6 SCHEME PROPOSALS

6.1 Overview of Scheme Design

6.1.1 The Scheme is approximately 51km (32 miles) in length from junction 3 (Hayes) to junction 12 (Theale). It will result in the conversion of the hard shoulder of the M4 to a permanent running lane, while providing the necessary signing and technology to manage traffic using variable mandatory speed limits ("VMSL"). This will require the construction of gantries with lane-specific, variable message signs. A motorway with these features is referred to as a “smart motorway” as explained in chapter 5 of this EDR. The operation of the Scheme as a smart motorway is described in chapter 8 of this EDR.

6.1.2 There are a number of hard shoulder discontinuities, i.e. there is no hard shoulder for short lengths where existing bridges limit the available carriageway width, between junction 4b and junction 8/9. The Scheme will demolish these bridges and rebuild them in order to enable the construction of the smart motorway. As previously discussed in chapter 5 of this EDR, no-TJR (or Dual 3 Lane Motorway (“D3M”) is proposed at junctions 5, 6, 8/9 and 11. At some locations minor works will be required to enable the appropriate lane widths to be achieved including alterations to the central reserve of the motorway.

6.1.3 The majority of the works along the motorway corridor will be within land currently owned by the Secretary of State. This is because the Secretary of State is the highway authority for, and landowner of, Special Roads such as the M4. Highways England manages and operates the strategic road network on behalf of the Secretary of State. Additional land will be required permanently to accommodate the Scheme, such as for side road realignment at overbridges and underbridge widening. This will be kept to the minimum area required. Land will also be required temporarily for access, storage and construction activities, and in most cases will be reinstated to its former use on completion of construction. Both permanent and temporary land-take is included within the Order limits shown on the General arrangement drawings in Annex F of this EDR.

6.1.4 An Environmental Impact Assessment was carried out based on the preliminary design for the Scheme. The DCO was granted based on the preliminary design and at that stage there were aspects of the design which were subject to further development. However, the design that was assessed in the Environmental Statement (“ES”) represented a worst-case scenario considering the factors known at the time, in terms of environmental impact and required land-take, to ensure that all foreseeable environmental effects of the Scheme were assessed and stakeholders informed.

6.1.5 The Scheme design has subsequently matured through, detailed surveys, discovering previously unknown utilities and site conditions as well as iterative working between designers and environmental specialists and through the discharge of the DCO requirements.

6.2 Design guidance

6.2.1 The development and design of major highway projects are addressed by guidance and standards set out in the Design Manual for Roads and Bridges (“DMRB”) (Ref 17). The DMRB is supplemented by a number of Interim Advice Notes (“IAN”s) that provide current advice and guidance on standards in relation to certain aspects of design, assessment and network management. DMRB and IANs are published by the DfT and Highways England respectively.

6.3 Improving a traditional motorway

6.3.1 This section describes the civil engineering works to the existing M4 motorway that are required for the Scheme. It provides an overview of the general approach to the Scheme which is illustrated on the General arrangement drawings in Annex F of this EDR. . An explanation of the specific works proposed within each section of the M4, on a junction-by-junction basis (referred to as links), is contained in chapter 7 of this EDR.

Improving the traditional motorway: general approach

6.3.2 Wherever possible, the proposed alignment of the road(s) for the Scheme has been designed to remain within the extent of the existing carriageway and the Secretary of State's land ownership. Some carriageway widening will be required at junctions to accommodate slip roads and in areas where there is no existing hard shoulder (generally at overbridges above the M4 between junction 4b and junction 8/9).

6.3.3 The majority of the M4 within the Scheme will be converted to four-lane ALR. In addition, five-lane carriageways are proposed between junction 4b (M25) and junction 4 (Heathrow), which currently has four lanes in each carriageway. This is to provide additional capacity for traffic exiting/joining the main carriageway, whilst enabling TJR at junction 4. Five lanes will also be provided on the eastbound carriageway from Sutton Lane overbridge (east of junction 5) to junction 4b to give additional diverge capacity for traffic leaving the M4 to join the M25. These sections are shown on the Scheme plans.

6.3.4 . At Windsor Branch Railway Bridge, the existing central reserve is to be reconstructed. This is achieved by installing new bridging slab spanning between the two existing bridges.

6.3.5 The existing motorway has been re-aligned over Thames Bray Bridge to allow for asymmetric widening. This is required in some locations due to engineering constraints and as a means of minimising disruption to the motorway during construction.

Improving the traditional motorway: lane widths

6.3.6 The proposed lane widths of the improved motorway are shown in Table 9 with regard to four-lane ALR and five-lane ALR operations.

