

4. Design Development

4.1. Introduction

- 4.1.1. The Design Manual for Roads and Bridges (DMRB) Stage 3 design of the Proposed Scheme, as described in Chapter 5, is the culmination of all the design and assessment work undertaken during the Stage 2 assessment of alignment/junction options, together with further refinement of the preferred route option during the Stage 3 assessment.
- 4.1.2. The design has been developed taking into account the A9 Strategic Environmental Design Principles set out in Appendix 4.1.
- 4.1.3. The Proposed Scheme design has been influenced by environmental information and assessment findings identified through the EIA process and has involved the environmental specialists working in tandem with the scheme designers, and in close collaboration with Transport Scotland and stakeholders. This has provided the opportunity to avoid or lessen potential environmental impacts through changes to the road alignment, land-take requirements and the type/location of specific design elements. Measures included in the Proposed Scheme design to avoid or reduce impacts are referred to as 'embedded mitigation' and are described below.
- 4.1.4. This chapter provides an overview of the iterative design process, setting out the main environmental considerations that have informed the final DMRB Stage 3 design. It does not consider potential impacts of earlier scheme design iterations. Alternatives considered during the design process are described in Chapter 3.

4.2. Iterative Design Process

- 4.2.1. The Scheme Design has undergone a process of continual refinement to achieve a solution that addresses issues arising through the collation of new information on constraints or understanding aspects identified as the scheme develops. Each design iteration has resulted in incremental changes that provide solutions, whilst adhering at all times to the overall scheme objectives, until an optimum DMRB Stage 3 level of design is reached.
- 4.2.2. For the Proposed Scheme, the iterative design process has involved the following:
- Project team meetings;
 - Development and use of an environmental constraints mapping tool, capturing survey data and information held by stakeholders;
 - Environmental mitigation workshops;
 - A series of design refreshes; and
 - Stakeholder input.
- 4.2.3. Project team meetings were held at regular intervals and this allowed environmental disciplines to have a clear understanding of the design proposals/refinements and to provide feedback on environmental constraints and also on opportunities for addressing potential impacts, which has informed the design development.
- 4.2.4. In order to collate and share environmental and design information across the project team, a web-based GIS tool was developed, known as WebGIS. WebGIS was a live tool accessible to all members of the project team and enabled easy access to a wide range of information including: environmental constraints (such as protected areas, habitats,

features of cultural heritage interest, etc.); geotechnical and topographical information; historic mapping, aerial imagery, site photographs and design information. Information was added and updated as necessary based on site surveys, desk studies, consultee information and design refreshes. The tool allowed data to be overlain to establish where there might be interface between the developing design and environmental constraints.

- 4.2.5. Environmental mitigation workshops were held during the Stage 3 design development. The workshops focussed on particular aspects of the design where contributions from specific environmental disciplines was required to discuss and influence the design development. Workshop themes included: road alignment and landscape fit, road drainage and watercourse crossings, flood risk, structures, soil and peat management, and primarily included landscape, ecology, geology and hydrology specialists together with EIA co-ordinators and the members of the design team.
- 4.2.6. The iterative design process has also included stakeholder input, primarily via the monthly meetings of the A9 Environmental Steering Group (ESG) (as described in Chapter 7 Consultation and Scoping), and other dedicated stakeholder consultation. ESG input in relation to the A9 Dualling programme as a whole have also been relevant to the Proposed Scheme, particularly around aspects such as road drainage design, flood risk, peat management, earthwork slope gradients and landscape fit.
- 4.2.7. Non-Motorised User (NMU) stakeholders have also influenced the Stage 3 design, via the NMU Forums (see Chapter 7 Consultation and Scoping) and meetings with the Cairngorms National Park Access Officer, The Highland Council Access Officer, Sustrans and Scotways. This, in addition to feedback from public exhibitions, has informed the design of NMU connections to and through the Proposed Scheme.
- 4.2.8. Discussion with affected landowners and local communities has also informed the Stage 3 design and has influenced the following:
- Compact (reduced footprint) grade separated junctions are proposed at Aviemore South, Granish and Black Mount. There was strong public support for this alternative which was presented alongside the preferred route option at Stage 2, for further consideration at Stage 3. Development of the 'down-sized' junctions included traffic prioritisation modifications at Aviemore South and Granish junctions (including the incorporation of a roundabout interface with local roads at the latter) to address related public feedback.
 - Private property accesses have been developed following consultation with property/land owners to seek to minimise disruption in terms of access to residences and in relation to commercial agricultural, forestry and field sports operations, resulting from closure of direct accesses on to the A9. Where possible private accesses have been designed to follow existing routes (e.g. forestry tracks) to minimise land-take and avoid severance.
 - At Avielochan earthworks and drainage design have been modified to ensure a clear route between permanent works and the adjacent railway such that the tenant farmers can continue to transfer cattle off-road between the farm house and holdings to the north/ north east.
 - Horizontal realignment of the mainline has been carried out between ch. 5500 and ch. 6100 to move the carriageway further away from the Macdonald Highland Resort Hotel and maintain sections of the existing bund in addition to incorporation of a new bund. Immediately to the north of the hotel, at the Scandinavian Village, the proposed road verge has been modified in order that a 5m buffer strip from the fence-line of this property can be maintained to the toe of the earthworks.

