High Speed Rail: Consultation on the route from the West Midlands to Manchester, Leeds and beyond

Sustainability Statement

Appendix E11 – Material Use

A report by Temple-ERM for HS2 Ltd

TEMPLE ERM

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1. INTRODUCTION

1.1.1. This report has been prepared to support the HS2 Phase Two proposed scheme for consultation Sustainability Statement (the Sustainability Statement, Volume 1), a report which describes the extent to which the Government's proposed scheme for HS2 Phase Two supports objectives for sustainable development. This document is a technical appendix which summarises the method for the material use appraisal, informing the Sustainability Statement main report. The Sustainability Statement places emphasis on the key impacts only. This technical report summarises all the conclusions relating to the material use appraisal.

2. SCOPE AND METHOD

2.1. Scope

2.1.1. The Sustainability Statement, Volume 1, places emphasis on the more significant impacts (moderate and major), whereas the Technical Reports provide detail on all levels of impact (including negligible and minor) identified using the HS2 Sustainability Framework in the Appraisal of Sustainability (AoS). Appendix B (AoS Method and Alternatives) provides an explanation of the methodology used for the AoS and the rationale behind it.

2.1.2. This report indicates the principal material resources used by the project, giving the estimated required tonnage of steel and concrete. These have taken into account the steel used for tracks, for tunnel reinforcement and for overhead wires and associated structures, and the concrete used for permanent way, tunnels, viaducts and stations. The appraisal uses standard conversion factors for steel, but has used more specific conversion factors for concrete that accommodate the different characteristics of the scheme structures. The information was also the basis for embedded carbon figures which were used during sifting stages. This report does not cover the operational phase.

2.1.3. Whilst steel and concrete are not the only materials required for construction of Phase Two, they would constitute both the majority of materials required for the scheme and the two materials with the greatest environmental impact.

2.1.4. Material use per metre of track type was calculated using the 2009 Network Rail document "Comparing environmental impact of conventional and high speed rail" and through discussion with engineers on scheme specifics.

2.2. Key assumptions

2.2.1. Material use in construction consists of:

- tracks, assumed to be constant for the length of the route;
- overhead line equipment (OHLE), assumed to be constant for the length of the route;
- permanent way (ballast, sleepers etc); assumed to be ballasted for all surface routes and viaducts and to be a ballastless concrete slab trackform for all tunnel types; and,
- Structures (piers, piles and trackbed) for viaducts, tunnel walls, stations and platforms.

2.2.2. For material use calculations the steel and concrete requirements of the different surface route types; cuttings, embankments and at grade, were assumed to be uniform.

2.2.3. The material use for the proposed route assumes 0.282t/m of steel for tracks and 0.5t/m of steel for OHLE as constants, taken from the 2009 Network Rail "Comparing environmental impact of conventional and high speed rail" document.

2.2.4. Ballasted permanent way consists of 0.99t/m of concrete and 0.039t/m of steel. Following discussions with HS2 Ltd, ballastless concrete slab rail driveway in the twin bore tunnels (to reduce potential vibrational impacts) is assumed to have an overall width of 14.3m (total width for twin bore tunnels) and a depth of 0.7m. This amounts to 24.02t/m of concrete with 0.132t/m of steel (from the National Rail document).

2.2.5. Steel reinforcement for concrete structures was assumed to be 200kg/m^3 of concrete. Steel reinforcement was not included where concrete is used for sleepers or slabs.

2.2.6. Where possible HS2 Ltd has provided the volume of concrete required per metre of tunnel from the cross sectional area of individual tunnel CAD drawings. If this information was not available, it would have been assumed the tunnels were cylindrical and the following formula would have applied: Volume = $\pi r^2 h$, to work out the volume of the cylinder. The volume of the interior cylinder (with assumed lining thickness of 0.5m) was taken away from that of the exterior cylinder to give the volume of the lining with h =1 to give volume of concrete per metre of tunnel length in.

2.2.7. This volume was multiplied by the density of concrete (taken as 2.4t per m^3) to give the weight of concrete required per metre of tunnel length (multiplied by two for twin bore tunnels). This amount was then multiplied by the length of the tunnel in metres to give the total weight of concrete required for the tunnel in tonnes.