Table 9 ALR lane widths

		Lane 1	Lane 2	Lane 3	Lane 4	Lane 5	
Four lane ALR	nearside	3.65m	3.50m	3.40m	3.20m	n/a	offside
Five lane ALR		3.65m	3.65m	3.50m	3.40m	3.20m	

6.3.7 In locations where the existing carriageway width is insufficient to accommodate the minimum ALR lane widths, the additional width will be achieved by widening the carriageway into the central reserve. In most locations, this widening will be between 0mm and 500mm. Between junction 8/9 (Holyport) and junction 3, this widening will reduce the central reserve width to a minimum of 2.6m, which is nevertheless within the required safety standards.

6.3.8 Any deviation from the proposed lane widths quoted above is noted in the relevant part of chapter 7 of this EDR.

Improving the traditional motorway: hard shoulder discontinuities (junction 8/9 to junction 4b)

6.3.9 The structures on the M4 from junction 8/9 (Holyport) to junction 4b (M25) were mostly built during the 1960s to accommodate a dual two-lane motorway. In the 1970s the motorway was widened to three lanes, but the structures were generally not modified. This resulted in the hard shoulder being discontinuous at some overbridges, as shown in Figure 3, and at some underbridges.

Figure 3 Typical existing overbridge with discontinuous hard-shoulder

6.3.10 Provision of ALR will require these constraints to be removed so that the hard shoulder can function as a continuous running lane. In total, 11 overbridges, all situated between junction 8/9 (Holyport) and junction 4b (M25), will be demolished and replaced. There

are two broad approaches to such works - replacement in situ, or "online", and replacement alongside/ nearby, or "offline" (in this context). Of the 11 bridges, it is proposed that 6 will be replaced as offline improvements to the side roads, allowing the existing bridges to remain in use to carry traffic during construction. It is proposed that the remaining five will be replaced as part of online improvements to the side roads requiring temporary closure of the side road. See chapter 7 of this EDR for details.

6.3.11 Where there is insufficient width at underbridges, it is proposed to widen the existing structure(s). One underbridge, one subway and four culverts require widening. See chapter 7 of this EDR for details.

Improving the traditional motorway: Through Junction Running

6.3.12 The Scheme was originally designed to IAN161/13 which required all junctions (other than free flow motorway to motorway links) within ALR schemes to have Through Junction Running ("TJR"). Therefore, junction 4 (Heathrow), , junction 7 (Huntercombe), and the access to Reading MSA will be widened to accommodate TJR.

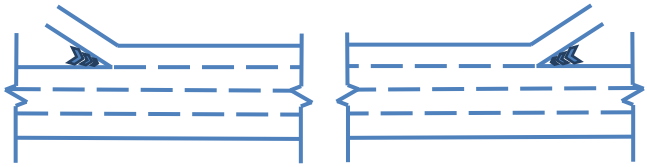
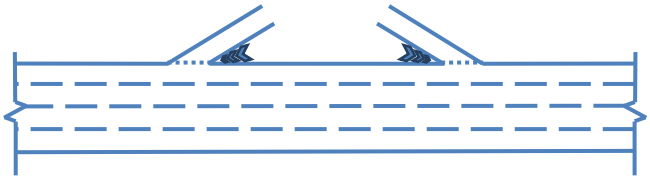
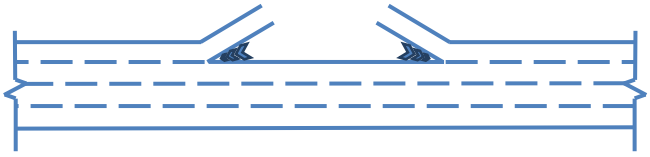
6.3.13 The Scheme is fully compliant with IAN 161/13. However, the latest guidance IAN 161/15 recommends that schemes identify the "most appropriate layout following analysis of the design year traffic flows and any operational or physical constraints". As a result of IAN 161/15, a review into the most appropriate layout for all junctions within the Scheme was undertaken, considering operational and physical constraints, traffic modelling/forecasting and safety assessments, along with feedback from operational All Lane Running ("ALR") schemes.

6.3.14 As detailed in chapter 5, the review found that the most suitable operating regime at junctions 5, 6, 8/9 and 11 would be No-TJR, i.e. retaining the existing lane loss/lane gain provision at those junctions. This decision was endorsed by the scheme's Safety Control Review Group ("SCRG").

6.3.15 TJR is not proposed at the terminal junctions where the Scheme begins and ends, namely junction 12 and junction 3. On the approach to these junctions, from outside the Scheme, the left-hand lane of the entry slip road will feed into the new lane 1 of the four-lane motorway (lane gain). At the end of the Scheme, lane 1 would diverge from the motorway (lane drop) into the exit slip road. The remaining three lanes will continue through the junction and align with the existing layout beyond the Scheme boundary.

