefore drainage system here will incorporate gully drains and runoff will be treated within the attenuation feature for the mainline drainage system.

A923

4.14.30 The realigned A923 arm of the proposed Dunkeld Junction shall tie-in with the existing A923 side road. The catchment within this area shall utilise an oversized filter drain system and then be attenuated by way of a swale, before tying into the existing A923 side road drainage network.

A822 and Unclassified road to Inver

4.14.31 The A822 (Old Military Road) and Unclassified road to Inver are separate arms on the proposed Dunkeld Roundabout. The runoff will be drained though gully drains and treated within the attenuation feature for the mainline drainage system.

B898

4.14.32 The realigned B898 side road passes under the mainline carriageway as part of the proposed Dalguise Junction and as such is included within the mainline catchment. The realigned B898 will be kerbed and therefore the drainage system here will incorporate gully drains and runoff will be treated within the attenuation feature for the mainline drainage system.

Private Access Drainage

4.14.33 Drainage for all private access tracks will be based on the catchment size and anticipated traffic level of each access. All private access tracks will have a minimum one level of treatment provided in the form of a grass ditch situated at either edge of the track. The ditch shall discharge into the adjacent minor watercourse where practicable. Where there is no receiving watercourse available, any runoff from the track will be collected by the ditch and allowed to infiltrate the ground, where appropriate. The Simple Index Approach (SIA) in accordance with the CIRIA guidance has been used to assess that the required water quality parameters are met, and this also takes cognisance of the projected usage of each access track.

4.14.34 The realigned section of Murthly Estate access Track has been included in the mainline drainage network (Catchment A).

Impact of Minor Watercourse Crossings

4.14.35 Impact of the proposed scheme on the existing minor watercourses has been assessed and extension and replacement of existing crossing structures has been proposed where required. Where existing structural culverts are to remain in place, they are to be extended in length to cater for the additional width of carriageway. A number of structures will be replaced to avoid conflicts with the proposed scheme and may also incorporate other features such as mammal crossings. Due to the alignment of the proposed scheme, a new culvert structure is required for WF13 to allow conveyance to bypass the proposed Dalguise Junction arrangement to the River

Tay (SAC). There are a total of 11 culvert extension and replacements, and 1 new culvert crossing as described in Table 3-5 in Chapter 3 of the DMRB Stage 3 Report. More detail can be found in the Watercourse Crossing Report (WCR) included as Appendix 19-3 of the EIAR.

Flood Risk Assessment

4.14.36 The flood risk impacts of the proposed scheme are included within the Flood Risk Assessment (FRA) in Appendix 19-2 of the EIAR. The FRA has been undertaken in order to assess the existing flood risk, identify potential flood risk impacts associated with the proposed scheme, and where necessary, give consideration to appropriate flood mitigation / flood management measures including compensatory flood storage. The FRA has been undertaken to evaluate the impacts of both the 1 in 30 year (3.33% AEP) and the 1 in 200 year (0.5% AEP) plus a 53% allowance for climate change, in accordance with SEPA climate change guidelines.

4.14.37 The proposed scheme drainage design development has been undertaken in conjunction with the FRA which has informed the associated flood risk and associated levels for the design of the outfalls which discharge into both principal watercourses and a number of minor watercourses. In addition, the location of the SuDS features has been assessed to ensure that they are outwith the functional floodplain where practicable and, where not, are not considered at risk of compromising the functional floodplain. However it is accepted these will be inundated with flood water during the 1 in 200 year (0.5% AEP) rainfall event plus climate change allowance.

Design Development

4.14.38 Various iterations have been made to the drainage design throughout the proposed DMRB Stage 3 scheme design process in order to avoid or mitigate the potential impacts to the surrounding environment and establish a suitable balance in accordance with the environmental constraints. These design iterations have focussed on the impacts to the receiving watercourses, the positioning of SuDS features relative to surrounding constraints and the decision-making process for the most appropriate SuDS measures at each site.

4.14.39 Following the design review process in relation to drainage outfall locations and the potential impacts upon water quality and geomorphology, there have been a number of iterations to the outfall sites in order to identify the most appropriate position, that minimises impacts to surrounding environmental and ecological constraints such as the Ancient Woodland Inventory and Fresh Water Pear Mussels within the River Tay (SAC).

4.14.40 The proposed scheme includes 12 SuDS features and a single Geocellular storage unit, to treat or store runoff before providing attenuation from the proposed dual carriageway to acceptable levels prior to discharging into receiving watercourse. The construction and footprint of the features are included as part of the proposed scheme as an embedded measure to mitigate potential water quality and flooding impacts.

4.14.41 Furthermore, the location of each SuDS feature has been given careful consideration in order to identify the most appropriate site in each instance and mitigate the impacts of providing these. The SuDS features are shown on the Drainage Catchment Drawings included in Volume 2:

Engineering Drawings. The following design refinements were made to the SuDS locations throughout the design process:

Catchment A

4.14.42 The original proposed SuDS attenuation feature, located between the A9 southbound carriageway and the realigned Murthly Estate Access Track, was relocated to minimise visual and landscape impacts on the Murthly Castle Gardens and Designed Landscapes (GDL). The revised location positions the SuDS feature on the north-east side of the realigned access track.

Catchment B

4.14.43 Due to insufficient cover levels for drainage pipes across Birnam Junction, Catchment B was subdivided into two Catchments B1 and B2. Catchment B1 (Ch. 885 – 2,230), incorporates a Detention Pond located immediately south of the proposed northbound diverge at Birnam Junction. Access to this location is provided directly from the realigned B867/Perth Road. The SuDS feature discharges into a minor watercourse (WF5A) within the northbound loop, which subsequently outfalls to the River Tay. Catchment B2 (Ch. 2,230 – 2,820): incorporates a Detention Basin with an element, located within the northern boundary of the GDL to mitigate potential visual impacts on adjacent properties.

Catchment C

4.14.44 To address insufficient cover across the proposed pedestrian underpass at Dunkeld & Birnam Station, Catchment C was divided into Catchments C1 (Ch. 2,820m to 3,350) and C2 (Ch. 3,350 to 3,460). Catchment C1 incorporates a High Velocity Separator (HVS), and a Geocellular storage unit which is located east of station car park. Catchment C2: Utilises filter drains for collection of runoff and a dry swale which is located west of station car park.

Catchment G

4.14.45 Due to issues with the drainage cover levels over the Inver Rail bridge, the catchment utilises combined drainage kerbs over the structure to convey the runoff. In order to provide the required levels of treatment, the drainage network is treated in the first instance via a swale located immediately adjacent to the southbound carriageway of the proposed A9 at Ch. 5650, and outfalling into the detention basin located between the swale and the River Tay.

Catchment H

4.14.46 The initial assessment indicated the requirement of a pumping station and rising main due to perceived limitations in achieving a gravity-fed drainage solution. However, through design refinement and adjustments to the vertical road geometry, a viable gravity-fed solution was identified, eliminating the need for a pumping station. Catchment I was incorporated into the design to manage drainage for the section of the project north of the River Tay Crossing. Drainage for this catchment will outfall to the River Tay via a detention basin.

4.15 Public Utilities

4.15.1 Public utility companies were contacted in accordance with the New Roads and Street Works Act 1991 (NRSWA) (UK Government, 1991) to identify locations of existing plant and details of preliminary proposals for diversions and budget costs. In total, five public utility companies: Openreach; Scottish Water; Scottish and Southern Electricity Networks (SSEN); SGN and O2/Vodafone have identified apparatus that conflict with the proposed scheme, requiring diversionary and/or protection measures to be provided prior to and during construction. Diversionary works may also be proposed where utilities run within an existing verge where works such as ITS, drainage and VRS are proposed and will clash with existing utilities.

4.15.2 During the DMRB Stage 3 scheme development and assessment it was agreed to forego the NRSWA C3 stage in favour of going directly to seeking C4 estimates regarding utility apparatus in the vicinity of the proposed scheme. This proposal was received positively from the Statutory Undertakers, and works have been progressing on this basis.

4.15.3 Throughout the design development, consultation has been undertaken with Statutory Undertakers to develop the required diversions.

Openreach

4.15.4 There are existing underground cables present in either one or both existing A9 verges for the length of the proposed scheme. There are also A9 crossings in the vicinity of the proposed Birnam Junction and the proposed Dunkeld Junction.

4.15.5 At the time of publication, although consultation has been undertaken throughout the design development, the final details of the diversions have still to be finalised in consultation with Openreach.

Scottish Water

4.15.6 There are four known locations where existing Scottish Water apparatus crosses the A9 and surrounding works. These are:

- Birnam Junction;
- Dunkeld and Birnam Railway Station;
- Birnam Glen; and
- Dunkeld Junction.

4.15.7 At the time of publication, although consultation has been undertaken throughout the design development, the final details of the diversions have still to be finalised in consultation with Scottish Water.

Scottish and Southern Electricity Networks (SSEN)

4.15.8 Based on information provided by SSEN as part of the NRSWA C4 estimate, there are existing SSEN cables in the vicinity of roads throughout the proposed scheme, with existing SSEN apparatus crossing the A9 at several locations. Existing SSEN apparatus will require a diversion in order to integrate with the proposed scheme as outlined below:

- Approximate Ch. 400 to Ch.900 – SSEN anticipate that the existing 11kV overhead line will be impacted by the proposed SuDS pond and connected Murthly Estate access track and should be diverted to avoid interaction with the proposed scheme.

- Approximate Ch. 1100 to Ch. 1250 – An existing 11kV overhead line runs parallel to the existing A9 at this location. SSEN has anticipated that this line will be impacted by the proposed A9 and should be replaced with an underground 11kV cable.