2.2.8. HS2 Ltd has provided an estimated average of 60m^3/m of concrete for cut and cover tunnels, this figure was also applied to green tunnels.

2.2.9. The viaduct trackbeds were assumed to be 14.3m wide and 0.7m deep slabs of concrete, these were added to the concrete requirements for piers and piles (9.5m^3 per m) and multiplied by the length of viaduct, then the density of concrete to give the weight of concrete required for the viaduct in tonnes. An exception to these assumptions was made for HSL15 (Sheffield Meadowhall Station) due to the size of the viaduct on which the station is situated and the extra width required to accommodate the tracks. This viaduct was assumed to be 35m wide.

2.2.10. At this early stage of design, stations were assumed to be concrete boxes with a wall thickness of 0.5m. Platforms were assumed to be 12m wide, 1m deep and 415m long except at Manchester Piccadilly where the box was assumed to be 440m long. No steel requirements have been included for the stations currently.

2.2.11. Routes connecting to depots are additional to the overall route length and has been calculated for each depot. No steel or concrete requirements were calculated for depot structures at this early stage of design.

3. FINDINGS

3.1. Western leg

3.1.1. **Table 3.1** shows the estimated material requirements for construction of the proposed route for the western leg. This includes steel and concrete requirements for; tracks, permanent way, OHLE and concrete structures (stations, platforms and reinforced viaducts and tunnels). Route connecting to depots on the western leg was considered negligible for both the Crewe and Golborne sites due to their proximity to the route.

Table 3.1 – Western Leg Estimated Material Requirements

Building Block	Steel required (in tonnes)	Concrete required (in tonnes)
HSM03	50,900	288,900
HSM06	18,800	150,100
HSM08	12,600	105,100
HSM09	7,100	55,400
HSM10	75,700	721,300
HSM12	8,400	25,000
HSM21	15,100	77,000
HSM22	6,400	28,200
HSM26*	5,900	151,800
HSM28*	112,000	1,445,800
HSM30	10,300	58,400
Western Total	323,100	3,106,900

* Includes station concrete

3.2. Eastern leg

3.2.1. **Table 3.2** shows the estimated material requirements for construction of the proposed route for the eastern leg. This includes steel and concrete requirements for tracks, permanent way, OHLE and concrete structures (stations, platforms and reinforced viaducts and tunnels).

Table 3.2 – Eastern leg Estimated Material Requirements

Building Block	Steel required (in tonnes)	Concrete required (in tonnes)
HSL01	17,900	143,700
HSL06	35,000	178,700
HSL09	51,200	565,900
HSL12*	6,600	176,200
HSL13	79,600	602,700
HSL14	23,700	176,800
HSL15*	25,700	367,200
HSL16	57,700	573,700
HSL17	55,100	370,300
HSL21	34,000	257,300
HSL22	4,500	12,100
HSL31*	3,300	143,200
New Crofton	7,200	27,800
Staveley	8,100	66,100
Eastern Total	409,400	3,661,600

* Includes station concrete

3.3. Phase Two totals

3.3.1. **Table 3.3** shows the total estimated material requirements for construction of both the eastern and western legs of the proposed scheme including steel and concrete requirements for tracks, permanent way, OHLE and concrete structures (stations, platforms and reinforced viaducts and tunnels). This includes track length for depots approaches on the eastern leg, those on the western leg are considered negligible as the locations of the depots are closer to the route. The route lengths stated in this table are the total lengths of constructed permanent way and as such are not equal to the route lengths stated in the main report. The totals given in Table 3.3 do not add up directly, this is to avoid round-off error. To achieve these figures each leg and the overall total were calculated and rounded separately.

Table 3.3 – HS2 Phase Two estimated material requirements

Leg	Length (in km)	Steel required (in tonnes)	Concrete required (in tonnes)
Eastern leg	205.6	409,400	3,661,600
Western leg	152.4	323,100	3,106,900
Phase Two Total:	358.1	732,400	6,768,600