6.3.16 TJR is also not proposed at junction 4b (M25) and junction 10 (Winnersh). These two junctions have free flow motorway-to-motorway two lane slip roads with high traffic flows. Use of TJR at these junctions would create additional traffic flow conflict between through traffic in lane 1 and diverging traffic approaching the junction in lane 2. At these junctions a "lane drop, lane gain" layout is proposed as shown in Table 10.

Table 10 Junction schematics

Junction Schematics	Description
Traffic Flow   LANE GAIN LANE DROP	Typical lane gain and lane drop junction layouts.
Traffic Flow   THROUGH JUNCTION RUNNING	Typical lane layout for through junction running.
Traffic Flow   NO-THROUGH JUNCTION RUNNING	Typical lane drop / lane gain layout at a junction with no through junction running.

Improving the traditional motorway: Emergency Areas ("EA"s)

6.3.17 'Emergency Areas' ("EA"), which are similar to laybys, are required to provide a safe area for vehicles to stop in an emergency without interrupting the flow of traffic on ALR motorways. This is because there will no longer be a hard shoulder.

6.3.18 The Scheme has 34 EAs, with no more than 2.5km between places of relative safety (including hard shoulders, motorway service areas and EAs), as indicated on the

General Arrangement drawings in Annex F of this EDR. These are 100m in length (25m entry taper, 30m length, 45m exit taper) and are a minimum of 4.3m wide. So far as possible, they are constructed on existing highway verges and within the existing highway boundary (and hence within the existing ownership of the Secretary of State).

6.3.19 In the event of a vehicle using an EA in an emergency, signing in the EA encourages drivers to contact the Regional Control Centre ("RCC"). The RCC will offer safety advice and ask if the driver requires assistance. Operators in the RCC will be able to monitor the vehicle using CCTV, and if necessary dispatch a traffic officer patrol and/or set signs and signals to assist the vehicle's safe exit, either under the vehicle's own power or under tow from a recovery agent.

6.3.20 Although it is expected that the majority of drivers will not need assistance to exit the EA, options range from setting warning legends on the variable message signs, through reducing carriageway speed limits, to setting up a rolling road block to allow a slow-moving vehicle to leave. These procedures are tried and tested and are currently used on the motorway network.

Improving the traditional motorway: Police Observation Platforms

6.3.21 Police Observation Platforms ("POPs") provide a safe area for stationary police vehicles. On the M4 currently the police access the POPs by pulling up on the hard shoulder and reversing into the POP. On completion of their observation they then re-access the motorway after accelerating to motorway speed on the hard shoulder.

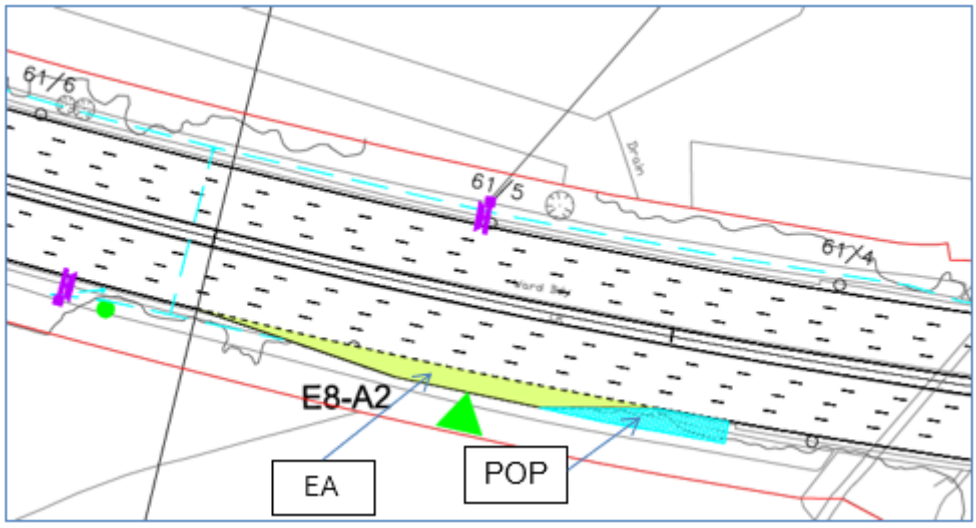


Figure 4 Typical EA with Police Observation Platform

6.3.22 With no hard shoulder on the Scheme it will not be possible to operate in this manner, so the existing POPs will be removed and new POPs positioned adjacent to EAs (Figure). An assessment of the number and location of the new POPs was undertaken in conjunction with key stakeholders (Police and HE Customer Operations). The assessment included sight lines to the POPs and available space to construct the

raised platform. There are 9 POPs in total.

