High Speed 2 - 1MC06 - Stage One C2 - MWCC – North Portal of Chiltern Tunnels to Brackley

South Heath Cutting and South Heath to Wendover Noise Demonstration Report

1MC06-CEK-TP-REP-CS03_CL05-000003

Rev	Date	Author	Checked by	Approved by	Revision Details	EKFB Reviewer
C01	23/11/21	Michael van der Merwe [redacted]	Colin Cobbing	Mark Alcock	For Issue	Mark Roberts

Stakeholder review required (SRR)	Purpose of SRR
☐ County / District / London Borough Council	☐ Acceptance
☐ LOV	☐ Approval
☐ LUL	☐ No Objection
☐ NRL	☐ Consent
☐ TFL	
☐ Utilities Company	
☐ Other (please specify)	

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Glossary of Terms

Term	Description
AFARP	As far as is reasonably practicable
AP	Additional Provisions
ARFC	All reasonably foreseeable circumstances
BC	Buckinghamshire Council
BS	British Standard
CBA	Cost Benefit Analysis
CoCP	Code of Construction Practice
CRN	Calculation of Railway Noise
CRTN	Calculation of Road Traffic Noise
dB	Decibel
dB(A)	'A' Weighted Decibel.
EIA	Environmental Impact Assessment
EMRs	Environmental Minimum Requirements
ES	Environmental Statement
LOAEL	Lowest Observed Adverse Effect Level
LPA	Local Planning Authority
LpAeq	'A' Weighted Equivalent Continuous Sound Level
LpAmax	Maximum 'A' Weighted Sound Pressure Level
NDR	Noise Demonstration Report
Nominated undertaker	The body or bodies appointed to implement the powers of the hybrid Bill to construct and maintain the railway
NPV	Net Present Value
SES	Supplementary Environmental Statement

Term	Description
SOAEL	Significant Observed Adverse Effect Level
the Act	The High-Speed Rail (London – West Midlands) Act 2017
TNPM	Train Noise Prediction Model
TSI	Technical Specifications for Interoperability
ToR	Top of Rail
U&As	Undertakings and Assurances

EXECUTIVE SUMMARY

This Noise Demonstration Report is compiled in accordance with the High Speed Two (HS2) *Phase 1 Planning Memorandum* and *Planning Forum Note 14: Operational Noise from the Railway and Altered Roads (PFN 14*).

The purpose of this report is to provide Buckinghamshire Council (BC) with supporting noise assessment information to assist with the determination of the

- South Heath Cutting–and Associated Earthworks - Plans and Specifications submitted under Schedule 17 of the High-Speed Rail (London – West Midlands) Act 2017.
- South Heath to Wendover –and Associated Earthworks - Plans and Specifications submitted under Schedule 17 of the High-Speed Rail (London – West Midlands) Act 2017

This report demonstrates how all reasonable steps have been taken for the combined airborne sound from altered roads and operational railways, predicted in all reasonably foreseeable circumstances, not to exceed the lowest observed adverse effect levels. The mitigation has been assessed as far as is reasonably practicable at this stage in the design process and has been shown to result in effects within the scope of those reported in the HS2 ES.

The presented options have been selected on the basis that they reduce noise as far as reasonably practicable and represent the optimum balance between maximising the acoustic benefits, whilst minimising visual impacts and considering other environmental aspects, engineering constraints, value for money and stakeholder engagement. The selected option has also been informed by the consultation process with the Council. BC indicated that the noise barrier would be preferable to an earthworks option as this would allow the land to be available for future agricultural use. Option 3 was therefore agreed to be the preferred option during stakeholder engagement.

For **South Heath** the assessment shows:

- The **Proposed Design** has the same minor and moderate L_{Aeq} impacts levels above LOAEL as reported in the Phase 1 ES and one fewer negligible impact above LOAEL than the ES.
- The **Proposed Design** has fewer LOAEL for L_{max} noise levels than presented within the Phase 1 ES. Overall, the acoustic performance of the Proposed Design is therefore similar to that reported in the ES (as amended).

