

HIGH SPEED RAIL (LONDON - WEST MIDLANDS)

Supplementary Environmental Statement 3 and
Additional Provision 4 Environmental Statement

Volume 5 | Technical appendices

Summary of carbon calculation outputs
(CL-002-000)

October 2015

SES3 and AP4 ES 3.5.1.2

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Department for Transport

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1 Introduction

- 1.1.1 This appendix provides an update to Appendix CL-002-000 from the main Environmental Statement (ES) (published in November 2013) as a result of design changes and amendments assessed as part of the Supplementary Environmental Statement 3 (SES3) and the Additional Provision 4 Environmental Statement (AP4 ES). This update should be read in conjunction with Appendix CL-002-000 from the main ES.

2 Description of the scoping assessment

- 2.1.1 A process was developed to identify which of the SES3 design changes and AP4 amendments could be material¹ from a greenhouse gas (GHG) emissions perspective and therefore require assessment. The assessment process comprised the following steps:

1. establish the percentage of construction elements², by type, in the main ES that are altered (i.e. a modification in design, a completely new addition or removal of a construction element) by the SES3 design changes or AP4 amendments. For example, there were 119 road-related elements in the main ES of which twenty are affected by the AP4 revised scheme, thus comprising 17% of the total of road-related elements;
2. estimate the potential for the SES3 design changes and AP4 amendments to influence the total construction or operational carbon footprint reported in the main ES based on the average contribution of the relevant construction elements. Where amendments are considered to exceed 1% of the construction carbon footprint; they have been identified as potentially material. For example, with reference to the road related AP4 amendments; based on the average construction carbon footprint of a road-related element, these amendments would increase the overall construction GHG emissions by 0.4% which has not been identified as material; and
3. review each SES3 design change and AP4 amendment to understand each change from a qualitative perspective. For example, relocation of construction elements that were set out as part of the original scheme may have associated impacts. For example, the Chiltern tunnel extension (AP4-009-001) has the primary impact of a change in the amount of construction material but also has secondary impacts on volumes and movement of excavated materials.

- 2.1.2 Using the three-stage process listed in paragraph 2.1.1 it was determined whether an amendment or design change was either:

- non-material: represents a situation where the presumed GHG emissions

¹ 'Material' in this context refers to changes in the design and construction of the HS2 scheme that are considered to be large enough to materially alter (increase or decrease) the scheme's total construction GHG emissions.

² Construction elements refers to elements that make up the HS2 scheme such as bridges, viaducts, roads, tunnels, track, stations etc.

impact of the design change or amendment is considered negligible and updating the carbon footprint for this element is not necessary (i.e. it is not necessary to update the carbon footprint as a result of the amendment); or

- potentially material: represents a situation where, for a single construction element (i.e. a bridge) or a combination of similar construction elements (i.e. a group of bridges), the GHG emission impact of the SES3 design changes or AP4 amendments are considered potentially material and that updating the carbon footprint of this construction element is necessary.

3 Scoping exercise results

3.1.1 Table 1 and Table 2 present the SES3 scoping exercise results. The impact of the SES3 design changes on the overall carbon footprint presented in Volume 3 of the main ES would be non-material and therefore do not require any further analysis.

3.1.2 Table 3 and Table 4 present the AP4 scoping exercise results, where AP4 amendments were compared to figures presented within Appendix CL-002-000 of the main ES. The scoping exercise results identified that amendments to two tunnels present a potentially material impact: Chiltern tunnel and Long Itchington Wood tunnel. Of these, the Chiltern tunnel portal amendment forms the majority i.e. 99% of the 5.8% increase in total tunnel/portal length. It is estimated that this increase in tunnel length is equivalent to a 1.3% increase in the construction GHG emissions (73,300 tCO₂e) of the proposed scheme. On this basis the extension to the Chiltern tunnel has been identified as the single potentially material AP4 amendment and requires further analysis to better quantify the impact that this could have.

4 Carbon assessment methodology

4.1.1 The total GHG emissions change was calculated from the sum of the changes for the identified material AP4 amendments. This calculation did not include contributions from the SES3 design changes since they were considered to be non-material at the route-wide level.