Improving the traditional motorway: overbridges

6.3.23 For the 11 sites where bridge reconstruction work is required, five will be replaced online and six offline as follows:

a) where a suitable temporary road diversion route is agreed with the local authority (i.e. an alternative way of reaching the same areas without a significant increase in distance), then a temporary closure of the side road will be implemented. The existing bridge demolished and the new bridge built at the same location as the old bridge (online replacement). Traffic, pedestrians, cyclists and equestrians will be diverted on to this alternative route during the active construction; or

b) where a suitable temporary diversion route does not exist and closure during construction is not feasible, then the new bridge will be built to one side of the existing bridge (offline reconstruction), whilst the existing bridge remains open to traffic. Following completion of the new bridge, traffic will then be diverted onto the new bridge and the old bridge will be demolished.

6.3.24 As part of the replacement of overbridges, the existing carriageway and footpath/cycleway/equestrian provisions will be maintained on a broadly like-for-like basis.

6.3.25 The height or “vertical alignment” of each of the 11 side roads will be increased to provide the required clearance height above the motorway and to accommodate the increased depth of the new replacement bridge.

6.3.26 Before describing the bridge works included in the Scheme in the link-by-link explanation provided in chapter 7 of this EDR, it is useful to outline some of the terms used:

a) “Super-structure” is the term used for the deck and parapets of the bridge;

b) “Sub-structure” is the columns and other supports on which the super- structure rests;

c) an “abutment” is the sub-structure at the end of a bridge. Abutments provide vertical and lateral support for the super-structure;

d) a “full height abutment” sits at the back of the verge and acts as a retaining wall to hold back the earthworks fill material of the bridge approach embankments;

e) a “bank seat abutment” is smaller than a full height abutment. It sits at the top of the approach embankment and results in a bridge with a more open aspect, but with a longer deck; and

f) a “pier” is an intermediate element of the sub-structure required on multi- span bridges. A pier usually consists of a column, a group of columns or a wall.

g) “overbridge” is a bridge supporting a road or footpath over the motorway

h) “underbridge” is a bridge supporting the motorway as it crosses over an obstacle such as a road or river

6.3.27 It is proposed that structural steelwork for all overbridges except the Oldway Lane footbridge (which would be a welded steel truss) is fabricated from “weathering” steel. This steel has improved atmospheric corrosion resistance, and it does not require painting. A number of different structural configurations are considered for each of the replacement bridges. A summary of these options is contained in Table for overbridges and Table for underbridges.

6.3.28 There are four different overbridge span arrangements for the Scheme;

a) single-span deck supported on full height abutments (Figure). This is the preferred solution at most sites, because of its advantages over the multi-span options. A two-span bridge requires a pier to be built, usually, close to live traffic, which leads to traffic delays, and impacts on safety, cost and programme;

b) two-span deck supported on abutments, (Figure). This arrangement is proposed in locations where there are significant statutory utilities close to and parallel with the motorway verges. In this situation, one span of the bridge is over the widened M4, the second span is over the statutory utilities. This option is preferable because it eliminates the need for costly diversions of utilities, minimises construction work and the presence of operatives around live statutory assets.

c) three-span deck with piers at the back of the verge and bank seat abutments (Figure). This arrangement is proposed for Monkey Island Lane. A three-span bridge is preferred because of construction benefits. The use of bank seats, rather than full height abutments, reduces the amount of temporary works required to construct immediately adjacent to the existing structure; and

d) single-span steel truss footbridge (Figure). This is suitable only for non-vehicular loading and is proposed only at Oldway Lane.