  Visually, a 190m long barrier 3m above ground level located at the crest of the cutting when compared to the ES assessed 1.4km long 3m barrier at the cutting crest would have noticeable local landscape and visual benefit for the sections where it has been removed. The proposed barrier would have no adjacent earth mound, in contrast to the ES assessed barrier which had a 2m high earth screen bund immediately adjacent to it. The barrier would therefore form a local linear landscape feature, albeit shielded in views by the adjacent retained mature boundary hedgerow on its east side and overtime screened by a combination of the existing hedgerow and the proposed planting. This screening would result in a similar landscape and visual effect as reported in the ES for the same section of barrier with an associated screen bund.

  A modified earthworks option in lieu of the 190m noise barrier was considered and proposed to BC during consultation. BC indicated that the noise barrier would be preferable as this would allow the

land to be available for future agricultural use. Option 3 was therefore agreed to be the preferred option during stakeholder engagement.

For **South Heath to Wendover** the assessment shows:

- The **Proposed Design** results in no adverse impacts whatsoever, in accordance with the EIA methodology.

  The **Proposed Design** has the same number of L_{max} noise levels above LOAEL as presented within the Phase 1 ES.

  An earthworks design was proposed in the ES and therefore the visual effects are neutral.

1 Introduction

1.1 Background and Aim

The purpose of this report is to provide Buckinghamshire Council (BC) with supporting noise assessment information to assist with the determination of both the South Heath Cutting and Associated Works - Plans and Specifications and the South Heath to Wendover –and Associated Earthworks - Plans and Specifications, submitted under Schedule 17 of the High-Speed Rail (London – West Midlands) Act 2017.

This Noise Demonstration Report (NDR) has been compiled in accordance with the *High Speed Two (HS2) Phase 1 Planning Memorandum (paragraph 7.5.2)* and *Planning Forum Note 14[1]: Operational Noise from the Railway and Altered Roads*.

The information in this NDR shows, as far as is reasonably practicable at the current stage in the design process, how the proposed noise mitigation performs and the expected conditions. This information will provide reassurance in advance of the request for approval under paragraph 9 that the mitigation is appropriate; and will present an opportunity to raise concerns.

To determine optimal mitigation measures a number of options have been assessed. The mitigation design options are presented in Section 4.

This submission does not include for approval details of the Chiltern Tunnel North Portal or the associated North Portal Building and Compound. These elements will be submitted under a separate Schedule 17 submission. In consultation with BC Council, it was requested that a noise assessment for the North Portal building is included in the Noise Demonstration Report to fully present the noise effects at South Heath.

1.2 Structure of Report

This report comprises the following sections:

- Policy, Requirements and Standards
- Description of the Works
- Methodology
- Options appraisal
- Assumptions
- Results of the assessment of the proposed noise mitigation
- Conclusions

1.3 Site Location

The area for the South Heath Cutting and Associated Works application is shown on the South Heath Cutting Site Location Plan (Drawing No. 1MC06-CEK-TP-DLO-CS03_CL05-000004) presented in Appendix A and reproduced as Image 1 below.

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1 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/833184/PFN_14_Operational_Noise.pdf

The application area for the South Heath to Wendover –and Associated Earthworks is shown on the South Heath to Wendover Site Location Plan (Drawing No. 1MC06-CEK-TP-DPL-CS03_CL05-000074) presented in Appendix A and reproduced as Image 2 below.