Table 1: SES₃ results from the quantitative element of the scoping exercise

Construction element types	Main ES - number of construction elements	Main ES - carbon contribution (%) by construction element type	Number of SES ₃ -related changes, by construction element	SES ₃ -related changes as a proportion (%) of the main ES construction elements type	Estimated carbon emissions (tCO ₂ e) per main ES construction element type	Estimated carbon emissions (tCO ₂ e) of SES ₃ -related changes	SES ₃ -related changes in carbon emissions as a % of total construction emissions
Earthworks	-	10.4%	-	see footnote	see footnote	see footnote	see footnote
Demolition	108	0.5%	-	-	-	-	-
Construction waste	184	0.3%	-	-	-	-	-
Land use, land-use change and forestry (LULUCF) ³	-	1.8%	6	see footnote	see footnote	see footnote	see footnote
Bridges	180	3.0%	-	-	-	-	-
Viaducts	59	9.8%	-	-	-	-	-
Roads	119	2.1%	5	4%	1,011	5,053	0.1%
Retaining walls	17	2.0%	-	-	-	-	-
Cuttings	31	5.8%	-	-	-	-	-
Embankments	41	0.1%	1	2%	128	128	0.0%
Tunnels and dive-under	35	22.6%	6	17%	36,310	217,863	3.9% ⁴
Tunnel boring machine (TBM)	-	4.9%	-	-	-	-	-
Stations/ interchanges	2	11.4%	-	-	-	-	-
Depots	2	0.1%	-	-	-	-	-

³ Carbon emissions associated with land use, land-use change and forestry (LULUCF) is estimated for the purposes of this scoping assessment on the basis of land area than number of construction elements.

⁴ See table 2 for an explanation as to why SES₃ tunnel changes were considered non-material.

Construction element types	Main ES - number of construction elements	Main ES - carbon contribution (%) by construction element type	Number of SES3-related changes, by construction element	SES3-related changes as a proportion (%) of the main ES construction elements type	Estimated carbon emissions (tCO ₂ e) per main ES construction element type	Estimated carbon emissions (tCO ₂ e) of SES3-related changes	SES3-related changes in carbon emissions as a % of total construction emissions
People mover	1	0.1%	-	-	-	-	-
Track ⁵	1	17.6%	-	see footnote	see footnote	see footnote	see footnote
Rolling stock (life span 35 years)	-	4.1%	-	-	-	-	-
Other	117	3.3%	9	8%	1,583	14,249	0.3%
Mitigation (tree planting)	-	0.0%	1	-	-	-	-

⁵ Assessing the significance of track changes is based on the anticipated distance involved in the change rather than the numbers of track related amendments.

Table 2: The SES₃ qualitative aspect of the scoping exercise, along with justification text as to whether the amendment(s) are material, and final scoping results

Construction element types	Justification text	Scoping result
Earthworks	SES design changes and AP ₂ amendments resulted in a decrease in mass haul emissions of 1,000 tCO ₂ e, effectively reducing the main ES's total construction GHG emissions by less than 0.02%. Likewise, SES ₂ and AP ₃ increased total construction GHG emissions from the main ES by less than 0.2%. Given the non-material impact that AP ₂ and AP ₃ have had on total construction emissions, the SES ₃ design changes are similarly considered to have a non-material impact.	Non-material impact-
Demolition	-	-
Construction waste	-	-
LULUCF	Six amendments relating to LULUCF are identified. Two of these amendments relate to additional land requirements for a HS ₂ staff training centre and to enable the relocation of a primary school; a further two relate to additional land requirements to realign footpath diversions; one relates to the movement of the construction boundary; and the final one relates to the relocation of a compound within the land within the bill limits. In total LULUCF area in the ES was 2,629 hectares. The anticipated area required for these amendments is a negligible percentage of this.	-
Bridges	-	-
Viaducts	-	-
Roads	Five amendments relate to roads. One relates to a new roundabout; two relate to temporary improvements to junctions; one relates to the update of a drawing for the re-alignment of construction access; and one relates to issuing access rights from a track on to a new road. Given the ES is comprised of 119 road related elements (which in total comprised a little over 2% of the overall carbon footprint for the scheme) and the minor nature of the proposed SES amendments they are considered, individually, and in combination as a non-material impact.	Non-material impact
Retaining walls	-	-
Cuttings	-	-
Embankments	Only a single amendment has been identified relating to embankments; a higher embankment to mitigate maintenance loop impacts at Stoke Mandeville. No details are provided on the size of the embankment. In total there are 41 embankment related elements across the route, which in total comprise 0.1% of the proposed scheme's total construction GHG emissions. Increasing the height of one embankment is therefore considered a non-material impact.	Non-material impact