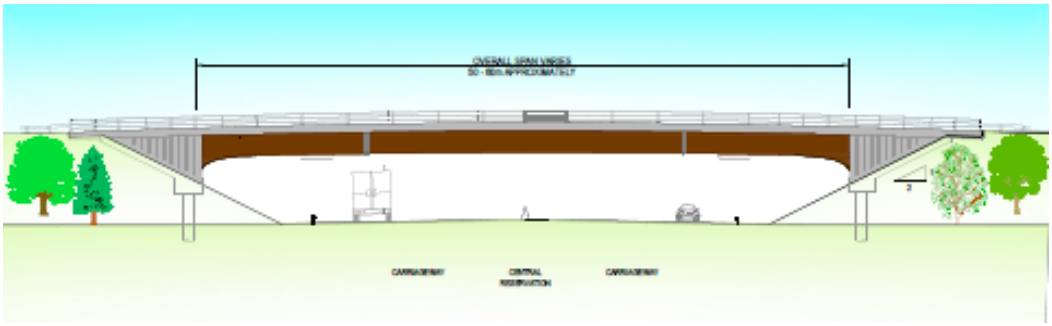


Figure 5 Typical elevation of proposed single-span structure

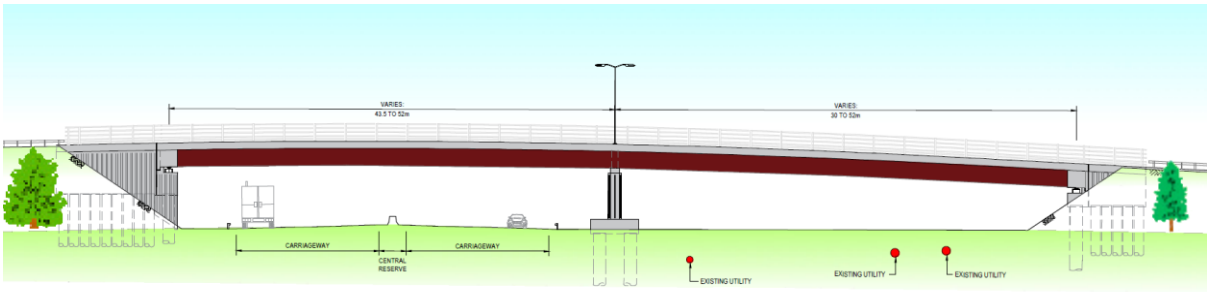


Figure 6 Typical Elevation of an asymmetric two-span structure

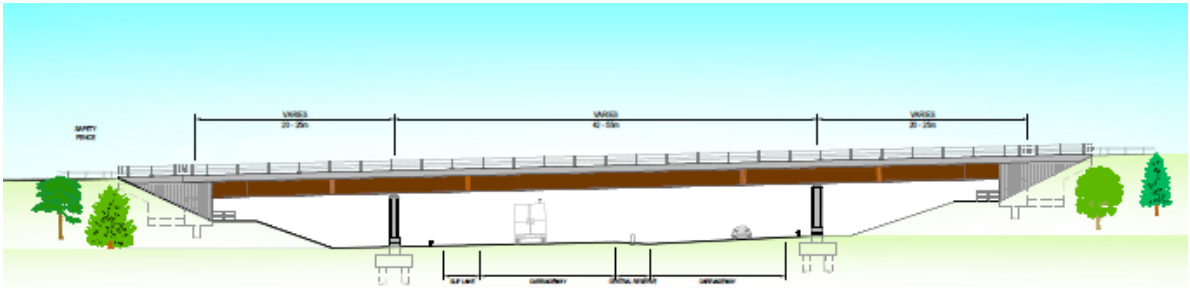


Figure 7 Typical elevation of proposed three-span structure

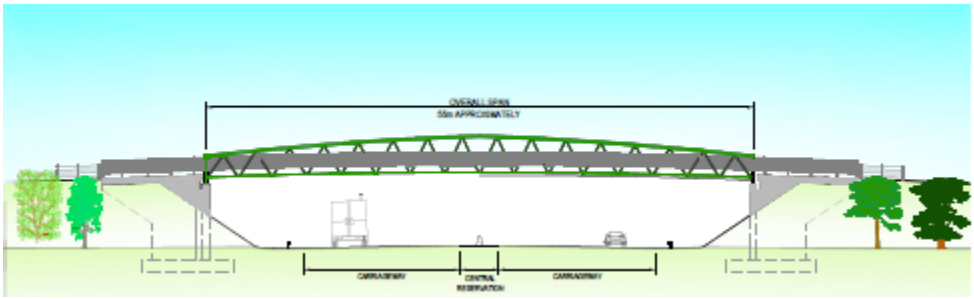


Figure 8 Typical elevation of proposed footbridge

6.3.29 Construction of overbridges and embankments may require works on land not currently owned by the National Highways. Both temporary and permanent land requirements are within the Order limits shown on the General Arrangement drawings in Annex F of this EDR.

6.3.30 The locations of structures that need to be demolished and reconstructed are indicated on the General Arrangement drawings in Annex F of this EDR. Details of the specific proposals at each location are included in chapter 7 of this EDR. The 11 overbridges to be demolished and replaced are listed in Table 11.

Table 11 Overbridges to be demolished and reconstructed

Overbridge	Location	Replacement structure
Ascot Road	J8/9 – J7	Offline, single-span
Monkey Island Lane	J8/9 – J7	Offline, three-span
Marsh Lane	J8/9 – J7	Online, single-span
Lake End Road	J8/9 – J7	Offline, two-span
Huntercombe Spur	J7	Online, single-span
Oldway Lane	J7 – J6	Online, single-span footbridge
Wood Lane	J7 – J6	Offline, two-span
Datchet Road	J6 – J5	Offline, two-span
Recreation Ground	J6 – J5	Online, single-span
Riding Court Road	J6 – J5	Offline, single-span
Old Slade Lane	J5 – J4b	Online, single-span

Improving the traditional motorway: underbridges, subways and culverts

6.3.31 As explained above, there are currently a number of links where the existing hard shoulder is discontinuous due to the width of the underbridges, subways and culverts. To accommodate ALR one underbridge, one subway and five culverts listed in Table require widening.

6.3.32 The preferred solution at each bridge is to extend the existing structure with a matching structural form. A number of different structural configurations have been considered for the widening of underbridges. A summary of the chosen options are contained in Table 12.