- Approximate Ch. 2850 – SSEN has anticipated that an existing pole will be affected by the A9 dualling and should be replaced with a new pole and stay. SSEN anticipate that directional drilling may be required under the existing railway to connect together both the existing and new poles.

- Approximate Ch. 3375 – The existing SSEN substation on Station Road will be impacted by the proposed train station car park. SSEN has anticipated that the substation will need to be relocated to avoid interaction with the proposed scheme.

- Approximate Ch. 4600 to Ch. 5360 – Existing 11kV underground and 11kV overhead lines run parallel to the existing A9 at this location and SSEN has anticipated that these lines will be impacted by the proposed A9 and should be replaced with an underground 11kV cable, including two directionally drilled crossings.

- Approximate Ch. 5750 to 6700 - Existing 11kV underground and 11kV overhead lines run parallel to the existing A9 at this location and SSEN has anticipated that these lines will be impacted by the proposed A9 and should be replaced with new 11kV underground and overhead lines, including a directionally drilled crossing.

SGN

4.15.9 High Pressure Gas - There is an existing High Pressure gas main which crosses the proposed A9 near Byres Wood at the southern extent of the scheme. It also crosses the A9 two times in the vicinity of the proposed Dunkeld Junction.

4.15.10 Intermediate Pressure Gas - There is an existing Intermediate Pressure gas main which interacts with the proposed A9 between Inver and north of Dalguise Junction. This Intermediate Pressure gas main also crosses the proposed A9 to the east of Inver and interacts with the proposed Dunkeld Junction.

4.15.11 Low Pressure Gas - There is an existing Low Pressure Gas main which crosses the proposed A9 to the west of Dunkeld and Birnam Railway Station.

4.15.12 At the time of publication, although consultation has been undertaken throughout the design development, the final details of the diversions have still to be finalised in consultation with SGN.

O2/Vodafone

4.15.13 Approximate Ch. 6500 - An existing telecommunications mast is located to the west of the A9. At the time of publication, although consultation has been undertaken throughout the design development, the final details of the diversions have still to be finalised in consultation with O2/Vodafone.

4.15.14 Approximate Ch. 7370 - An existing telecommunications mast is located to the south of the River Tay Underbridge, east of the A9. This mast will likely be impacted by the proposed A9 and require relocating.

4.16 Structures

General

4.16.1 Various structures are included within the design of the proposed scheme. Within this section of the report, these structures are described from south to north.

4.16.2 Details of the likely structural solution are provided in each case. All structural solutions described have been designed in accordance with DMRB standards and Eurocodes. It is not envisaged that any Departures from Standards will be required at this stage of the scheme development in relation to the proposed structures.

4.16.3 The proposals below are based on adopting concrete construction, either cast in-situ or precast, where spans and clearance permit, as this is generally the most cost-effective type of construction. However, where larger spans cannot be avoided, steel concrete composite construction is likely to be used.

4.16.4 Wherever possible, integral construction has been proposed to minimise long-term maintenance requirements and costs where the overall length of the structure does not exceed 60m and the skew does not exceed 30 degrees. In cases where integral construction is not appropriate, bearings and movement joints will be provided in conjunction with abutment inspection galleries.

4.16.5 The general arrangements of the proposed structures that are referred to below are shown on the Structural General Arrangement Drawings included in Volume 2: Engineering Drawings.

4.16.6 The proposed scheme incorporates:

- Three existing bridges and one existing culvert, all of which are retained and modified;
- Replacement of two bridges;

- One existing retaining wall which is retained without modifications;
- Five new bridges and one new underpass; and
- Seven new retaining walls.

4.16.7 These structures are as follows:

Murthly Estate Bridge (Ch. 0880)

4.16.8 This new structure will carry the A9 dual carriageway over a new road providing access to Murthly Estate. The dual carriageway alignment remains at existing carriageway level and the access road is in cutting below.

4.16.9 The new structure will be a single span integral bridge with a clear square span length of approximately 11 metres and no skew. The structure width will be approximately 27 metres. The structure will comprise precast concrete arch units on concrete abutments. It is likely that the new structure will adopt piled footings. Stone masonry cladding will be applied to the exposed concrete surfaces to improve the structure's aesthetics. The structure will provide minimum headroom of 5.3m.

4.16.10 1.0m high N2 parapets will be provided over the structure.

Birnam Junction Bridge (Ch. 2200)

4.16.11 This new structure will carry the A9 dual carriageway over the realigned B867/Perth Road. The cross-section of the dual carriageway tapers over the length of the structure to accommodate the northbound merge slip road.

4.16.12 The structure will be a skewed three-span structure with the deck continuous over short raking leg supports close to each abutment. It will be simply supported at the abutments, as the skew is approximately 58° i.e. in excess of 30°. The skewed central span length is approximately 43.5 metres and the side span length is approximately 9.0 metres. The square width of the deck is approximately 32 metres. The deck will comprise built-up steel plate girders composite with an in-situ reinforced concrete slab. The structure will provide minimum headroom of 5.3m.

4.16.13 The substructure will be reinforced concrete bank seat abutments and intermediate supports comprising inclined built-up steel plate girders. It is likely that the new structure will be footed on rock. Abutment galleries will be provided to allow for future inspection and maintenance of bearings and expansion joints.

4.16.14 1.0m high N2 parapets will be provided over the structure.

Dunkeld and Birnam Station Underpass (Ch. 3340)

4.16.15 This new structure will carry the A9 dual carriageway and existing railway over a pedestrian access from the new station car park and entrance plaza area to Dunkeld & Birnam Station.

4.16.16 The structure will have four discrete sections, comprising an underpass beneath the dualled A9, a section comprising lift and stair access to Platform 1, an underpass beneath the existing railway and a section comprising lift and stair access to Platform 2.

4.16.17 The underpass beneath the dualled A9 will be a single span structure with a clear square span length of 5 metres, no skew and a roof with a shallow arched profile achieving a minimum headroom of 2.5 metres. The underpass will have an entrance canopy incorporating an arched profile to match the underpass roof profile. The length of the underpass will be approximately 28 metres. The underpass will comprise precast concrete box sections to minimise construction time. 1.0 metre high N2 parapets will be provided over the structure.

4.16.18 The section between the two underpasses will facilitate access to and from Platform 1 and will incorporate structures supporting stair and lift access.

4.16.19 The underpass beneath the existing railway will be a single span structure with a clear square span length of 2.5 metres, no skew and a roof with a shallow arched profile achieving a minimum headroom of 2.5 metres. The length of the underpass will be approximately 14 metres. The underpass will comprise precast concrete box sections to minimise construction time. It is anticipated that the structure will be constructed during a weekend closure of the HML railway.

4.16.20 The section at the south end of the underpass will facilitate access to and from Platform 2 and will incorporate structures supporting stair and lift access.

Dunkeld and Birnam Station Car Park Retaining Wall (Ch. 3320 – Ch. 3360)

4.16.21 A new retaining wall is required at the eastern end of the station car park to minimise encroachment of the cutting slope into adjacent private property. It is likely to be a contiguous bored pile wall with a reinforced concrete facing, with the piles being of in-situ reinforced concrete construction. The wall will have a retained height of up to 3.5m with a front elevation approximately 40m long.

Dunkeld and Birnam Station Retaining Wall (Ch. 3280 – Ch. 3380)

4.16.22 A new retaining wall is required at the rear of the southbound verge to accommodate the level difference between the A9 carriageway and the new station car park area. It is likely to be a contiguous bored pile wall with a masonry facing to the car park side. It is anticipated that the wall will extend up to 2 metres above the A9 verge level to provide visual screening of the carriageway area for visual receptors on Station Road. This screening wall will also act as the vehicle parapet over the length of the wall, with the roadside face also having a masonry facing. The piles will be of in-situ reinforced concrete construction and the wall will have a retained height of up to 5.5m with a front elevation approximately 100m long.

Birnam Glen and Inchewan Burn Bridge (Ch. 3460)

4.16.23 The existing structure is to be demolished and a new structure is to be constructed. The complete replacement of the existing bridge is required to accommodate the dualled alignment and to

maintain the headroom provision above Birnam Glen Road at a clearance no less than the adjacent railway structure.

4.16.24 The new structure will carry the A9 dual carriageway over Birnam Glen road and Inchewan Burn, which is a tributary of the River Tay.

4.16.25 The new bridge will be a single-span structure with a width of approximately 28.4 metres and a skew angle of approximately 6°. The clear skew span over Birnam Glen and Inchewan Burn will be approximately 25 metres long.

4.16.26 The structure will be integral and the superstructure will comprise built-up steel plate girders composite with an in-situ reinforced concrete deck slab. The substructure will comprise reinforced concrete abutments. It is likely that the new structure will be able to adopt spread footings.

4.16.27 1.0m high N2 parapets will be provided over the structure.

Birnam Retaining Wall (Ch. 3500 – Ch. 3850)

4.16.28 A new retaining wall is required to minimise the plan extent of cutting required on the northbound side of the A9 dual carriageway extending towards the Highland Main Line (HML) railway embankment. It is likely to be a contiguous bored pile wall with a reinforced concrete facing, with the piles being of in-situ reinforced concrete construction. The wall will have a retained height of up to 5.2 metres with a front elevation approximately 350 metres long.

A822 Retaining Wall (Ch. 3960 – Ch. 4040)

4.16.29 A new retaining wall is required to minimise the plan extent of cutting resulting from this section of the realigned A822 extending into the HML railway embankment. It is likely to be a contiguous bored pile wall with a reinforced concrete facing, with the piles being of in-situ reinforced concrete construction. The wall will have a retained height of up to 4.4 metres with a front elevation approximately 75 metres long.

A923 Retaining Wall (Ch. 4020 – Ch. 4050)

4.16.30 A new retaining wall is required to minimise the plan extent of embankment required adjacent to the realigned A923, accommodating the level difference to an existing access road. It is likely to be of reinforced concrete construction. The wall will have a retained height of up to 3.0 metres with a front elevation approximately 70 metres long.