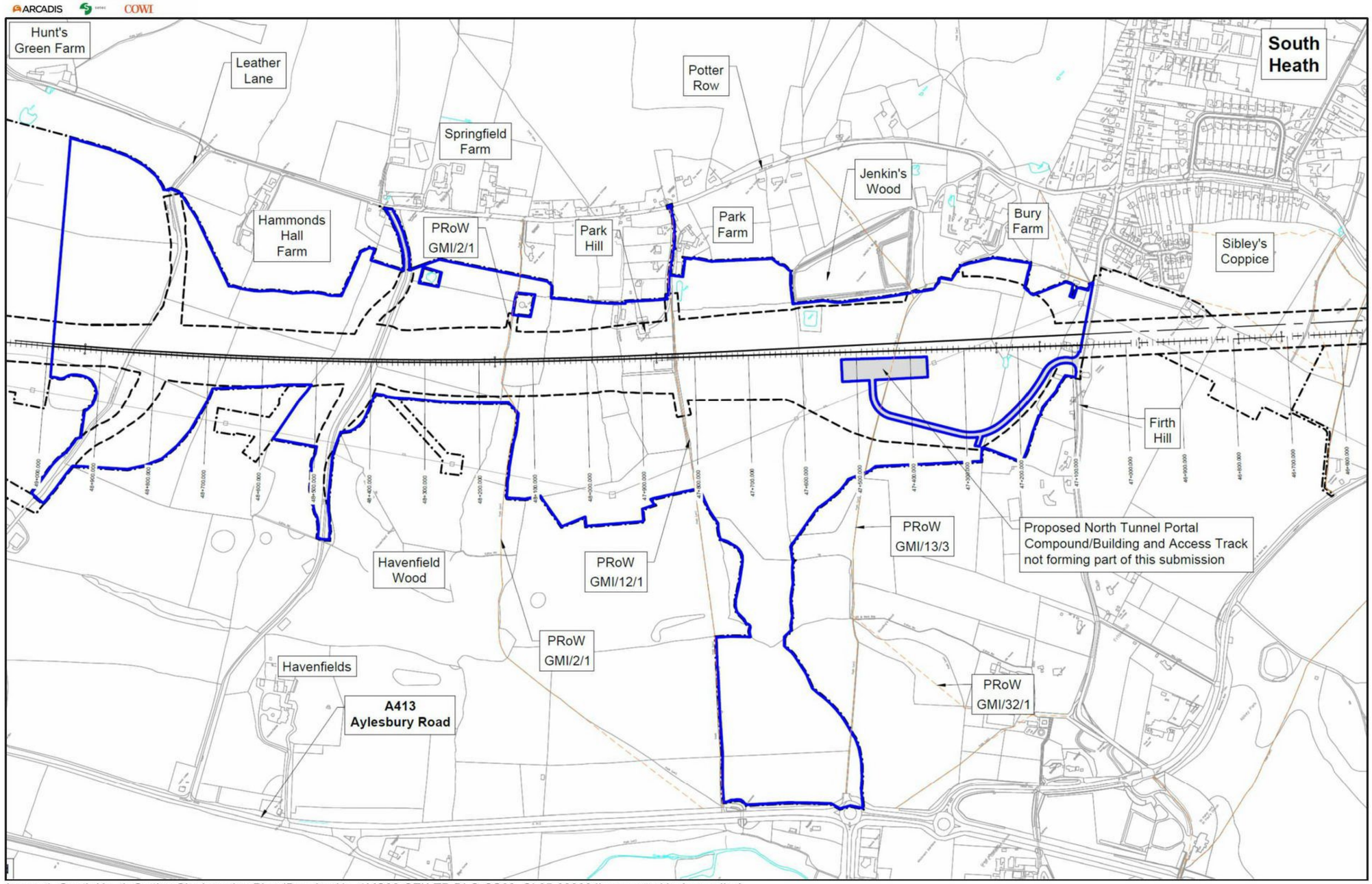

Image 1 South Heath Cutting Site Location Plan (Drawing No. 1MC06-CEK-TP-DLO-CS03_CL05-000004) presented in Appendix A