Construction element types	Justification text	Scoping result
Tunnels and dive-under	Six amendments relate to tunnels, portals and dive-unders. In total the amendments comprise an increase in total tunnel length of 660m. The tunnel related SES ₃ amendments combined represent a 1.26% increase in total tunnel/portal length. Assuming a direct correlation between tunnel length and construction emissions, these amendments in combination would result in a 16,000 tCO ₂ e increase in construction GHG emissions, equivalent to 0.3% increase in the proposed scheme's total construction GHG emissions.	Non-material impact
TBM	-	-
Stations/ interchanges	-	-
Depots	-	-
People mover	-	-
Track	-	-
Rolling stock (life span 35 years)	-	-
Other	Nine amendments are classed as "other" comprising amendments relating to mitigation, pedestrian crossings, structures and utilities. Five of these amendments relate to new structures: an HS2 staff training centre where there is little change to bulk material as the training area will not require any new land than originally proposed, in addition there will be a minor re-shaping of the screening bunds. A new prefabricated primary school for 330 pupils whose structural construction emissions are estimated at less than 500 tonnes of carbon, less than 0.01% of total GHG construction emissions. The relocated civic amenity site whose construction emissions, based on preliminary bulk material data, accounts for less than 0.1% of HS2's total GHG emissions. A small extension to bat mitigation structure by 30 metres of planting and fencing, and maintenance base composed of 120m ² of accommodation space, 200m ² of storage space and 20 car park spaces. The structure of the maintenance base is basic with little fit-out and unlikely to require significant construction. One amendment relates to the provision of temporary pedestrian crossings with little to no construction necessary. Two amendments relate to the relocation of an overhead power line and another to the requirement for further utility related assessments - none of which result in new construction. The final amendment relates to a balancing pond where the change is the retention of surrounding trees and hedgerows, again with no new construction being proposed here. Given that in the ES there were 117 "other" related elements and total "other" emissions comprise 3% of the total ES footprint these 9 amendments, individually and in combination are classed as a non-material impact.	Non-material impact
Mitigation (tree planting)	Only a single amendment noted - the addition of a single noise mitigation barrier. This is unlikely to materially impact construction emissions. Non-material impact.	Non-material impact

Table 3: AP4 results from the quantitative element of the scoping exercise

Construction element types	Original ES elements	ES Carbon emissions % of total	Number of AP4-related changes, by construction element	AP4- related changes as a proportion (%) of the main ES construction elements type	Estimated carbon emissions (tCO ₂ e) per main ES construction element type	Estimated carbon emissions (tCO ₂ e) of AP4-related changes	AP4-related changes in carbon emissions as a % of total construction emissions
Earthworks ⁶	-	10.4%	-	see footnote	see footnote	see footnote-	see footnote
Demolition	108	0.5%	-	-	-	-	-
Construction waste	184	0.3%	-	-	-	-	-
LULUCF ⁷	-	1.8%	31	-	-	-	-
Bridges	180	3.0%	2	1%	926	1,852	0.0%
Viaducts	59	9.8%	2	3%	9,392	18,785	0.3%
Roads	119	2.1%	20	17%	1,011	22,232	0.4%
Retaining walls	17	2.0%	-	-	-	-	-
Cuttings	31	5.8%	-	-	-	-	-
Embankments	41	0.1%	2	5%	128	256	0.0%
Tunnels and dive-under	35	22.6%	2	6%	36,310	72,621	1.3%
TBM	-	4.9%	-	-	-	-	-
Stations/ interchanges	2	11.4%	-	-	-	-	-
Depots	2	0.1%	-	-	-	-	-
People mover	1	0.1%	-	-	-	-	-

⁶ Movement of excavated materials assessment considers the whole route not individual amendments or small sections. On this basis, determining potential materiality is based on likely scale of relevant changes not numbers or %.