4.16.31 A 1.0m high N2 parapet will be provided over the structure.

River Braan Bridge (Ch. 4330)

4.16.32 The existing structure is to be demolished and a new structure is to be constructed. The complete replacement of the existing bridge is required as it lies below the 1 in 200 year plus climate change flood level, meaning that it cannot be retained.

4.16.33 The new structure will carry the A9 dual carriageway over the River Braan, which is a tributary of the River Tay and forms part of the River Tay SAC. The new alignment raises the proposed mainline carriageway by approximately 3 metres above the existing A9 carriageway at the river crossing. The new structure will be a single span integral bridge with a clear square span length of approximately 53 metres and no skew. The width of the new bridge will be approximately 33.6 metres.

4.16.34 The structure will have a composite deck of five braced pairs of steel plate girders with a transversely spanning reinforced concrete slab. The substructure will be reinforced concrete bank seat abutments. It is likely that the new structure will be able to adopt spread footings.

4.16.35 1.0m high N2 parapets will be provided over the structure.

River Braan Flood Relief Culverts (Ch. 4450 – Ch.4560)

4.16.36 14 new flood relief culverts are required through the A9 embankment. These are likely to be reinforced concrete boxes of 3.2 metres wide and 1.2 metres high internal dimensions.

River Braan Retaining Wall (Ch. 4370 – Ch. 4640)

4.16.37 A new retaining wall is required to minimise the plan extent of embankment on the southbound side of the A9 dual carriageway. It is likely to be of reinforced concrete construction. The wall will have a retained height of up to 2 metres with a front elevation approximately 270 metres long.

4.16.38 1.0m high N2 parapets will be provided over the structure.

Inver Mill Lade Culvert (Ch. 4940)

4.16.39 The existing culvert will be retained to carry the A9 dual carriageway over the Inver Mill Lade watercourse. The proposed road alignment at this location would require an embankment extending beyond the plan extent of the existing structure on one side only (the north side). A new, structurally separate, retaining wall (see below) will retain the road in this area to prevent encroachment of the embankment into the adjacent riverside area and flood plain.

4.16.40 A structural assessment has recorded that the existing culvert has adequate capacity to sustain the effects of 40t Assessment Live Load as defined in DMRB CS 454 'Assessment of highway bridges and structures' (hereafter referred to as CS 454) (DMRB, 2022c), and also the SV80, SV100, SV150 and SV196 vehicles as defined in DMRB CS 458 'The assessment of highway bridges and structures for the effects of special type general order (STGO) and special order (SO) vehicles' (hereafter referred to as CS 458) (DMRB, 2020e).

4.16.41 The culvert will require a short extension of about 2 metres in width at the downstream (north) end to accommodate a re-routed footpath in this area. The extension will mirror the form and dimensions of the existing culvert. The existing downstream wingwalls will be demolished and reconstructed as part of this modification.

Inver Mill Lade Culvert Retaining Wall (Ch. 4870 – Ch. 4980)

4.16.42 A new retaining wall is required at the rear of the southbound verge of the A9 dual carriageway to prevent encroachment of the embankment into the adjacent riverside area and flood plain. It is likely to be of reinforced earth construction with precast concrete facing panels. Precast concrete cope units will provide support to a 1.0m high N2 parapet. The wall will have a retained height of up to 9.0 metres with a front elevation approximately 110 metres long.

Hermitage Retaining Wall (Ch. 5170 – Ch. 5230)

4.16.43 The existing retaining wall on the northbound approach to the Hermitage access will be retained without modification.

Inver Rail Bridge (Ch. 5750)

4.16.44 The existing structure will be retained and extended to the north to accommodate the proposed dualling. Although this will require a joint beneath the A9 central reserve, the size of the existing structure and the associated railway interface means complete replacement of the structure is not deemed necessary.

4.16.45 The extended structure will carry the A9 dual carriageway across the HML railway.

4.16.46 The existing bridge is a single span structure of precast, prestressed concrete beams composite with in-situ concrete infill. A structural assessment has recorded that the structure has adequate capacity to sustain the effects of 40t Assessment Live Load as defined in CS 454 and also the SV80, SV100, SV150 and SV196 vehicles as defined in CS 458, all at the ultimate limit state.

4.16.47 The extension will be an integral single span structure with a 30-degree skew and a square span length of 10.5 metres, allowing the abutments to be setback 4.5 metres from the railway tracks. The extension will be approximately 70 metres long. The superstructure will comprise precast, prestressed concrete MY beams composite with in-situ concrete infill to minimise construction time and hence railway possessions.

4.16.48 The abutments will comprise full height reinforced concrete walls and the abutments and wingwalls are likely to be supported on piled footings. The existing wingwalls at the north end of the existing structure will be demolished to accommodate the new extension.

4.16.49 1.8 metre high H4a very high containment parapets will be provided over the structure.

4.16.50 Potential works to the retained structure include installation of H4a parapets, provision of ducts, bridge deck re-waterproofing, re-surfacing, renewal of expansion joints and remedial work to any identified defects.

Dalguise Junction Bridge (Ch. 6950)

4.16.51 This new structure will carry the A9 dual carriageway and northbound merge slip road over the realigned B898. The bridge curves in plan and the span increases to the western end of the bridge to follow the curvature of the road.

4.16.52 The bridge will be an integral single span structure with a clear square span length varying from approximately 17.3 metres to 20 metres, a clear skew span length varying from approximately 20 metres to 23.5 metres and a skew angle of approximately 30°. The overall length of the proposed structure will be approximately 130 metres. The substructure will be formed of full height reinforced concrete abutments on piled footings. The structure will provide minimum headroom of 5.3 metres.

4.16.53 1.0m high N2 parapets will be provided over the structure.

Dalguise Access Track Rail Bridge (Ch. 7030)

4.16.54 This new structure will carry the HML railway over a maintenance access track.

4.16.55 The bridge will be a buried single span structure with a clear square span length of 4.5 metres, a skew of 30° and headroom of 3.9 metres. The width of the bridge will be approximately 15 metres.

4.16.56 The bridge will comprise an in-situ reinforced concrete box structure. It is anticipated that the structure will be constructed offline and rolled into place during a weekend closure of the HML railway.

Inch Rail Bridge (Ch. 7370)

4.16.57 The existing structure will be retained and extended to the south to accommodate the proposed dualling. Although this will require a joint beneath the A9 southbound carriageway between the existing and the proposed structures, the size of the existing structure and the associated railway interface means complete replacement of the structure is not deemed necessary.

4.16.58 The extended structure will carry the A9 dual carriageway across the HML railway.

4.16.59 The existing bridge is a single span structure of precast, prestressed concrete beams composite with in-situ concrete infill. A structural assessment has recorded that the structure has adequate capacity to sustain the effects of 40t Assessment Live Load as defined in CS 454 and also the SV80, SV100, SV150 and SV196 vehicles as defined in CS 458.

4.16.60 The structure will be extended using a similar span configuration to the existing. The extension will be an integral single span structure with the deck square to the abutments and with a 9.7 metre clear span length. The extension will be approximately 62 metres long. The superstructure will comprise precast, prestressed concrete MY beams composite with in-situ concrete infill to minimise construction time and hence railway possessions.

4.16.61 The abutments will comprise full height reinforced concrete walls and the abutments and wingwalls are likely to be supported on piled footings. The existing wingwalls at the south end of the existing structure will be demolished to accommodate the new extension. The new wingwall at the southwestern corner of the structure will be unusually long as it is positioned at the rear of the Dalguise Junction southbound diverge and accommodates the level difference between the slip road and the railway.

4.16.62 1.8 metre high H4a very high containment parapets will be provided over the structure.

4.16.63 Potential works to the retained structure include installation of H4a parapets, provision of ducts, bridge deck re-waterproofing, re-surfacing, renewal of expansion joints and remedial work to any identified defects.

River Tay Bridge (Ch. 7550)

4.16.64 The existing three span structure across the River Tay is to be retained to accommodate the proposed northbound carriageway. Retaining the existing structure provides a cost-efficient solution, whilst reducing potential construction impacts on the River Tay SAC. Significant assessment and consultation were undertaken to determine the most suitable widening option for this location due to the sensitive nature of the site.

4.16.65 The existing bridge is a three span structure with the superstructure comprising two steel 'I' girders composite with a reinforced concrete slab deck. The intermediate supports comprise reinforced concrete columns on piled footings and the end supports comprise reinforced concrete bank seat abutments on piled footings. A structural assessment has recorded that, with local exceptions, the structure has adequate capacity to sustain the effects of 40t Assessment Live Load as defined in CS 454 and also the SV80, SV100, SV150 and SV196 vehicles as defined in CS 458. The local exceptions relate to specific main girder stiffeners, where the addition of targeted plate strengthening will resolve the capacity issues.

4.16.66 The new structure will be structurally separate from the existing structure and will carry the southbound carriageway of the dualled A9 over the River Tay, a Core Path on the southern bank and a Core Path and NCN Route 77 on the northern bank. The watercourse and areas of the adjacent bank are within the River Tay SAC.

4.16.67 The new structure will be a three-span square structure, with a central span length of 133 metres and side span lengths of 84 metres. The superstructure for the new deck will adopt twin continuous steel box girders with a composite reinforced concrete slab deck. The box girders will be of uniform depth over the central span and will incorporate a shallow taper over the side spans to keep the bridge soffit above design flood levels. The intermediate supports are likely to be twin circular columns on piled footings. The abutments will be reinforced concrete bank seats on piled footings. The bridge deck width tapers in plan over the length of the south span to accommodate the Dalguise Junction southbound diverge slip road.