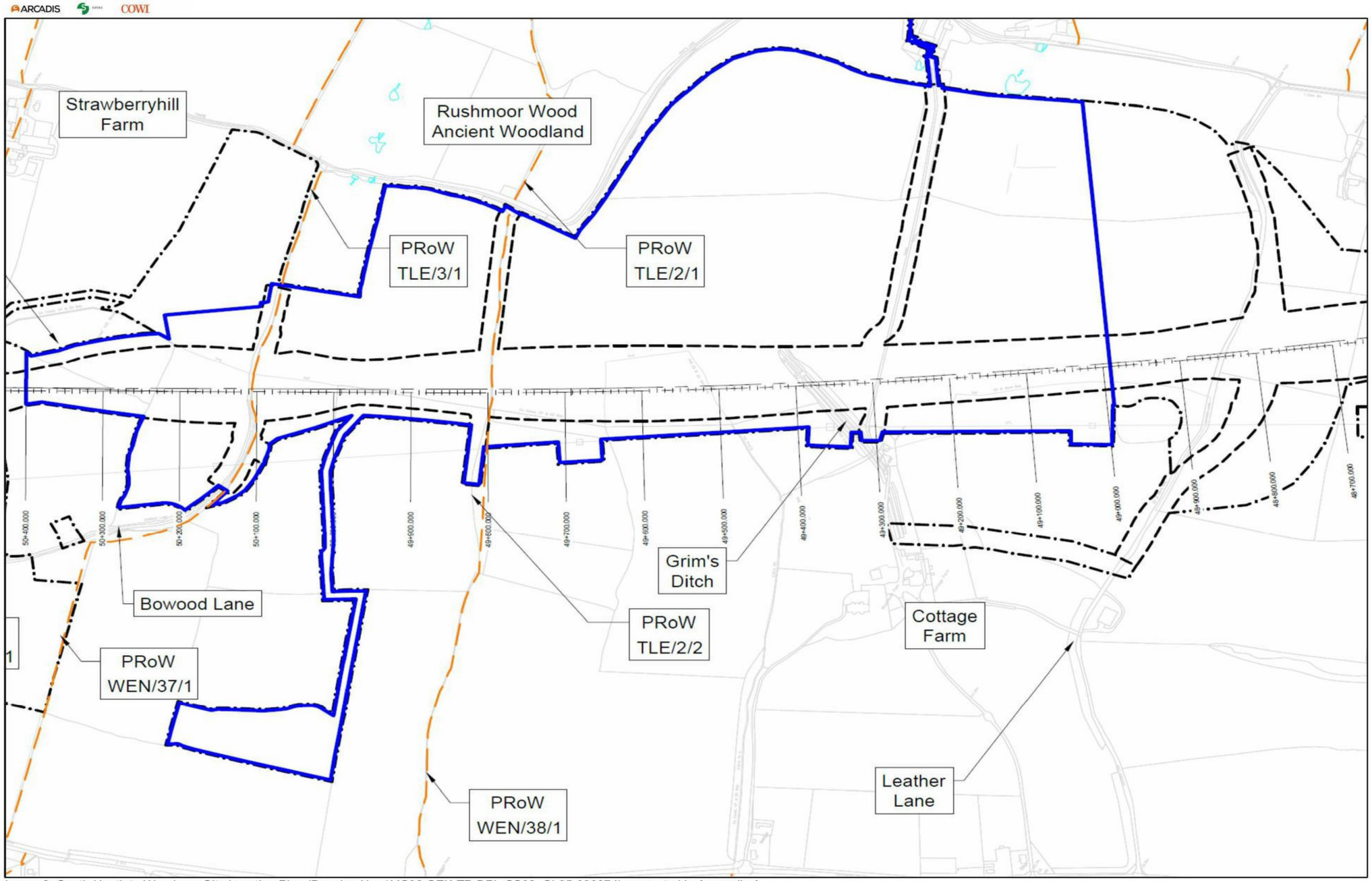

Image 2 South Heath to Wendover Site Location Plan (Drawing No. 1MC06-CEK-TP-DPL-CS03_CL05-000074) presented in Appendix A

General descriptions of both the South Heath Cutting and South Heath to Wendover areas is presented below:

- South Heath Cutting - The application site boundary extends from the north of Frith Hill to the north of Leather Lane, between the settlements of Wendover, South Heath and Great Missenden. The site broadly follows the alignment of Potter Row to the east and the A413 London Road to the west.

  The closest residential properties are the scattered farmsteads that surround the site and the residential properties located to the west of South Heath and along Aylesbury Road, Frith Hill and Potter Row. These include Bury Farm, Park Farm, Park Hill, and Hammonds Hall Farm.