⁷ Carbon emissions associated with land use, land-use change and forestry (LULUCF) is estimated for the purposes of this scoping assessment on the basis of land area than number of construction elements

Construction element types	Original ES elements	ES Carbon emissions % of total	Number of AP ₄ -related changes, by construction element	AP ₄ - related changes as a proportion (%) of the main ES construction elements type	Estimated carbon emissions (tCO ₂ e) per main ES construction element type	Estimated carbon emissions (tCO ₂ e) of AP ₄ -related changes	AP ₄ -related changes in carbon emissions as a % of total construction emissions
Track ⁸	1	17.6%	4	see footnote	see footnote	see footnote	see footnote
Rolling stock (life span 35 years)	-	4.1%	-	-	-	-	-
Other	117	3.3%	31	26%	1,583	49,080	0.9%
Mitigation (tree planting)	-	0.0%	1	-	-	-	-

⁸ Assessing the significance of track changes is based on the anticipated distance involved in the change rather than the numbers of track related amendments.

Table 4: The AP4 qualitative aspect of the scoping exercise, along with justification text as to whether the amendment(s) are material, and final scoping results

Construction element types	Justification text	Scoping result
Earthworks	Eight amendments are identified with the potential to impact movement of excavated materials related GHG emissions. In general their impact is believed to be negligible based on previous experience. For example, SES and AP2 resulted in a decrease in mass haul emissions of 1,000 tCO ₂ e, effectively reducing the main ES's total construction GHG emissions by less than 0.02%. Likewise, SES2 and AP3 increased total construction GHG emissions from the main ES by less than 0.2%. The Chiltern tunnel extension which has been scoped in as potentially material (see Tunnels and dive-under section) has a secondary impact on movement of excavated material volumes. In order to fully capture the impact of this amendment, bulk material construction emissions, waste as well as mass haul implications will be assessed, irrespective of whether the mass haul changes are material or not on their own.	Potentially material impact-
Demolition	-	-
Construction waste	-	-
LULUCF	Thirty-one land use, land use change and forestry (LULUCF) related amendments are identified. Sixteen amendments relate to additional land take which include ecological mitigation, floodplain storage and widening of access routes; all cases appear to represent only a marginal increase in land requirements to existing construction element proposals. Twelve amendments relate to alternative land take requirements and three amendments relate to reduced land take requirements. In total LULUCF area in the ES was 2,629 hectares. Due to the relatively small change to land take requirements for all amendments, they are considered both individually and in combination as a non-material impact.	Non-material impact.
Bridges	One amendment relates to the provision of an accommodation overbridge to enable stock movements and access. The second is a bridleway which is converted in to a bridge. In total 180 bridge related elements were identified for the ES proposed scheme, comprising approximately 1% of the proposed scheme's construction GHG emissions. The provision of two access overbridges is considered to have a non-material impact.	Non-material impact.
Viaducts	Two viaduct related amendments are identified. One relates to moving a viaduct position but maintaining the same span; and one relates to the Chattle Hill Area amendment where a viaduct is proposed in place of an embankment. Only the Chattle Hill area amendment will result in additional construction activity; albeit with a consequential decrease in embankment related construction GHG emissions. Assuming, on average, a viaduct related element equates to approximately 9,400 tCO ₂ e, this represents only 0.17% of the total AP2 construction GHG emissions. Looking at the Chattle Hill changes as a whole, construction emissions (based on detailed construction and logistics design information) is actually reduced by 9,500 tCO ₂ , which in itself is less than a 0.2% reduction in total construction GHG emissions. Non-material impact.	Non-material impact
Roads	Twenty road related amendments are identified. Six relate to amendments to existing access proposals; two relate to temporary road improvements; four relate to new construction access and two to new permanent access; there are four roundabout amendments; two amendments relating to dualling - one for new dualling and one for the provision of new dualling; an access rights amendment added on a map and one realignment. 119 road related elements were identified in the ES representing 2% of total construction GHG emissions. While nine of the amendments relate to likely additional construction activity (roundabouts, access and dualling) they are not anticipated, individually, or in combination to result in increased construction GHG emissions of over 1%.	Non-material impact.
Retaining walls	-	-