4.16.68 1.5 metre high N2 parapets will be provided over the structure.

4.16.69 Traffic flow can be maintained over the existing bridge during construction of the new structure.

4.16.70 Potential works to the retained existing structure include installation of N2 parapets, provision of ducts, bridge deck re-waterproofing, re-surfacing, renewal of expansion joints and remedial work to any identified defects.

4.17 Fencing and Environmental Barriers

Fencing

4.17.1 Temporary fencing will be erected prior to the commencement of construction to delineate the Land Made Available (LMA) to the contractor, where appropriate. The land take in the surrounding area is mostly comprised of woodland and farmland. Stock proof fencing may be required in some areas where pastureland bounds the proposed scheme.

4.17.2 Upon completion of the works the proposed scheme boundary will not be fenced as a matter of course which will enhance the idea of a seamless landscape. In some instances, fencing may be provided where required.

4.17.3 Further details with respect to the fencing requirement for the proposed scheme is provided in Chapter 6 (The Proposed Scheme) of the EIAR.

Environmental Barriers

4.17.4 Environmental barriers will be required to reduce the potential impacts of the proposed scheme at specific locations. The requirement for such measures including mammal mitigation or noise attenuation will be provided in accordance with Chapter 12 (Biodiversity) and Chapter 15 (Noise and Vibration) of the EIAR.

4.18 Traffic Signs and Road Markings, Traffic Signals and Lighting

Traffic Signs and Road Markings

4.18.1 As part of the proposed scheme design development, the A9 Traffic Sign Strategy has been developed to establish and confirm signing requirements for the proposed scheme.

4.18.2 The traffic signs and road markings required for the proposed scheme have been designed in accordance with relevant design standards, with key reference to:

- A9 Traffic Sign Design Strategy (Jacobs, 2021);
- The Traffic Signs Regulations and General Directions 2016 (TSRGD) (Department for Transport, 2016b);
- Traffic Signs Manual (Department for Transport, 2006a);

- Local Transport Note (LTN) 1/94 – Design and Use of Directional Informatory Signs (The Department for Transport, 1994);
- Interim Advice Note (IAN) 144/16 – Directional Signs on Motorway and All-Purpose Trunk Roads: Grade Separated Junctions (Highways England, 2016a);
- Interim Advice Note (IAN) 145/16 – Directional Signs on Motorway and All-Purpose Trunk Roads: At Grade and Compact Grade Separated Junctions (Highways England, 2016b); and
- Trunk Road and Motorway Tourist Signposting Policy and Guidance (Transport Scotland, 2006).

4.18.3 A key aim of this particular element of the design at this stage is to identify locations where any additional land may be required to accommodate particularly large signs, for example Advance Direction Signs (ADS), where there is no earthworks slope to locate them on and the verge is effectively 'at-grade' with surrounding land. The Compulsory Purchase Order (CPO) boundary allows sufficient space for these large signs to be incorporated into the scheme. In order to confirm this, a traffic sign design has been developed.

4.18.4 Subsequent detailed design of traffic signs and road markings will be progressed in consultation with Transport Scotland, PKC, Visit Scotland and other appropriate stakeholders with regards to the provision of the required signage.

4.18.5 Signage will generally be provided by the use of post mounted signs. The use of gantry mounted signs is not anticipated to avoid adverse visual impact on the rural landscape.

4.18.6 In accordance with Scottish Government policy, the traffic sign design takes cognisance of the requirement for all trunk road Directional and Route Confirmatory Signs to include Gaelic translation in accordance with the Traffic Signs Regulations and General Directions 2016.

Advanced Direction Signs

4.18.7 As part of the proposed scheme, Advance Direction Signs will be included to provide the road user with route information in respect of a junction ahead. Three Advanced Direction Signs are provided on approach to each grade separated junction and at-grade roundabout. These are located 1 mile in advance (or 2/3 mile), 1/2 mile in advance (or 1/3 mile) and at the diverge taper in accordance with IAN 144/16.

4.18.8 Figure 4.4 depicts a typical map type Advanced Direction Signs prepared as part of this traffic sign design for the approach to Dunkeld Roundabout.

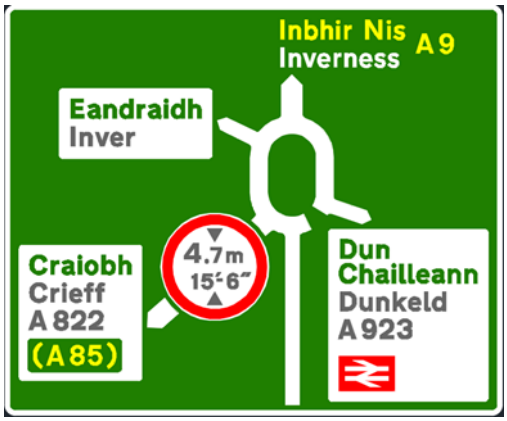

Figure 4.4: Typical Example of an Advanced Direction Sign

Signage on Approach to Dunkeld Junction Roundabout

4.18.9 On the approach to Dunkeld Junction Roundabout the proposed scheme is constrained by the Highland Main Line railway, Dunkeld & Birnam Station, existing topography and the River Tay designated flood zone.

4.18.10 As the majority of junctions on the proposed A9 are grade separated – and Dunkeld Junction Roundabout is the only proposed roundabout– it is key that appropriate signage is implemented on approach to the roundabout to maximise the safety for drivers. This is especially important on the A9 southbound approach, as vehicles will have travelled approximately 140km from Inverness on an uninterrupted dual carriageway. Therefore, appropriate ADS, warning signs, and road markings have been provided in accordance with the standards where the local constraints permit.

Road Lighting

4.18.11 An appraisal of road lighting has been undertaken in accordance with DMRB TA 501 'Road lighting appraisal' (DMRB, 2020d), which concluded that the main carriageway of the proposed scheme does not require to be lit at night, with the exception of conflict areas such as the at-grade Dunkeld Roundabout. By lighting these areas, a higher level of safety and awareness is included into the scheme.

4.18.12 It is proposed that localised lighting will also be provided in the following locations:

- Replacement Dunkeld and Birnam Station Car Park and associated pedestrian underpass.

  Dunkeld and Birnam Car Park is designed to be lit in accordance with BS-5489 'Design of road lighting' (British Standard Institution, 2020), for a medium traffic outdoor car park. This provides an average lux of 10 and 0.25 uniformity.

  The station pedestrian underpass is designed to be lit in accordance with BS-5489 for an enclosed subway. This provides a daytime average lux of 350 and a minimum lux of 150. Whereas at night it provides an average lux of 20 and a minimum lux of 10.

- Proposed at-grade Dunkeld Roundabout and associated arms.

  Dunkeld Roundabout is designed to be lit to a C3 lighting class in accordance with BS-5489. Due to recorded traffic flow data, the lighting class level was selected as M4, however due to the location being a conflict area the lighting class is increased by 1 to C3. This provides an average lux of 15 and a uniformity of 0.4.

- Alongside the WCH provision on the southern side of the replacement River Braan Bridge, crossing under the proposed A9 carriageway to match existing provision. This is designed to be lit in accordance with BS-5489 for an open subway. This provides an average lux of 20 and a minimum of 10. The luminaires in this location use a warmer 2200K light to be more accommodating to environmental surroundings.

4.19 Road Restraint Systems

4.19.1 As part of the development of the proposed scheme, a Road Restraint Risk Assessment Process (RRRAP) has been carried out to determine requirements for safety barriers in accordance with DMRB CD377 'Requirements for Road Restraint Systems' and 'Design & Maintenance Guidance for Local Authority Roads: Provision of Road Restraint Systems on Local Authority Roads' (Department for Transport, 2011).

4.19.2 Following the outcome of the RRRAP, Road Restraint Systems (RRS) are proposed within the central reserve for the full length of the proposed dual carriageway, and in numerous locations within the verge of the A9 carriageways and associated junctions. The locations of RRS will be refined and finalised at specimen and detailed design. Generally, the hazards which the RRS have been introduced to protect include high embankments, reinforced cutting slopes, rock cuttings, waterbodies, watercourses, adjacent Highland Main Line (HML) railway, adjacent side roads, structures, large road furniture (such as traffic signs and ITS equipment) and residential and public buildings (Dunkeld & Birnam Station building).

4.19.3 A key aim of the design of the RRS at this stage is to inform the management of verge space and consequently identify any additional land that may be required as a consequence of increasing the proposed verge width at locations along the proposed scheme. The verge width may need localised widening should a RRS be introduced, to provide compliant stopping sight distance (SSD). Verge width may also need localised widening to accommodate all necessary road furniture (for example drainage, ITS ducting and the road restraint system).

4.19.4 The central reserve barrier will be continuous along the full length of the scheme, only breaking at the Dunkeld Roundabout. There will be maintenance crossover points along the proposed scheme, as described in Paragraph 4.21.5. At these locations the central reserve will consist of opening sections of safety barrier.

4.20 Intelligent Transport Systems Technologies (ITS) and Associated Infrastructure

4.20.1 ITS technologies and associated infrastructure will be deployed along the proposed scheme and integrated into the existing Traffic Scotland Service (TSS). Key components of the ITS technologies and associated infrastructure include Variable Messaging Signs (VMS), Closed Circuit Television (CCTV) Cameras and 2x2-way ducting in each verge with regularly spaced Type A chambers to provide access to the ducts.

4.20.2 The requirements for ITS technologies have been developed in the proposed scheme in accordance with the A9 Dualling Programme ITS Strategy (Transport Scotland, 2017) and through consultation with Transport Scotland.