- In the absence of an alternative access via the local road network, new access provisions for Network Rail maintenance activities at Slochd are proposed. Retaining walls have been incorporated into the design where the proposed scheme is in close proximity to the Highland Mainline railway track in the vicinity of Carrbridge.
- Retaining walls are also proposed at Allt Mhor housing and Granish caravan park development sites to minimise mainline incursion at these locations and avoid compromising the consented development layout. In addition, SuDS accesses have been developed which are sympathetic to the layout of the caravan park following discussions with the developer. The retaining wall proposed at Allt Mhor also has the advantage of preventing encroachment closer to the orbital path.
- The proposed alignment of the public road access to Lynwilg (incorporating a footpath), from the proposed new Aviemore South grade separated junction has been developed through consultation with local residents to minimise potentially adverse visual impacts on residential property and to provide optimal connectivity to the A9 (northbound and southbound) via the new junction. The Highland Council was also central to road alignment design development discussions, given the road's adopted status.
- Discussions with Aviemore and Vicinity Community Council representatives, influenced the location of a lay-by on the southbound carriageway at Milton Wood where the preference for it to be located towards the southern end of the Aviemore orbital path (as opposed to further north on the edge of Milton Wood) was recognised in the proposed scheme design.

4.3. Embedded Mitigation

4.3.1. The development of the Proposed Scheme has included consideration of the environmental constraints present within the scheme extents and has sought to mitigate, where possible, the potential for adverse environmental impact. Such mitigation has been embedded into the design of the Proposed Scheme and this has focussed on the avoidance of features of environmental interest/importance and on achieving best fit within the existing environment. The following overall principles were considered in identifying embedded mitigation:

- Minimising potential impact on people and communities by avoiding direct encroachment onto property, optimising land take and facilitating access requirements;
- Horizontal and vertical alignments designed to be as close to the existing A9 as possible to minimise resultant earthwork embankments/cuttings and land take;
- Minimising encroachment into areas of ancient woodland and other sensitive habitat;
- Consideration of opportunities for potential variation of slope gradients to achieve best landscape fit and to reduce impact on ancient woodland;
- Minimising encroachment into areas at risk of flooding;
- Management of surface water runoff arising from the proposed A9 dual carriageway and side roads through appropriately located and designed drainage features;
- Avoidance of known areas of priority/deeper peat; and
- Alignments designed to facilitate access through the A9 corridor for Non-Motorised Users with specific consideration to the National Cycle Network, Core Paths and Rights of Way.