- South Heath to Wendover - The site is located approximately 1.5km to the south of Wendover and 3km to the north of Great Missenden. The Lees lies 1km to the east and Dunsmore lies 2km to the east.

The nearest receptors are Strawberryhill Farm, Hammond's Hall Farm and Hunt's Green Farm to the north of the HS2 line and Cottage Farm and Wendover Dean Farm to the south of the HS2 line. There are further scattered farmsteads and individual residential properties located along the A413, Bowood Lane, Leather Lane and King's Lane and the adjacent local tracks off them.

The sensitive receptor locations are presented on Image 3 below; referenced to the receptor numbers defined in the HS2 Stage 1 ES documentation.

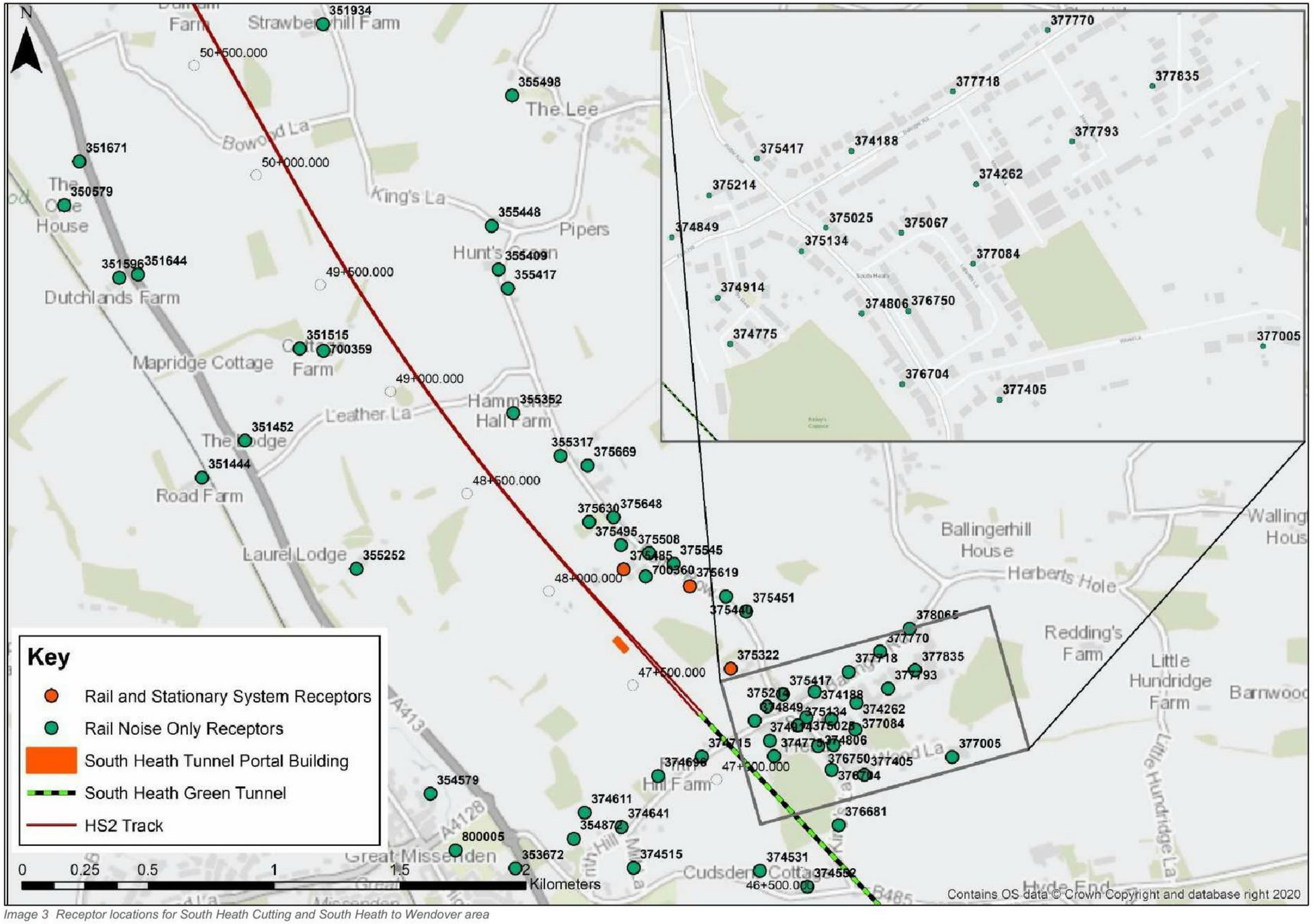

Image 3 Receptor locations for South Heath Cutting and South Heath to Wendover area

2 Policy, Requirements and Standards

High Speed Two (HS2) is the Government's proposal for a new high-speed north-south railway. The proposal is being taken forward in two phases: Phase One will connect London with Birmingham and the West Midlands.,

The High-Speed Rail (London – West Midlands) Act 2017, referred to from this point forward as "*the Act*", provides powers for the construction and operation of Phase 1 of High Speed Two, for which HS2 Ltd is the nominated undertaker. The Secretary of State has also published Environmental Minimum Requirements (EMRs), which set out the environmental and sustainability commitments that will be observed in the construction of the Proposed Scheme.

Section 20 to *the Act* grants deemed planning permission for the works authorised by it, subject to the conditions set out in Schedule 17. Schedule 17 includes conditions requiring various matters to be approved by the relevant Local Planning Authority(ies) (LPA).

Schedule 17 of *the Act* sets out the specific grounds on which the LPA may impose conditions on approvals or refuse requests for approval. With respect to noise one of the specific grounds the LPA may refuse to approve plans or specifications is if "*the design or external appearance of the building works ought to be modified to preserve the local environment or local amenity and is reasonably capable of being so modified*".