Variable Message Signs (VMS)

4.20.3 VMS are typically used to inform travellers of traffic and weather conditions on the local and wider Trunk Road Network. A total of three VMS are proposed. Two of these are to be provided on the northbound carriageway, with one on approach to the proposed Birnam Junction, and one on the approach to the Dalguise Junction. There is also a VMS site proposed on the southbound carriageway on approach to the Dunkeld Junction at-grade roundabout. The proposed locations are shown in Table 4-21.

Closed Circuit Television (CCTV) Cameras

4.20.4 CCTV Cameras are typically used to observe traffic movements through a particular point of interest on the trunk road network. In certain situations, these can be viewed by the general public through the Traffic Scotland website. A total of seven CCTV sites are proposed and are to be provided on the new dual carriageway. These proposed locations are noted in Table 4-20.

Road	Carriageway	Chainage (Ch.)	Co-located with VMS (Yes / No)
A9	Northbound	420	Yes
A9	Northbound (Birnam Junction northbound diverge)	1860	No
A9	Southbound	4100	No
A9	Northbound	4200	No
A9	Northbound	4900	Yes
A9	Southbound	5390	Yes
A9	Southbound	6800	No

Table 4-20: CCTV Camera Sites

Four-Way Ducting / Type A Chambers

4.20.5 2x2-way ducting has been allowed for in both verges of the proposed scheme. A check has been undertaken to establish if these ducts and the associated Type A chambers can be accommodated in the typical 2.5 metre D2AP verge width. This assessment concluded that Type A chambers could be accommodated next to filter drains up to 300mm diameter without any localised verge widening or earthworks steepening required. As noted in Note 2 of Table 4-5, the proposed verge width for the proposed scheme is 3 metres, providing an additional 0.5 metres that the typical D2AP verge used in this assessment.

Access to ITS Technologies and Associated Infrastructure Sites

4.20.6 A key consideration of the VMS and CCTV locations is providing access to these sites for maintenance. Through consultation with Transport Scotland, it was confirmed that access to these sites should be by alternative routes rather than directly from the dual carriageway where practical. The proposed location of the VMS and CCTV sites and proposed access arrangements are outlined in Table 4-21.

Reference	Approximate Chainage	Site Type	Proposed Access Arrangement
Site 1	Northbound Ch. 400	Offset-T MS4 VMS with CCTV Camera	A hardstanding is located on the B867 for vehicular parking. Footway from access track to VMS site.
Site 2	Northbound Ch. 1950	CCTV Camera and sub-surface loop detectors	Maintenance access is proposed from the SuDS pond to the west of the northbound diverge slip road.
Site 3	Southbound Ch. 4160	CCTV Camera and sub-surface loop detectors	Maintenance access is proposed from the local side road.
Site 4	Northbound Ch. 4200	CCTV Camera and sub-surface loop detectors	Maintenance access is proposed from the SuDS pond.
Site 5	Northbound Ch .4900	Offset-T MS4 VMS with CCTV Camera	Vehicle access along the proposed SuDS. Footway from access track to VMS site.
Site 6	Southbound Ch. 5400	Offset-T MS4 VMS with CCTV Camera	Vehicle access along the field access.
Site 7	Southbound Ch. 6800	CCTV Camera and sub-surface loop detectors	Vehicle access on the farm access track, with stairs & footway provided from B898.

Table 4-21: ITS Technology Sites

4.21 Operation and Maintenance

4.21.1 The Operation and Maintenance Strategy (Jacobs, 2016.b) is a live document that was developed to provide guidance on Operations and Maintenance to the design teams working on the A9 Dualling Programme between Perth and Inverness. The Operations and Maintenance Strategy is intended to be the centre point for collation of relevant programme wide information such as specific programme wide proposals for operational features. As such, it is important to comment on these features in order to assess measures taken across the project amongst designers.

Operation and Maintenance Features

Snow Gates

4.21.2 The proposed scheme does not contain any snow gates within the project extents. However, advanced or strategic warning of adverse conditions would be achieved through the use of the proposed network of VMS.

Snow Poles

4.21.3 Snow poles will be supplied and erected by the operating company when needed.

Police Observation Platforms

4.21.4 Following consultation with Police Scotland locations have been identified where provision of a POP would be advantageous. However, these locations do not align with the standards and would require a departure from standards. Provisions will be further refined in consultation with the relevant authorities.

Maintenance Crossovers

4.21.5 Maintenance crossovers are proposed at a number of locations within the proposed scheme. Table 4-22 below provides further information on the proposed locations of crossovers.

Crossover	Approximate Chainage (m)	Description of Location
Location 1	Ch. 1200 - 1300	Located approximately 230m south of Birnam Junction.
Location 2	Ch. 3550 - 3650	Located between Inchewan Burn Bridge and Dunkeld Roundabout.
Location 3	Ch. 5000 - 5100	Located immediately prior to the Hermitage junction.
Location 4	Ch. 7800 - 7900	Located approximately 100m north of River Tay crossing.

Table 4-22: Maintenance Crossovers

Snow Drift

4.21.6 Additional design considerations are also outlined in the Operations and Maintenance Strategy (Jacobs, 2016) with particular attention towards snow and snow drift.

4.21.7 No areas are identified within the proposed scheme as being at risk of snow drift.

4.22 Road Pavement

4.22.1 For the purpose of the development of the proposed scheme design, it has been assumed that the existing pavement will be subject to full reconstruction. Full reconstruction would create a uniform residual life and provide a baseline for a standardised approach to future maintenance.

4.22.2 Further analysis of the available pavement data could be undertaken during detailed design to determine if other alternative treatment options could be developed to utilise sections of the existing pavement where appropriate.

4.22.3 The type and specification of road pavement surfacing will be TS2010. To comply with the proposed essential mitigation and schedule of commitments of the Environmental Impact Assessment, all lengths of pavement on the new dual carriageway of the proposed scheme will be surfaced with low noise road surfacing material.

4.23 Walking, Wheeling, Cycling and Horse-riding (WCH) Provision

4.23.1 Proposed WCH crossing points, route realignments and new connections are described in Chapter 3 (Proposed Scheme) of this report. A WCH assessment was undertaken in accordance with DMRB GG 142 'Walking, cycling and horse-riding assessment and review' (hereafter referred to as GG 142) (DMRB, 2019). The output of the assessment was the A9 Dualling Programme: Pass of Birnam to Tay Crossing: Walking, Cycling and Horse-riding Assessment Report (hereafter referred to as WCH Assessment Report) (Jacobs, 2024). The Assessment Report has been prepared to help verify, and improve where required, the development of the proposed scheme design in accordance with the needs of WCH users and best practice standards.

4.23.2 Following the announcement of the preferred route in December 2023, the proposed WCH crossing points, route realignments and new connections have been developed and refined, taking cognisance of various consultations held during the development of the proposed scheme including:

- Public Exhibition – Preferred Route Option January 2024,
- A9 Dualling: NMU and Accessibility Forum Workshop April 2024,
- Public Exhibition – DMRB Stage 3 Design Development August 2024,
- Consultation with stakeholders in 2024 and 2025.

4.23.3 These events were attended by representatives of Transport Scotland, their design consultants and a number of WCH stakeholders including:

- Birnam to Ballinluig A9 Community Group;
- British Horse Society (BHS) Scotland;
- ByCycle;
- Cycling Scotland;
- Cycling UK;
- Disability without Borders;
- Local residents and landowners;
- NatureScot;
- Perth and Kinross Council (PKC);
- Perth and Kinross Countryside Trust;
- Ramblers Scotland; and
- Sustrans.

4.23.4 A number of specific issues were raised by the stakeholders, and these have been addressed where technically feasible during the proposed scheme design development.

4.23.5 There are 26 Departures from Standard associated with the proposed WCH provision, identified when assessed against the standards contained within Roads for All: Good Practice Guide for Roads and Cycling by Design. These Departures from Standard are outlined in Table 4-23.