Property

- 4.3.2. Inclusion of compact grade separated junctions at Aviemore South, Granish and Black Mount (discussed above), has substantially reduced land-take at these locations and has facilitated more flexibility in terms of private accesses connections configuration, via the junctions, when compared with standard full grade separated junction layouts. This in turn has helped reduce land-take requirements in the vicinity of the junctions.
- 4.3.3. 4No. Left-in Left-out (LILO) junctions are proposed. 1No. of these is for a public road and 3No. serve private accesses. These are at Craigellachie (northbound ch. 5650) to provide access to the Craigellachie NNR, northbound and southbound between Kinveachy and Carrbridge (ch. 13870 and ch. 14300, respectively), primarily for forestry and estate operations access, and at Slochd (ch. 22750) to facilitate access to a cluster of residential properties and to retain the through route from Black Mount via the U2400 unclassified road.
- 4.3.4. Sections of northbound widening at the southern end of the proposed scheme and at Avielochan, as incorporated into the preferred route option at DMRB Stage 2 have been refined. In order to reduce visual impacts at Druim Mhor residential property, northbound widening has been extended by approximately 100m northwards (proposed northbound widening now extends from ch. 0 to ch. 2600). Similarly, northbound widening at Avielochan has been refined resulting in an extension of approximately 1000m (ch. 9600 to ch.10700) to reduce impacts on the farm.
- 4.3.5. In addition to the horizontal realignment of the carriageway proposed at Macdonald Highland Resort (described above), earthworks at this location have been revised to incorporate a 0.75m bund (ch. 5650 to ch. 5675) and false cutting (ch. 5675 to ch. 5875) to provide extra visual screening. This is in addition to the retention of the existing bund (between ch. 5690 and ch. 5800), where possible.
- 4.3.6. Provision of 8890m² of land to the south of Milton Woods community land is included to compensate for the loss of open space community land at Milton Woods. This land will be safeguarded for public access post construction.

Woodland

- 4.3.7. Aviemore South junction has been relocated approximately 90m south of the identified DMRB Stage 2 Preferred Scheme Option location. This has been possible due to the adoption of a compact design and has resulted in a substantial reduction in the impact on ancient woodland, including an area of aspen woodland habitat which is known to support BAP Priority Species Aspen Hoverfly. Incorporation of a ghost island connection (where the through-road has been widened sufficiently to provide a central refuge, delineated by road markings, for right-turning traffic) to the B9152 has further reduced impacts on ancient woodland.
- 4.3.8. Similarly, at Granish junction the proposed compact junction layout including roundabout connection to the A95/B9152 considerably reduces impacts in terms of ancient woodland land-take when compared with the previous full specification junction (TD22 design standard) identified at DMRB Stage 2.
- 4.3.9. As discussed above, the routing of access tracks within woodland areas has, where possible, followed existing forestry tracks to reduce woodland loss, fragmentation of habitats and potential disturbance to wildlife.

Peatlands

- 4.3.10. Peat excavation, in the construction of the mainline road embankments across the Feith Mhor floodplain and the Black Mount areas, will be minimised through the use of non-excavation construction techniques (e.g. piling).

Landscape Design

- 4.3.11. Black Mount junction has been relocated approximately 650m to the south of the location identified in the DMRB Stage 2 Preferred Option design and includes an underpass below the A9, providing substantial improvements in terms of landscape and visual impact.
- 4.3.12. The alignment of the Proposed Scheme and the design of associated earthworks has been developed through an iterative design process involving engineering, environmental and landscape specialists in order to minimise landscape and visual impacts, integrate the road with the surrounding landscape and provide a pleasant experience for travellers.
- 4.3.13. The landform sensitivity of the route was determined to identify particular areas that required a specific approach to the earthworks design. In these locations (summarised below) embankment slope profiles were steepened or slackened from the initial engineering design gradient of 1:3 (vertical:horizontal, approximately 18 degrees). At locations where a more naturalistic and integrated landform is required to help embed the Proposed Scheme into the existing landscape, slope profiles were slackened. At locations where safeguarding of existing landscape cover is desirable to maintain the pattern of the landscape and/or screening of the A9 to visual receptors, or other environmental constraints encountered, slopes were steepened.
- 4.3.14. Details of proposed slope gradients are provided in Chapter 13 (Landscape) and in Appendix 13.1, and summarised in the sections below.

Chainage 5500-7000 (Northbound)

- 4.3.15. The cutting slope adjacent to the northbound carriageway of the A9 has been steepened to a gradient of 1:2 in order to reduce the potential need for felling and maintain the wooded character of the landscape. Slope stability was identified as a constraint, therefore chainages 6100-6300 and 6600-6625 were steepened to 1:2.5, to avoid the need for slope stabilisation measures such as soil nailing which would have an adverse impact on appearance and localised landscape character.