Construction element types	Justification text	Scoping result
Cuttings	-	-
Embankments	Two embankment related amendments are identified. One relates to reinforcing earth slopes for a temporary diversion and one refers to the change from an embankment to a viaduct as part of the Chattle Hill Area Amendments. The Chattle Hill area change will result in embankment construction related GHG emissions replaced with viaduct construction related GHG emissions. Given that total embankment related GHG emissions are 5,246 tCO ₂ e (equivalent to 0.1% of the total ES construction GHG emissions) these two amendments are considered to be of minor importance. Looking at the Chattle Hill changes as a whole, construction GHG emissions are actually reduced by 9,500 tCO ₂ e, which in itself is less than a 0.2% reduction in total construction GHG emissions. Non-material impact.	Non-material impact.
Tunnels and dive-under	Two tunnels, portals and dive-unders related amendments have been identified. The first, a small extension to the Long Itchington Wood Tunnel north portal by 20m. The second is a 3km extension of the Chiltern tunnel. The total tunnel length for the proposed AP ₂ scheme is 52,333m. The tunnel related AP ₄ amendments combined represent a 5.8% increase in total tunnel/portal length. Assuming a direct correlation between tunnel length and construction emissions, these amendments in combination would result in a 73,300 tCO ₂ e increase in construction GHG emissions, equivalent to 1.3% increase in the proposed scheme's total construction GHG emissions (1.29% of this increase in construction emissions is due to the Chiltern tunnel extension).	Potentially material impact.
TBM	-	-
Stations/interchanges	-	-
Depots	-	-
People mover	-	-
Track	Four track related amendments are identified. One relates to a passing loop near Greenford Station; one relates to the relocation of track to create space the new Western access turnback siding and the future Kensal Portobello station; one relates to a new switch from the Chiltern Line in West Ruislip to connect to existing siding on south side of Chiltern Line; and one relates to a revised location for the crossovers and neutral section on the Handsacre spur. It is not specified what additional track length would be required for the passing loop or relocation of track. However in the context of the 253km of track and extensive track related activities for the proposed scheme these relatively small amendments to track are considered a non-material impact.	Non-material impact.
Rolling stock (life span 35 years)	-	-
Other	Thirty-one "other" related amendments are identified, of which 27 are primary amendments and 4 are secondary. Secondary amendments are a result of the primary amendments. For example, a new footpath will result in new construction, but also the loss or change of existing land use to a footpath. A quick summary shows the following breakdown of all thirty-one 'other' amendments: 8 relating to 'other buildings', 5 to drainage, 5 to footpaths, 5 to balancing ponds, 5 to utilities, 2 to culverts, and 1 brideway. Setting aside the 'other buildings' category discussed later on, 15 relate to realignments, relocations or re-routing of elements with no new construction; 4 relate to additional land requirements with no impact on construction and given that total LULUCF GHG emissions is less than 2% of construction this is unlikely to be material; 2 relate to upgrades or improvements of a footpaths which is minor in terms of GHG emissions; and only	Non-material impact.

Construction element types	Justification text	Scoping result
	<p>two are new constructions of a drainage system and an access point to a footpath. The combination of these changes was considered non-material. The key 'other buildings' amendments from a potential GHG perspective are considered to be the following: the relocation of a Bottom Ash Plant (this is likely to be a fairly simple train depot-like structure with preliminary construction bulk material data showing that it represents less than 0.1% of total HS2 construction GHG emissions); the installation of temporary turbidity treatment equipment at each of the three groundwater pump stations regarded as minor based on the size of the equipment (2.5 x 2.5 x 6 m) and therefore the expected requirement for only a small concrete base; the relocation of the Island Project School regarded as non-material as the school is small with only around 40 pupils where the existing building is not being demolished and the new building proposed is a Grade 2 listed building which requires refurbishing; and finally the relocation of a pharmaceutical research facility whereby the existing facility will only partially be demolished and the new proposed location in Milton Keynes is already owned by the pharmaceutical company with no new construction necessary. These amendments, individually and in combination are considered a non-material impact.</p>	
Mitigation (tree planting)	<p>One climate change mitigation related amendment is identified and relates to the relocation of woodland planting. Since this is relocation and not new planting which could have contributed to carbon sequestration, the change is considered non-material.</p>	Non-material impact.

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