4.23.6 The Departures from Standard as identified are formally recorded in a Departures from Standard application and the Cycling by Design: Design Review submitted to Transport Scotland's Project Manager.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH01	Cycling by Design Table 3.5 (desirable maximum gradient) and Table 3.6. Maximum gradient on the footway level cycle track in verge of the realigned B867 is 6%. Approximate mainline Ch. 2080 – 2120.	The realigned section of the B867 that includes a cycle track at footway level has a maximum gradient of 6% which is a result of reducing the carriageway level to pass under the proposed A9 dual carriageway via a new underbridge. This section of the route is an improvement with the cycle track at footway level compared with the previous on carriageway provision and although the gradient exceeds 3%, it is over a relatively short distance. Provision of a route with a compliant gradient would result in an increased scheme footprint and require additional rock cutting and increased span of the proposed Birnam Junction Bridge.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH02	Cycling by Design Table 3.5 (desirable maximum gradient) and Table 3.6. Maximum gradient on the detached cycle track between B867 and A9 verge is a constant 5% for 92.49m. Approximate mainline Ch. 2100 – 2180.	The realigned section of detached cycle track connecting the B867 with the mainline has a maximum gradient of 5%. This is a result of reducing the B867 carriageway level to pass under the proposed A9 dual carriageway via a new underbridge, in combination with the existing topography sloping steeply towards the Highland Main Line Railway. Although the gradient exceeds 3%, it is over a relatively short distance. Provision of a route with a compliant gradient would result in an increased scheme footprint and require the introduction of steepened earthwork cuttings or a new retaining wall.
DEPWCH03	Cycling by Design Table 3.5 (desirable minimum dynamic sight distance (DSD)). Minimum DSD on the detached cycle track between B867 and A9 verge is 39m. Approximate mainline Ch. 2190 – 2280.	The realigned section of detached cycle track connecting the B867 with the mainline contains a section of route with non-compliant DSD for users travelling both northbound and southbound. This is due to the existing topography sloping up towards the Highland Main Line Railway. Provision of a route with a compliant DSD would require widening of up to 5.5m over a 60m length. This would result in an increased scheme footprint with higher and wider earthwork cuttings or a new retaining wall.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH04	Cycling by Design, users must dismount at stepped access between Dunkeld & Birnam Station and Birnam Glen. Approximate mainline Ch. 3420 – 3450.	The realigned section of detached cycle track connecting Dunkeld and Birnam Station with Birnam Glen contains stepped access where cycle users are required to dismount. Provision of a compliant ramp is not possible due to the highly constrained nature of this area therefore, a replacement of the existing stepped access is proposed. The proposed Dunkeld & Birnam Station Pedestrian Underpass provides an alternative step free access, however cycle users will still be required to dismount to enter the lift.
DEPWCH05	Cycling by Design Table 3.5 (desirable maximum gradient, desirable minimum vertical crest curvature, and desirable minimum vertical sag curvature) and Table 3.6. Maximum instantaneous gradient on the mixed traffic street along Birnam Glen is 8.0%, and is >4.25% for approximately 18.5m split between four separate sections of non-compliant gradient. Minimum crest curve on the mixed traffic street along Birnam Glen of two non-compliant crest curves on the mixed traffic street along Birnam Glen has K value of 2.789. Minimum sag curve of one non-compliant sag curve has K value of 2.669. Approximate mainline Ch. 3455.	The realigned section of Birnam Glen is a mixed traffic street with a maximum gradient of 8%. This is a result of reducing the carriageway level to achieve the required headroom clearance under the proposed A9 dual carriageway. Provision of a route with a compliant gradient would result in an increased length of realignment, increase the scheme footprint, and require modification to the existing railway bridge to the south.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH06	Cycling by Design Table 3.5 (desirable maximum gradient) and Table 3.6. Maximum gradient on the mixed traffic street along Perth Road and A923 is 6%. Approximate mainline Ch. 3980 – 4020.	The realigned junction between Perth Road and the A923, and the realigned section of the A923, that are mixed traffic streets have a maximum gradient of 6%. This is a result of the A923 being designed in accordance with the DMRB and with the aim of reducing the tie-in length between the Dunkeld Junction Roundabout and the existing A923. Provision of a route with a compliant gradient would result in an increased length of tie-ins to the existing A923 and to Perth Road. This would increase the height of the retaining wall on the A923, increase the scheme footprint with higher and wider earthwork embankments, and impact the commercial and residential properties on the A923 and Perth Road.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH07	Cycling by Design Clause 3.3.1, Clause 3.8.2, and Clause 3.8.13. Cycle users are required to mix with motor traffic along Perth Road and the A923 which is considered a low level of service. Approximate mainline Ch. 3980 – 4020.	The realigned junction between Perth Road and the A923, and the realigned section of the A923, that are mixed traffic streets provide a low level of safety for cycle users due to the lack of protection for cycle users, the speed limit of the roads, and the anticipated two-way traffic flow on these roads. Provision of a compliant route would require dedicated cycling provision which would result in an increased scheme footprint. The existing provision for the cycle route to the north and south of this short realigned section provides the same level of provision as the proposed section.
DEPWCH08	Cycling by Design Clause 3.4.7. Maximum crossfall on the mixed traffic street along Perth Road/A923 is 6%. Approximate mainline Ch. 3980 – 4020.	The realigned junction between Perth Road and the A923 is a mixed traffic street that has a maximum crossfall of 6%. This is a result of the A923 being designed in accordance with the DMRB and with the aim of reducing the tie-in length between the Dunkeld Junction Roundabout and the existing A923 by using a gradient of 6%. Provision of a route with a compliant crossfall would result in an increased length of the tie-ins to the existing A923 and to Perth Road. This would increase the height of the retaining wall on the A923, increase the scheme footprint with higher and wider earthwork embankments, and impact the commercial and residential properties on the A923 and Perth Road.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH09	Cycling by Design Clause 3.3.1, Clause 3.8.2, and Clause 3.8.13. Cycle users are required to mix with motor traffic on the B898 which is considered a low level of service. Approximate mainline Ch. 7450 - 7510.	The realigned section of the B898 is a mixed traffic street providing a low level of safety for cycle users due to the lack of protection for cycle users, the speed limit of the road, and the anticipated two-way traffic flow on the road. Provision of a compliant route would require dedicated cycling provision which would result in an increased scheme footprint. As the area surrounding the B898 is ancient woodland, increasing the scheme footprint would result in an increased loss of ancient woodland. The proposed scheme provides the same level of provision as the existing north of this section.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH10	Cycling by Design Table 3.5 (desirable minimum horizontal radius, desirable minimum SSD, and desirable minimum DSD). Minimum horizontal radius of two non-compliant curves on the cycle track in the verge of the B898 is 6.5m. Minimum SSD on the cycle track in the verge of the B898 is 10m. Minimum DSD on the cycle track in the verge of the B898is 17m. Approximate mainline Ch. 6800 - 6920.	The realigned section of the B898 that includes a cycle track at footway level has a minimum horizontal radius of 6.5m, a minimum SSD of 10m, and a minimum DSD of 17m. This is a result of the cycle route navigating around the junction between the Dalguise Junction Southbound Diverge and the B898 immediately south of the proposed Dalguise Junction bridge and north of a large earthwork cutting. Provision of a compliant route would result in a significant realignment of the proposed A9 carriageway and Dalguise Junction, increasing the scheme footprint with higher and wider earthworks.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH11	Cycling by Design Table 3.5 (desirable maximum gradient, desirable minimum vertical crest curvature, and desirable minimum vertical sag curvature) and Table 3.6. Maximum gradient on the mixed traffic street along Inverwood Access Track (North) is 8.0%, and is >4.75% for approximately 93m split between six separate sections of non-compliant gradient. Minimum crest curve on the mixed traffic street along Inverwood Access Track (North) of three non-compliant crest curves has K value of 2.0. Minimum sag curve on the mixed traffic street along Inverwood Access Track (North) of five non-compliant sag curve has K value of 2.0. Approximate mainline Ch. 6800 - 7020.	The proposed Inverwood Access Track (North) is a mixed traffic street with a maximum gradient of 8%, a minimum vertical crest curvature of K=2, and a minimum vertical sag curvature of K=2. This is due to the access track being designed in accordance with the National Roads Development Guide (NRDG) 2015. Provision of a compliant route would result in an increased scheme footprint with higher and wider earthworks. As this access track is within the River Tay flood plain, the increased earthworks would result in a loss of flood plain, potentially increasing flood risk.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH12	Cycling by Design Table 3.5 (desirable minimum horizontal radius, desirable minimum SSD, and desirable minimum DSD). Minimum horizontal radius of two non-compliant curves on the mixed traffic street along Inverwood Access Track (North) is 15m. Minimum SSD on the mixed traffic street along Inverwood Access Track (North) is 10m. Minimum DSD on the mixed traffic street along Inverwood Access Track (North) is 10m. Approximate mainline Ch. 6970 - 7090	The proposed Inverwood Access Track (North) is a mixed traffic street with a minimum horizontal radius of 15m, a minimum SSD of 10m, and a minimum DSD of 10m. This is due to the highly constrained nature of this area and the need for a bridge under the Highland Main Line railway. Provision of a compliant route would result in the skew angle of the proposed bridge to be increased from the proposed 30° skew. This would increase the length of the structure, increasing the cost and impact on the railway during construction.
DEPWCH13	Cycling by Design Table 3.5 (desirable maximum gradient) and Table 3.6. Maximum gradient on the detached cycle track between Inverwood Access Track (North) and the A9 verge is a constant 5% for 181.5m. Approximate mainline Ch. 7210 – 7370.	The proposed section of detached cycle track connecting Inverwood Access Track (North) with the mainline has a maximum gradient of 5%. This is due to the level difference between the access track and the mainline. Provision of a compliant route would require an increased length of route, which would increase the scheme footprint and increase the earthworks. As part of this detached cycle track is within the River Tay flood plain, the increased earthworks would result in a loss of flood plain, potentially increasing flood risk.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH14	Cycling by Design Table 3.5 (desirable minimum horizontal radius). Minimum horizontal radius of six non-compliant back-to-back curves on the detached cycle track between Inverwood Access Track (North) and the A9 verge is 14m. Minimum horizontal radius of one non-compliant curve on the detached cycle track between Inverwood Access Track (North) and the A9 verge is 5.5m (inside radius of 4.0m). Approximate mainline Ch. 7210 – 7390.	The proposed section of detached cycle track connecting Inverwood Access Track (North) with the mainline has a minimum horizontal radius of 5.5m (including six back-to-back 14m radius curves) due to the highly constrained nature of this area. Provision of a compliant route would result in an increased scheme footprint with wider curves and higher and wider earthworks. As the area to the east of the detached cycle track is ancient woodland, increasing the scheme footprint would result in an additional loss of ancient woodland. The 5.5m radius curve has been designed as a junction between cycle tracks to ensure cycle users slow down on approach to the cycle track at footway level in the southbound verge of the A9 carriageway.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH15	Cycling by Design Table 3.8. Minimum buffer width between cycle track at footway level and the A9 carriageway is 2.5m. Approximate mainline Ch. 7390 – 7780.	The section of cycle track at footway level in the southbound verge of the A9 carriageway has a minimum buffer width of 2.5m due to the verge width of the proposed River Tay Bridge. Provision of a compliant route would result in widening the River Tay Bridge. However, as the pier locations are constrained due to the River Tay's classification as a Special Area of Conservation, the structural capacity of the proposed bridge cannot be increased further in its current form to accommodate a widened verge. A Road Restraint System is proposed within the buffer width, increasing safety for cycle users.
DEPWCH16	Cycling by Design Table 3.5 (desirable minimum horizontal radius, desirable minimum SSD, and desirable minimum DSD). Minimum SSD on the mixed traffic street along) is 10m. Minimum horizontal radius of one non-compliant curve on the detached cycle track between the A9 southbound verge and the existing provision on the northern bank of the River Tay and is 5.5m (inside radius of 4.0m).	The section of cycle track at footway level in the southbound verge of the A9 carriageway has a minimum SSD of 10m and a minimum DSD of 11m. This is due to the 5.5m radius horizontal geometry where the cycle track at footway level and the detached cycle track to its north intersect. Provision of a compliant route would result in an increased scheme footprint with curves with increased radius and higher and wider earthworks cuttings. The 5.5m radius curve has been designed