Chainage 5650-5875 (Southbound)

- 4.3.16. From chainage 5650 to 5675 a 0.75m bund has been provided to provide screening to visual receptors at this location within the Macdonald resort.
- 4.3.17. From chainage 5675 to 5875 it was considered that a bund could not be formed without compromising the existing backslope. Therefore, a slight cutting has been formed to square-off the landform and provide the greatest extent of screening to receptors within the Macdonald Resort.

Chainage 10650-11000 (Southbound)

- 4.3.18. The embankment adjacent to the southbound carriageway has been eased out to a gradient of 1:4 to integrate the Proposed Scheme into the adjacent landscape and mitigate against visual impacts for receptors on the A95 and NCN7.

Chainage 22300-23000 (Southbound)

- 4.3.19. From chainage 22300 to 22650 the cutting slope has been steepened to a gradient of 1:1 to minimise the surface area of soil nailing.
- 4.3.20. From chainage 22650 to 23000 the cutting slope has been eased out to a gradient of 1:3 to integrate the Proposed Scheme into the adjacent landscape and mitigate against visual impacts for receptors on the A9 and NCN7 by avoiding the requirement for soil nailing.

Drainage Design

- 4.3.21. The locations and form of proposed permanent and temporary Sustainable Drainage System (SuDS) facilities have developed through a number of iterations informed by review of the proposals against environmental constraints, including the presence of ancient woodland and areas of deeper peat, areas at risk of flooding and through detailed consideration of landscape fit.
- 4.3.22. Where possible, a 3m track has been included around the SuDS features. Where ponds are designed for surface water discharge (retention ponds and detention basins), zero infiltration has been accounted for in the design. This will be achieved by lining of the ponds, unless the ground conditions are found to be suitably impermeable. A liner will also be required prevent encroachment of groundwater where it is higher than the base of the pond.

Floodplains

- 4.3.23. The design of the Proposed Scheme has been guided by the principle that it should not be located within the functional floodplain. Where this is not possible, the A9 should remain operational and safe for users during times of flood; result in no loss of floodplain storage; and the movement of water should not be impeded and flood risk should not be increased elsewhere. The functional floodplain is defined by the 0.5% AEP (1 in 200 year) flood event.
- 4.3.24. The mainline vertical profile between ch.7900 and ch.8960 (including Granish junction levels) has been raised (by up to 2.3m) to bring the mainline above the 0.5% AEP floodplain with a 20% allowance for climate change and freeboard. A 115m length, 0.5m high raised embankment is proposed along the right bank of Allt na Criche burn to protect downstream receptors from flooding.
- 4.3.25. Flood compensation storage has been provided at ch.14500 where the proposed scheme lies within the 0.5% AEP (1 in 200 year) floodplain of the Feith Mhor. A storage basin of approximately 5150m³ is proposed upstream of the A9 due to the constraints that the railway presents in its close proximity to areas downstream of the A9. Retaining water upstream of the A9 requires blocking off the flow path between the southern and northern channels of Feith Mhor Burn and ground levels of the base of the proposed storage area have been set to 258.5 mAOD.
- 4.3.26. As with the proposed mainline and junction infrastructure, private accesses and SuDS (including maintenance track routes) have been designed to avoid impacting upon the functional floodplain, including at Allt an Fhearna/Loch Alvie, Allt na Criche (Lynwilg), Aviemore/Milton Burn, Aviemore North Easter Shielling, Allt na Criche (Granish), Avielochan, Allt Cnapach, Feith Mhor, River Dulnain, Allt nan Ceatharnach, Bogbain Burn and Slochd Mhuic. In all cases it has been possible to avoid locating SuDS in the functional floodplain.

- 4.3.27. The results of hydraulic modelling confirm that all the proposed structures under the main A9 alignment pass the 0.5% AEP (1 in 200 year) with a 20% allowance for climate change and an appropriate freeboard allowance design standard. In this context freeboard is defined as the difference between the proposed scheme road level and the peak water level during the 0.5% AEP (1 in 200 year) plus climate change allowance, event. The minimum freeboard allowance is 600mm for structures larger than 1.2m high and 300mm for smaller openings.