6.3.33 As with the overbridges, widening of the underbridges and embankments will require works on land not currently owned by National Highways. Both temporary and permanent land requirements are within the Order limits shown on the General Arrangement drawings in Annex F of this EDR.

6.3.34 The most notable of the underbridges is Thames Bray underbridge, which requires 7.8m of widening. The locations of structures that need to be widened are indicated on the General Arrangement drawings in Annex F of this EDR and details of the specific proposals at each location are included in chapter 7 of this EDR.

Table 12 Underbridges, subways and culverts to be widened

Underbridge	Location	Nature of widening
Thames Bray	J8/9 – J7	7.8m asymmetric widening to the north
Chalvey Culvert	J7 – J6	Asymmetric widening of 4.65m to the south and 4.11m to the north.
Railway Culvert	J6 – J5	7.6m widening to the north.
Water and gas main culvert	J6 – J5	Asymmetric widening of 1.35m to west and 2m to the east ends selected.
Water main culvert	J6 – J5	Asymmetric widening of 2m to the west and 3.8m to the east selected
Ashley's Arch culvert	J6 – J5	1.25m asymmetric widening to the north
Sipson Road North Subway	J4b – J4	1.2 m widening to the north.

Improving the traditional motorway: earthworks widening

6.3.35 Existing earthwork embankments and cuttings will need to be widened in the following situations:

a) to accommodate motorway and slip road widening;

b) for realigned side roads;

c) for foundations for new structures and gantries where the existing verge width is inadequate;

d) for constructing EAs and POPs where the existing verge width is inadequate;

e) for cabinets and chambers where the existing verge width is inadequate; and

f) for new environmental barriers where the existing verge width is inadequate.

Improving the traditional motorway: drainage

6.3.36 Highway drainage is designed to remove rainfall from the carriageway surface to ensure safe operation of the road network.

6.3.37 New drainage systems are required in the central reserve and the verges where appropriate.

6.3.38 Superelevated sections, where the running carriageway is falling towards the central reserve, drainage is provided by slotted linear drainage channels. In locations along the motorway, where the existing hard shoulder falls in the opposite direction to the carriageway, new coplanar (in the same plane) lengths are proposed, such that both the hardshoulder and carriageway drain in the same direction. Lengths of existing hard shoulder that currently slope in the opposite direction to the carriageway will be changed to slope in the same direction as the carriageway camber. Redundant drainage as a result of correcting no-coplanar sections will be removed. The new drainage system for the main carriageway will be sized to accommodate the additional run-off arising from the reprofiled hard shoulder.

6.3.39 In the verges of embankments, it is proposed to replace the existing kerb and gully system with slot drains, linear drainage channels and combined kerb and gully systems where appropriate. Combined carrier filter drains will be provided when the road is in cutting. Where the road is at-grade (level with existing ground), the choice of drainage system will be as per the measures for embankments.

6.3.40 At EAs, attenuation of run-off from the additional carriageway areas will be in the form of oversized kerb drainage units; pipes and/or manhole chambers with spillages control devices prior to connection into the drainage system.

6.3.41 In line with Highways England design standards, existing peak discharge rates from the highway drainage system to the receiving watercourses will not be increased, and therefore there will be no impact on flood risk from the mainline works (see ES chapter 15 (Water)). Spillage control and pollution containment devices will be provided at all EA sites.

6.3.42 Mitigation to compensate for any loss of floodplain as a result of the Scheme will be

provided with floodplain compensation areas within Order limits. The flood compensation scheme must ensure that compensation works provide sufficient compensation to ensure that the authorised development will not increase flood risk for all events up to and including the 1% annual exceedance probability plus a 20 per cent allowance for climate change. For example, new road embankment slopes are steepened in floodplain areas to minimise loss of floodplain capacity, or bridge spans increased to compensate for reduction due to embankments.

Improving the traditional motorway: signs

6.3.43 Detail in relation to the signage to be used for the Scheme is provided in chapter 7. The majority of new advanced direction signs required for the Scheme will be mounted overhead on gantries.

Improving the traditional motorway: road restraint system

6.3.44 A 900mm high rigid concrete barrier (RCB) (see Figure 9 for an example) and paved central reserve is included in the Scheme. This prevents cross-over accidents, resulting in improved safety for road users. RCBs also require minimal maintenance and therefore reduce the amount of maintenance works required, improving safety for road workers.

6.3.45 Within the RCB are removable steel step barrier sections at maintenance cross-over points. These steel sections of barrier can be unbolted and removed to allow contraflow traffic (i.e. traffic moving in the opposite direction to how it should normally flow) it also allows access for emergency services during severe incidents.