Paragraph 7.5.2 of the Planning Memorandum states that when submitting designs for approval under Schedule 17 the nominated undertaker:

"shall, where reasonably necessary for the proper consideration of the design proposed, provide an indication or outline of the appropriate mitigation measures (if any) which it intends to submit subsequently under paragraphs 9 or 12 of the Planning Conditions Schedule. Where works for approval will have a mitigating effect in relation to the operational noise from the railway or new roads, the nominated undertaker will provide information to show, so far as is reasonably practicable at that stage in the design process, how the noise mitigation performs and the expected conditions. While not material to approvals under paragraph 2 or 3 this information will provide re-assurance in advance of the request for approval under paragraph 9 that the mitigation is appropriate and will present an opportunity to raise concerns."

This report provides information about how the noise mitigation, proposed at this stage of the design development, performs and the expected conditions.

When seeking 'Bringing Into Use' approvals in relation to the relevant scheduled works under Schedule 17(9), an update to this report will be provided to the Local Planning Authority in order to assist it in determining whether there are any reasonably practicable measures which need to be taken for the purposes of mitigating the effect of the work or its operation on the local environment or local amenity.

The following section provides a summary of the EMRs and relevant information papers that have been produced to explain the commitments made in *the Act* and the Undertakings and Assurances (U&As) given by the Secretary of State, and how they will be applied to the design and construction of HS2 Phase 1.

2.1 Environmental Minimum Requirements (EMRs)

The EMRs set out environmental and sustainability commitments that will be observed during the construction and operation of the Proposed Scheme. The EMRs include the Code of Construction Practice (CoCP) and a series of other supporting documents.