Wildlife Permeability

- 4.3.28. The sizing of bridges, underpasses and culverts has taken cognisance of recommended dimensions to facilitate wildlife (deer, otter, bats, etc.) passage and also to allow mammal ledges to be incorporated, whilst not unduly affecting the proposed vertical road alignment that could have other landscape, visual and land take implications. This has involved a number of iterations informed by ecological survey findings, landscape appraisal, flood risk/hydromorphology and design standard/maintenance requirements.

NMU Access

- 4.3.29. Non-Motorised User (NMU) provision, developed to mitigate impacts of the Proposed Scheme on footpaths and NCN7 and providing enhancements where possible, are described in detail in Chapter 9 (Effects on all Travellers) with an overview presented below (in south to north order):
- New NMU route running alongside the A9 (northbound) from the start of the scheme to the proposed Aviemore South junction, to connect with the NMU route created as part of the Kincairdie to Dalraddy project;
 - New underbridge beneath the A9 to replace existing underpass thereby retaining NMU route connectivity between Druim Mhor and Ballinluig;
 - New NMU route alongside Lynwilg Road that crosses the new overbridge at Aviemore South GSJ and links to the Right of Way (RoW HB83 leading north to Aviemore);
 - RoW HB83 will be formalised with an improved cross section and surfacing (the mainline alignment was modified from ch.3800 to ch. 4750 to accommodate the cyclepath/footpath, avoiding impacts to the rock outcrop face and any consequent upslope impacts on Craigellachie SSSI/NNR). A new widened underbridge (with a 2m wide footpath on the northern side) is proposed at the location of the existing underbridge providing access to Grampian Road residential properties to the west of the existing A9;
 - The underbridge providing access to Craigellachie NNR will be retained/improved;
 - A new footpath is proposed at the B9152 on the approach to the Granish GSJ that links to RoW HB52 to the east and continues across the A9 via an underbridge to forestry tracks on the northbound side and RoW HB45 to the west;
 - Rationalisation of crossing points in the vicinity of Kinveachy with a new underbridge at approximately ch. 12300 and access road for both NMUs and vehicles;
 - A new vehicular access track is provided to the west of the A9 between Kinveachy and Lethendry North and this will be available for use by NMUs;
 - Rationalisation of two A9 at-grade crossing points near Lethendry to the north of Kinveachy with the provision of an underbridge at approximate chainage 14400 that is shared use for NMUs and vehicles;
 - An NMU and vehicle underbridge is proposed at Dalrachney Beag to replace the existing at-grade crossing of the A9 (ch.17050);

- The existing at grade crossing at Black Mount will be closed and access across the A9 will be via Black Mount GSJ to the south.
- A new underbridge across the A9 on the approach to Slochd Beag (at approx. ch. 20700), 320m to the east of the existing at-grade crossing (approx. ch. 21025) which will be closed;
- NCN7 / Core Path INV27.01 will be realigned at Slochd LILO to accommodate the proposed road layout and widening. The new route will be on the U2400 before connecting onto the dedicated NCN7 adjacent to the northbound carriageway of the A9;
- NCN7 / Core Path INV27.01 is diverted adjacent to the southbound carriageway at Slochd Mor at approx. ch. 23550; and
- There is a proposed A9 underbridge for the diverted NCN7 / Core Path INV27.01 to replace the existing A9 at grade crossing at approx. ch. 24300.

Lay-bys

- 4.3.30. An iterative assessment was carried out that considered locations for proposed lay-bys in terms of engineering/safety and environmental impact. The potential locations of lay-bys were constrained by horizontal road alignment design (e.g. visibility requirements), proposed junction locations and accesses and physical and environmental constraints.
- 4.3.31. Opportunities have been sought to enhance the quality of lay-bys, in terms of providing improved connectivity, cultural associations and views. Whilst environmental constraints and landowner considerations have limited these opportunities across the scheme generally, Layby 11 (ch. 23550, near Slochd Summit) facilitates onward NMU access through a direct connection with NCN7 and Core Path INV27.01, as well as geodiversity interest and the northern entrance to the National Park.