Figure 9 Rigid concrete barrier

6.3.46 The majority of the existing safety barrier in the verges will be removed and replaced with a new safety barrier. Additional safety barriers will be provided at new hazards in the verge, such as gantries, signs and CCTV cameras. Where a new safety barrier is provided in the verge, this will normally be a steel safety barrier system (see Figure 1 for an example).

Figure 1 **Steel Safety Barrier**

Improving the traditional motorway: lighting

6.3.47 Within the extent of the Scheme (junction 3 to junction 12), the existing M4 is lit with either central reserve or verge lighting between junction 3 to junction J8/9 and junction 10 to junction 12.

6.3.48 The Scheme will replace the existing lighting between junctions 3 and 7, and remove the lighting between junction 7 and junction 8/9 and junctions 10 to 12.

6.3.49 The height of lighting columns varies and is a maximum of 12.9m above the carriageway. Lighting columns are mounted on top of the central reserve RCB and carry LED luminaires.

6.3.50 The LED luminaires use much less energy than the existing luminaires.

Improving the traditional motorway: road surfacing

6.3.51 The existing hard shoulders are surfaced in either Hot Rolled Asphalt ("HRA") with stone chippings or Thin Surface Course System ("TSCS"). HRA is the traditional asphalt surfacing material that has been used in the UK since the 1960s. TSCS has been available since the early 1990s and is classified as ‘low-noise surfacing’. It is Highways England policy (Ref 17) to use TSCS for all new roads and for replacement of life-expired surfacing.

6.3.52 The Scheme will provide TSCS throughout. The existing TSCS at junction 5 will be retained. This will reduce the noise impact of the Scheme, and will minimise the need for further maintenance work in the five years after Scheme opening.

Improving the traditional motorway: noise barriers

6.3.53 Barriers, in the form of fencing to mitigate noise effects, are included within the Scheme where the ES has identified that this form of environmental mitigation is required. This is addressed in greater detail in chapters 8 (Landscape) and 12 (Noise) of the ES. Noise Barriers are shown on the Environmental Masterplan in Annex A

Improving the traditional motorway: replacement planting

6.3.54 Vegetation lost to construction activities will be replanted where possible with locally appropriate species. Environmental enhancement will also be applied in appropriate circumstances, see chapter 8 of the ES.

This is shown on the Environmental Masterplan drawings included at Appendix A to this EDR, and as have been discharged under the DCO.

6.3.55 Semi-natural habitat cleared during construction is re-planted using local species that are considered appropriate to the nature of the soil and the pre-existing vegetation composition. In the medium to long-term, this planting will mature to provide habitats and visual screening, which will replace the vegetation removed.

6.4 Features of a smart motorway

6.4.1 This section describes the technology, signal and gantry works that are required for the Scheme. It provides an overview of the general approach to the Scheme, describing the individual items that will be used in the Scheme. An explanation of what specific works are proposed at each section of the M4 on a junction-by- junction basis is contained in chapter 7 of this EDR. The operation of the smart motorway using this infrastructure to manage traffic flow and speed is described in chapter 9.

Features of a smart motorway: motorway signals

6.4.2 Operation of the smart motorway will be controlled via LED signals mounted on overhead gantries. There are three main types of LED signals which are described below.

6.4.3 Advanced Motorway Indicators ("AMI") (Figure 2) are used to display VMSL for each lane using programmable high-resolution LEDs. These will be located on gateway gantry structures after each entry slip road to the Scheme and on intermediate gantries at intervals of not more than 6km.

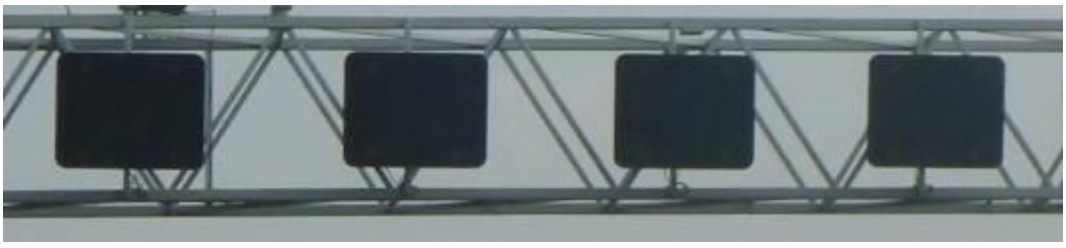


Figure 2 Typical view of AMI signals

6.4.4 Motorway Signals Mark 4 ("MS4") (shown in Figure 3 and Figure 4) is a type of variable message sign (“VMS”) used to provide driver information in the form of text and pictograms. These will be located at regular intervals along the Scheme either above a gantry boom, generally positioned over lane 1, or on the verge, mounted on a cantilever structure.