The EMR general principles state:

The controls contained in the EMRs, along with powers contained in the Act and the Undertakings given by the Secretary of State, will ensure that impacts which have been assessed in the ES will not be exceeded, unless any new impact or impacts in excess of those assessed in the ES:

- *results from a change in circumstances which was not likely at the time of the ES[2]; or*
- *would not be likely to be environmentally significant[3]; or*
- *results from a change or extension to the project, where that change or extension does not itself require environmental impact assessment (EIA) under either (i) article 4(1) of and paragraph 24 of Annex 1 to the EIA Directive4; or (ii) article 4(2) of and paragraph 13 of Annex 2 to the EIA Directive[5]; or*
- *would be considered as part of a separate consent process (and therefore further EIA if required).*

In the circumstances described in the first bullet point above, if the significant adverse impacts identified in the ES are likely to be exceeded, HS2 and their contractors will take all reasonable steps to minimise or eliminate those additional impacts. If despite these reasonable steps, significant adverse impacts remain HS2 and their contractors will report them.

2.2 HS2 Information Paper E20: Control of Airborne Noise from Altered Roads and the Operational Railway

HS2 Information Paper E20 outlines the measures that are required to be put in place to control operational airborne noise. It sets out various objectives to minimise operational noise effects as summarised below.

- HS2 and their contractors will take all reasonable steps to design and construct the scheme so that the combined airborne noise predicted, in all reasonably foreseeable circumstances (ARFC), does not exceed LOAEL as set out in Appendix B. Where it is not reasonably practicable to achieve this objective, HS2 and their contractors will reduce airborne noise "As Far As Reasonably Practicable" (AFARP).
- Noise insulation will be offered with the aim that operational airborne noise from the scheme does not give rise to significant adverse effects on health and quality of life that would otherwise be

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[2] *In addition, Supplementary Environmental Statements and Additional Provision Environmental Statements were published and tabled by the Promoter in July 2015, September 2015, October 2015 and December 2015.*
[3] *i.e. a situation that could not reasonably have been anticipated at the time of the Environmental Statement. This covers all effects (both positive and adverse) where those effects are simply of no environmental significance.*
[4] *2011 consolidated EIA Directive (2011/92/EU).*
[5] *Broadly, this would not allow those changes or extensions to the project (once it has received Royal Assent) which would give rise to adverse environmental effects within the EIA.*

expected when airborne noise exceeds the significant observed adverse effect levels (SOAEL) (Appendix B).

2.3 HS2 Information Paper E22: Control of Noise from the Operation of Stationary Systems

Information Paper E22 describes the measures that will be adopted to control the effects of noise from the operation of stationary systems designed and installed by the nominated undertaker for delivering the Proposed Scheme. The main objectives listed in Information Paper E22 are stated below.

- The nominated undertaker will design, construct, operate and maintain the stationary systems so that the rating level of the fixed installations in normal operation at the worst affected residential receptor, minus the background level, is not more than -5 dB, determined in accordance with BS 4142:2014.
- Where it is not reasonably practicable to achieve this objective, the nominated undertaker will develop and adopt robust procedures to ensure that sound from all stationary systems is reduced as far as is reasonably practicable. In such cases, the nominated undertaker will design, construct, operate and maintain the stationary systems so that, under all reasonably foreseeable circumstances, the rating level of the stationary systems in normal operation at the worst affected residential receptor, minus the existing background level, is not more than +5 dB, determined in accordance with BS4142:2014.
- Special consideration will be given to the assessment of sound from stationary systems when the background level is low, namely where the background levels are less than 30 dB.

3 Scheduled Works

3.1 Application Design

3.1.1 South Heath

The works submitted for approval comprises of the South Heath Cutting, Leather Lane overbridge and highway realignment, Havenfield Wood Accommodation overbridge and Footpath GMI/12 overbridge, land and track drainage infiltration ponds, noise fence barriers, permanent fencing and gates and highway and footway construction. Further details of these works are described below and are shown on the General Arrangement Plan – For Approval Sheets 1 and 2 (Drawing No. 1MC06-CEK-TP-DGA-CS03_CL05-000016 and 1MC06-CEK-TP-DGA-CS03_CL05-000017).

Proposed Permanent Earthworks for Approval

The proposed earthworks for approval are shown on the following drawings for approval. Landform Plans and Earthwork Cross Sections have been provided to indicate the existing and proposed ground levels.