Departure Reference	Type / Description	Comment on Suitability of Access Provision
	Approximate mainline Ch. 7780 - 7810.	as a junction between cycle tracks to ensure cycle users slow down on approach to the cycle track at footway level in the southbound verge of the A9 carriageway. As the sections of detached cycle track and cycle track at footway level where this departure occurs run parallel to each other, cycle users will have visibility to the side and see if another user is heading towards them on the other section of track and allow them to anticipate and adjust to suit.
DEPWCH17	Cycling by Design Table 3.5 (desirable minimum SSD, and desirable minimum DSD). Minimum SSD on the detached cycle track is 29m. Minimum SSD on the detached cycle track is 46m. Approximate mainline Ch. 7690 - 7760.	The section of detached cycle track connecting the southbound verge of the proposed A9 carriageway with the existing detached cycle track on the northern bank of the River Tay has a minimum SSD of 29m and a minimum DSD of 46m. This is due to the large earthwork cuttings on the southbound side of the detached cycle track. Provision of a compliant route would result in an increased scheme footprint with wider verges and higher and wider earthworks cuttings. Additionally, the scheme footprint would be increased if a compliant gradient was provided with a straighter and longer alignment.
DEPWCH18	Gradient on WCH link exceeds 5%. Murthly Estate Access Track. Approximate mainline Ch. 536 - 582, Ch. 812 - 833 & Ch. 896 - 1009.	The realigned section of the Murthly Estate access track shared with WCH users has a maximum gradient of 8% over three separate sections, which is largely a result of reducing the carriageway levels to pass under the proposed A9 dual carriageway via a new bridge. This local path is an important route for WCH users and although the gradient

Departure Reference	Type / Description	Comment on Suitability of Access Provision
		exceeds 5%, it is over relatively short distances. Provision of a WCH route with a compliant gradient would result in increased land take and increased impacts on the surrounding environment including further encroachment on AWI.
DEPWCH19	Gradient on WCH link exceeds 5%. WCH Provision. Approximate mainline Ch. 1785 - 1878.	The WCH provision provides a connection between two existing rural woodland walking routes that have been historically cut off from each other. The route generally utilises the existing A9 carriageway that will be detrunked and provides a tie in at either end and will form a continuous loop route. The tie in with the existing route has a gradient of 8.5% which is a result of the existing steep topography in this locality. Provision of a compliant gradient would increase the height/width of the earthworks and would have a significant environmental impact including loss of AWI.
DEPWCH20	Gradient on WCH link exceeds 5%. Re-aligned Perth Road. Approximate mainline Ch. 2080 - 2120.	The re-aligned B867/Perth Road carriageway has a maximum gradient of 6%, which is a result of reducing the carriageway levels to pass under the proposed A9 dual carriageway via a new bridge. This new provision will provide a segregated shared path connecting Birnam Hill with Perth Road and remove the requirement to cross the existing A9 carriageway. Although the gradient exceeds 5% it is over a relatively short distance. Provision of a WCH route with a compliant gradient would result in

Departure Reference	Type / Description	Comment on Suitability of Access Provision
		increased length of realignment and increased impact on residential properties and the surrounding environment.
DEPWCH21	Gradient on WCH link exceeds 5% Re-aligned Sewage Works Access Track Approximate mainline Ch. 2370 - 2380 & Ch. 2415 - 2430	The re-aligned Sewage Works access track has a maximum gradient of 5.6% which is a result of the existing topography in the locality. Core path DUNK/10 is an important route for WCH users and although the gradient exceeds 5%, it is over relatively short distances. Provision of a WCH route with a compliant gradient would result in increased length of realignment and increased impacts on the surrounding environment.
DEPWCH22	Steps must always be provided as an alternative to a ramp. Birnam Glen to Station Building Approximate mainline Ch. 3420 - 3450	The re-aligned stairs between Birnam Glen and the Station Building are required due to the change in level on Birnam Glen and provides the same provision as the existing. An alternative step free route is available approximately 70m southeast of this location via the proposed pedestrian underpass connecting the Station to the new car park, and a ramp connection to Birnam Glen is provided. Due to the constraints (Inchewan Burn, Railway Line, Railway Station & A9 dual carriageway) it is not possible to provide a ramp with landings in this location.
DEPWCH23	Gradient on WCH link exceeds 5% Birnam Glen Access Road Approximate mainline Ch. 3455	Birnam Glen has been re-aligned vertically and has a maximum gradient of 7.9%, which is a result of lowering Birnam Glen to maintain a similar headroom clearance under the structure as the existing, which already has a reduced standard headroom

Departure Reference	Type / Description	Comment on Suitability of Access Provision
		clearance in the existing scenario. Core path DUNK/11 is an important route for WCH users and although the gradient exceeds 5%, it is over a relatively short distance. Provision of a WCH route with a compliant gradient would require the level of the A9 mainline carriageway to be raised significantly which would adversely increase the impacts on the surrounding environment, residential properties and Dunkeld and Birnam Station.
DEPWCH24	Gradient on WCH link exceeds 5% Re-aligned A822 Approximate mainline Ch. 3940- 4040	The A822 has been re-aligned as part of the proposed scheme and connects into the proposed Dunkeld Roundabout. There is no existing footway provision at this location and users are required to walk along the carriageway/verge of the single carriageway. This new provision will provide a safer route for WCH users travelling between Ladywell and Dunkeld and Inver. Although the gradient exceeds 5%, it is over a relatively short distance. Provision of a compliant gradient would result in increased impacts on the surrounding environment, railway over bridge and the proposed Dunkeld Roundabout.

Departure Reference	Type / Description	Comment on Suitability of Access Provision
DEPWCH25	Steps must always be provided as an alternative to a ramp. B898 to DUNK/23 Approximate mainline Ch. 7420	The provision of stairs between the B898 and DUNK/23 are provided due to the re-alignment and change in level on the B898 and provides the same provision as the existing provision. Due to the steep topography and Railway Line it is not possible to provide a ramp with landings. Provision of a WCH route with a compliant gradient would increase the loss of AWI in this area.
DEPWCH26	Gradient on WCH link exceeds 5% Re-aligned Douglas Fir Wood Access Approximate mainline Ch. 7390 - 7410	The re-aligned Douglas Fir Wood Junction has a maximum gradient of 6.1% which matches these existing ground levels to minimise the extent of the design. A new footway has been provided in the southbound verge to segregate WCH users from vehicular traffic at the junction where previously WCH users were required to walk on the verge/carriageway. Core path DUNK/65 is an important route for WCH users and although the gradient exceeds 5%, it is over a relatively short distance. Provision of a WCH route with a compliant gradient would result in increased impacts on the surrounding environment including additional impact on AWI.

Table 4-23 : General Cycle Facility and WCH Departures from Standard

Review of the Proposed Scheme against the A9 Dualling Non-Motorised User (NMU) Access Strategy Objectives

4.23.7 The A9 Dualling NMU Access Strategy Objectives (Transport Scotland, 2016) are described in Chapter 3 (Proposed Scheme) of this report. The proposed scheme has been reviewed against each of the objectives to assess if they have been achieved, and the assessment is outlined below. The following descriptions should be read in conjunction with Table 3.7 included in Chapter 3

(Proposed Scheme) of this report and Drawings A9P02-JAC-ENM-D_ZZZZZ_ZZ_FG-RD-0001 and A9P02-JAC-ENM-D_ZZZZZ_ZZ_FG-RD-0002 included in Volume 2: Engineering Drawings.

There will be no surface (at-grade) crossings of the dualled A9.

4.23.8 It is considered that this objective has been achieved through the removal of the two existing WCH at-grade crossings of the A9 within the proposed scheme extents, which have been replaced with two new grade separated crossing points. Additionally, the five existing WCH grade separated crossings of the A9 within the proposed scheme extents have been retained.

The integrity and sensitivity of existing NMU routes will be taken into account to inform the design process.

4.23.9 It is considered that this objective has been achieved through sensible and considered application of the Design Standards within the extents of the proposed scheme. The proposed design ensures all existing routes are maintained or suitable alternatives provided, with new routes included to improved connectivity to the surrounding WCH routes where feasible.

Avoid Permanent Severance of Core Paths and Rights of Way, where possible.

4.23.10 It is considered that this objective has been achieved through:

- The proposed realignment of various Core Paths and Rights of Way to retain connectivity throughout the proposed scheme;
- The provision of new WCH routes which improve connectivity of the surrounding WCH network; and
- The inclusion of a number of grade separated crossings that not only avoid severance but improve safety at the various locations.

4.23.11 The same approach has been taken for local paths and the National Cycle Network to retain connectivity throughout the proposed scheme.

Maintain existing levels of NMU route connectivity and, where possible, improve for all types of user, including vulnerable users, such as children, older people and disabled people.

4.23.12 It is considered that this objective has been achieved through the proposed realignment of various WCH routes to retain connectivity, provision of new WCH routes to improve connectivity, and the retention of all existing and inclusion of new grade separated crossings. It is acknowledged, however, that due to existing physical constraints, existing topography, and existing provision beyond the proposed WCH provision tie ins, some of the proposed routes are below the required standards in Roads for All: Good Practice Guide for Roads. These are recorded as 'Departures from Standard' which have been submitted for approval.