Figure 3 Typical MS4

Figure 4 A cantilever gantry solely supporting an MS4 over lane 1

6.4.5 The other type of VMS proposed for use in the Scheme is a Message Sign Mark 3 ("MS3") (Figure 5 and Figure 6). These will be deployed in advance of strategic junctions and provide information to road users in the form of text messages (3x18 Characters). MS3s are located on cantilever gantries in the verge.

Figure 5 Typical MS3

Figure 6 A cantilever gantry solely supporting an MS3 over lane 1

6.4.6 VMS signals will be located on the gateway gantries and on additional gantries all along the scheme. The distance between successive VMS signals varies but, generally the distance between one signal and the start of the visibility of the next signal will not exceed 500m. The average distance between VMSs in the Scheme is 900m.

Features of a smart motorway: signs

6.4.7 Overhead signs are mounted on gantries to provide drivers with information and to help them select the most appropriate lane. Signs types include Advance Direction Signs ("ADS") (shown at Figure 7), route confirmation signs and other information signs. All gantry mounted signs are illuminated at night.

Figure 7 Typical 'lane drop' direction sign (westbound approach to junction 11)

Features of a smart motorway: gantries

6.4.8 Gantry structures are required to support overhead signs, signals, vehicle detection and enforcement equipment. To minimise the number of new gantry structures required, the design includes multi-function gantries, e.g. a single gantry may carry ADSs, AMIs and/or a VMS. The positioning of the gantries is optimised to ensure maximum reuse of existing gantry structures.

6.4.9 Each existing gantry has been structurally assessed to determine if it is sufficient to carry the required signs and signals. Where there is sufficient structural capacity the gantry is retained. Where there is insufficient capacity the gantry is replaced, or the signs and or signals were redesigned to reduce loading.

6.4.10 In some cases a full super span gantry replaced existing cantilevers to improve sign and signal provision.

6.4.11 Cantilever structures are used to mount signs located in the motorway verge. A cantilever structure is supported on a single leg in the verge of the motorway (Figure 8). There are various types of cantilever depending on the equipment or signs that they are supporting. The largest cantilever gantries support signs and signals; these are known as super-cantilever gantries (Figure 9).

Figure 8 Typical sign-only cantilever gantry (one leg)

Figure 9 Typical super cantilever gantry

6.4.12 Portal gantry structures are used to provide overhead support for signs over one motorway carriageway. A portal gantry has two supporting legs, one at each end of the horizontal boom (Figure 10).

Figure 10 Typical portal gantry (two legs)

6.4.13 Super-span portal gantries (Figure 11) provide overhead support for signs over both motorway carriageways. A super-span portal gantry is a lightweight structure which enables a single portal to span the entire motorway with no support in the central reserve. A super-span portal gantry is not designed for maintenance loading and has no walkway.

Figure 11 Typical super-span portal gantry

6.4.14 The quantity of each type of gantry included in the Scheme is shown in Table . The location of gantries are provided in the General Arrangement drawings in Annex F of this report.

Table 13 Gantry types used in the scheme

Gantry type	Number
Portal	4
Super-span portal	18
Super cantilever	42

Gantry type	Number
Sign only cantilever	12
MS4 cantilever	50
MS3 cantilever	6
Existing portal	5
Existing MS4 cantilever	19
Existing MS3 cantilever	0

Features of a smart motorway: Temporary Traffic Management ("TTM") signs

6.4.15 At Preliminary Design the Scheme proposed use of Remotely Operated Temporary Traffic Management Signs (“ROTTMS”) for signing Temporary Traffic Management (“TTM”) to allow maintenance activities post-completion. However, advances in techniques to use gantry mounted signage to provide this feature mean that ROTTMS are no longer proposed on the Scheme. The use of gantry mounted signs for this purpose is called Signalling for Roadworks (“SfR”).

6.4.16 The implementation of SfR has been subject to extensive risk assessments to ensure the safety of road workers and users. The proposal to remove ROTTMS from the Scheme’s design has been endorsed by the National Safety Control Review Group. The National Safety Control Review Group reviews and advises on complex or unique safety issues and network consistency items and reviews the highest level of safety categorised matters.

Feature of a smart motorway: cameras

6.4.17 115 Pan, Tilt and Zoom ("PTZ") CCTV cameras (Figure 20) are provided. They are installed on a combination of gantries and 15m masts to ensure there is full coverage of all driving lanes. This enables Traffic Officers at Highways England existing RCC at South Mimms to manage incidents and set the appropriate signs and signals As part of the mainline scope, the CCTV locations were re-assessed using requirements to achieve Interim Advice Notice, (IAN) 161/15 and consequently a comprehensive review of the CCTV design was undertaken. This comprehensive review considered the use of “full CCTV coverage” in accordance with the principles of this Engineering and Design Report (“EDR”).

Figure 12 Typical mast mounted CCTV camera

Figure 13 Typical **gantry mounted CCTV camera**