Identify opportunities to integrate A9 dualling with existing NMU routes, public transport facilities and local communities within the corridor.

4.23.13 It is considered that the objective of integrating the A9 dualling with existing WCH provision has been achieved through the proposed realignment of various WCH routes to retain connectivity, provision of new WCH routes to improve connectivity with the wider WCH network, and the retention and inclusion of numerous grade separated crossings.

4.23.14 It is considered that the objective of integrating public transport facilities and local communities within the corridor has been achieved through the retention of both the northbound and southbound bus lay-bys on the A9 carriageway, and through the relocation of the Dunkeld & Birnam Station Car Park to allow it to act as a transport hub with facilities for private cars, WCH users, taxis, and buses, as well as links to the Highland main Line railway. It is acknowledged, however, that the relocation of the bus lay-bys adversely impacts the WCH journey lengths between the bus lay-bys and Inver. However, the relocation is required due to physical constraints in the area surrounding the existing locations such as the proximity of the River Tay and The Hermitage junction.

Where not required by safety standards, barriers will be removed that may impede or restrict movement by all NMUs within the extent of the A9 Projects.

4.23.15 It is considered that this objective has been achieved through the removal of the two existing WCH at-grade crossings of the A9 within the proposed scheme extents, and replacing them with two new grade separated crossing points. Additionally, the five existing WCH grade separated crossings of the A9 within the proposed scheme extents have been retained.

4.23.16 WCH connectivity also has been improved over the River Braan through the inclusion of WCH routes over the river in both the northbound and southbound verges of the proposed A9. This ensures the WCH provision is not impacted by future 1 in 200-year return period (0.5% AEP) plus climate change flood events. This reduces the likelihood that connectivity between Inver and Dunkeld & Birnam will be removed following a flood event.

4.23.17 During consultations, the existing WCH provision over the River Tay Bridge was raised as a safety concern and potential barrier to inexperienced users due to the lack of buffer between the edge of carriageway and the WCH provision. Therefore, the realignment of this provision from the northbound verge into the southbound verge has improved WCH safety and removed a potential barrier by increasing this buffer width.

Where achievable in line with safety standards, provide access to the NMU network from proposed enhanced lay-bys.

4.23.18 There are no enhanced lay-bys proposed for this proposed scheme. However, access to all existing WCH routes have been retained, and increased parking provision has been provided via the proposed Dunkeld & Birnam Station Car Park.

Consider NMU access to, and interaction with, local features of interest to inform locations for lay-bys and public transport provisions.

4.23.19 It is considered that this objective has been achieved through maintaining all existing WCH routes between Dunkeld & Birnam, Inver, and popular local WCH destinations. New WCH provision is proposed between the WCH routes on the Sewage Works Access Track and at Dalpowie Plantation, and through Birnam Junction to enhance WCH connectivity within the proposed scheme extents.

4.23.20 Additionally, one lay-by in each direction has been retained and improved at the southern extent of the scheme, and both the northbound and southbound bus lay-bys near Inver have been retained within the scheme.

Where appropriate utilise redundant sections of carriageway as NMU routes and facilities.

4.23.21 It is considered that this objective has been achieved through utilising the redundant section of the A9 carriageway in two locations to:

- Realign the WCH provision between Inver and The Hermitage further away from the edge of the River Braan, while still maintaining more than the required buffer width between a WCH route and the A9 carriageway, and
- provide new WCH provision between the WCH routes on the Sewage Works Access Track and at Dalpowie Plantation.

At crossings of the dualled A9, NMU routes will be rationalised and combined where possible.

4.23.22 Due to the number of WCH routes within the proposed scheme extents and frequency of their use (especially in the summer months), the crossing points on the proposed scheme have not been rationalised. Both existing at-grade crossings of the A9 within the proposed scheme extents have been replaced by nearby grade separated crossings, all existing grade separated crossings have been retained, and two new grade separated crossings have been included in the proposed design as described in Chapter 3 (Proposed Scheme).

Junctions and accommodation works underpasses will be utilised, where possible, to provide safer NMU crossing points.

4.23.23 It is considered that this objective has been achieved through the:

- Realignment of a WCH route through the proposed Murthly Estate Bridge;
- Inclusion of WCH provision through the proposed Birnam Junction and Dalguise Junction to provide grade separated crossings of the A9;
- Inclusion of proposed WCH provision around Dunkeld Roundabout on the A822 (Old Military Road) and the Unclassified Road to Inver to a safe grade separated crossing point on the southern bank of the River Braan; and
- Inclusion of the proposed new Dunkeld & Birnam Station Pedestrian Underpass.

Incorporate consideration of NMU requirements and provisions into the design of side roads and access diversions.

4.23.24 It is considered that this objective has been achieved through the inclusion of WCH provision along a number of the realigned side roads including the B867/Perth Road, Birnam Glen, A822 (Old Military Road), Unclassified Road to Inver, and the B898. Additionally, some new and existing WCH routes have been realigned along realigned access tracks to create mixed traffic streets (as described in Cycling by Design) along the Sewage Works Access Track, Network Rail Maintenance Access Track, Inver Maintenance Access Track (South), and Inverwood Access Track (North).

Over or under road (grade separated) crossing points solely for NMUs will be provided where engineering, environmental, traffic and economic assessments, including site specific considerations, indicate this is justified.

4.23.25 It is considered that this objective has been achieved through the inclusion of the Dunkeld & Birnam Station Pedestrian Underpass, and the retention of three of the four existing WCH only grade separated crossing points within the proposed scheme extents. The only existing WCH only grade separated crossing that has not been retained as WCH only is on the northern bank of the River Braan which Core Path DUNK/23 and DUNK/137 utilise. This route and crossing have been retained, and still accommodate DUNK/23 and DUNK/137, but have been widened to become a mixed traffic street on Inver Maintenance Access Track (South). This will be used for maintenance inspections of the River Braan Bridge only and will therefore be infrequently used by vehicles and have a low traffic count.

Ensure movement of NMUs and their health and safety are not adversely impacted during construction or under permanent arrangements.

4.23.26 It is considered that this objective has been achieved through the development of the A9 Dualling Programme: Pass of Birnam to Tay Crossing Constructability & Phasing report (Jacobs, 2025a) Outline Constructability Report. This assessment considers the health and safety and movement of WCH users during and after construction.

Review of the Proposed Scheme against Cycling By Design 2021 Guidance

4.23.27 There are locations where certain design elements of the proposed WCH provision do not fully comply with the guidance contained within Cycling by Design 2021. In accordance with Appendix A within Cycling by Design 2021, a full Design Review has been undertaken, and a summary of the proposed departures are listed in Table 4-23.

4.23.28 It is recognised that there are existing topography and physical constraints which prevent full compliance with the guidance contained within Cycling by Design 2021, and that the proposed WCH provision aims to find a balance between the existing WCH provision found in the wider area, and creating further impacts as a result of providing a fully compliant design.

Review of the NMU Design against Stakeholder and Public Consultation

4.23.29 The WCH Assessment Report notes that design development on the proposed scheme was ongoing throughout various Stakeholder forums and exhibitions. As a result of the ongoing design, the comments described in Section 2.6 of the WCH Assessment Report were received at various stages during the design development.

4.23.30 Where technically feasible, all suggestions or comments by Stakeholders and members of the public to improve the proposed WCH provision have been incorporated within the proposed scheme.

4.24 Indicative Construction Programme

4.24.1 Construction of the proposed scheme can only commence if the scheme is approved under the statutory procedures and thereafter a timetable for progress can be determined. For assessment purposes the construction phase of the proposed scheme is expected to take approximately 3 to 3.5 years.

4.24.2 An Outline Constructability and Phasing Report (Jacobs, 2025) has been prepared in parallel with the design development of the proposed scheme. However, it should be noted that the appointed Contractor is able, within the constraints of the contract documents, to adopt a construction sequence of their choosing, and therefore, the construction sequence described within the outline constructability assessment should not be considered to be prescriptive.

4.24.3 The proposed scheme could be split into three main sections, namely the south, central and north sections. The section split will reduce the scheme into smaller work packages and allow works to run concurrently to ensure the project is constructed within a reasonable timeframe. It is anticipated that each section will be individually managed and contain their own phases and sub phases. For the purpose of the constructability assessment the sections have been split into 3 relatively equal chainages. A preconstruction phase has been allowed for to include detailed design, statutory advance works, environmental, ecological and archaeological works and offsite mobilisation.

Traffic Management

4.24.4 A key element of the outline constructability assessment is determining traffic management requirements and the impact/limitations that this has on the construction programme. The present assumption is that the entire scheme would be subject to traffic management as this would have significant construction programme benefits. Traffic management over such a length does however constitute a Departure from Standard from guidance within the Traffic Signs Manual, Chapter 8 'Road Works and Temporary Situations', and this will be submitted for consideration by the Overseeing Organisation. During construction, temporary traffic management will be required to undertake the works, whilst minimising disruption to users of the active road network.

4.24.5 In general, construction phasing and temporary traffic management proposals have been prepared on the basis of keeping one lane in each direction available on the A9 at all times, except for very specific short term restrictions. Where considered appropriate, the Contractor will be required to provide a vehicle recovery service to promptly remove any broken down vehicles within the temporary traffic management areas. Where a lane closure is required to construct a site access or temporary side road access for example, the works shall be carried out at night time where practicable using traffic signals. All road closures will be approved by Transport Scotland and the other relevant authorities.

4.24.6 The use of temporary diversion roads will be required to bypass the construction of some of the new principal structures. These will be full width carriageways and most likely be under speed restrictions but will be bi-directional to reduce the impact on traffic flow through the works. Various traffic management configurations will be utilised during the works to ensure safety of the workforce, road users and pedestrians.

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