- South Heath Cutting General Arrangement Plan – For Approval (Sheet 1 of 2) - 1MC06-CEK-TP-DGA-CS03_CL05-000016
- South Heath Cutting General Arrangement Plan – For Approval (Sheet 2 of 2) - 1MC06-CEK-TP-DGA-CS03_CL05-000017
- South Heath Cutting Proposed Landform Plan (Sheet 1 of 2) - 1MC06-CEK-TP-DPL-CS03_CL05-000035
- South Heath Cutting Proposed Landform Plan (Sheet 2 of 2) - 1MC06-CEK-TP-DPL-CS03_CL05-000036
- South Heath Cutting Earthworks Cross Sections (Sheet 1 of 8) - 1MC06-CEK-TP-DSE-CS03_CL05-000011
- South Heath Cutting Earthworks Cross Sections (Sheet 2 of 8) - 1MC06-CEK-TP-DSE-CS03_CL05-000012
- South Heath Cutting Earthworks Cross Sections (Sheet 3 of 8) - 1MC06-CEK-TP-DSE-CS03_CL05-000013
- South Heath Cutting Earthworks Cross Sections (Sheet 4 of 8) - 1MC06-CEK-TP-DSE-CS03_CL05-000014
- South Heath Cutting Earthworks Cross Sections (Sheet 5 of 8) - 1MC06-CEK-TP-DSE-CS03_CL05-000015
- South Heath Cutting Earthworks Cross Sections (Sheet 6 of 8) - 1MC06-CEK-TP-DSE-CS03_CL05-000016
- South Heath Cutting Earthworks Cross Sections (Sheet 7 of 8) - 1MC06-CEK-TP-DSE-CS03_CL05-000017
- South Heath Cutting Earthworks Cross Sections (Sheet 8 of 8) - 1MC06-CEK-TP-DSE-CS03_CL05-000018
- South Heath Cutting Pond Details and Sections (Sheet 1 of 2) - 1MC06-CEK-TP-DDE-CS03_CL05-000032
- South Heath Cutting Pond Details and Sections (Sheet 2 of 2) - 1MC06-CEK-TP-DDE-CS03_CL05-000033

South Heath Cutting (Part of)

In this package area the HS2 line runs along the bottom of South Heath Cutting. The cutting starts outside of this package area to the east in CDC Package 1 - South Heath Cutting and extends just beyond the Schedule 17 into AVDC Package 2 - Wendover Dean. The total length of the cutting is approximately 3,160m long, with 1,440m of this falling within this package area. The cutting will be up to 10m depth.

The Chilterns Tunnel requires earthworks to reduce the ground to the levels required for the tunnel portal access. South Heath Cutting is up to 16m (height of track) below existing ground level. The existing ground level ranges from approximately 185m to 196m AOD within the site.

South Heath Cutting within the site will extend from chainage 47+220 to 48+990 and will be approximately 1.7km (1770m) in length. The total length of the cutting will extend beyond the site and will be 3180m in length. The HS2 line will be located at the base of the cutting.

At the landscape bund to the east of the HS2 line between chainage 47+830 and 48+770 the ground is at an existing level of 194m AOD sloping up to an existing level of 197m AOD. The proposed earthwork will increase the level to 201m AOD rising above South Heath Cutting to the east. The gradients of the outward slope will be 1 in 16 whilst the inner slope gradient will be 1 in 4.

At the landscape bund to the west of the HS2 line between chainage 47+270 and 47+820 the ground is at an existing level of 182m AOD sloping up to an existing level of 185m AOD. The proposed earthwork will increase the level to 196m AOD rising above South Heath Cutting to the west. The gradients of the outward slope will be 1 in 15 whilst the inner slope gradient will be 1 in 4.

The earthwork design for South Heath Cutting is shown on the Earthworks Cross Section Drawing Sheets 1-8 (Drawings Nos. 1MC06-CEK-TP-DSE-CS03_CL05-000011, 1MC06-CEK-TP-DSE-CS03_CL05-000012, 1MC06-CEK-TP-DSE-CS03_CL05-000013, 1MC06-CEK-TP-DSE-CS03_CL05-000014, 1MC06-CEK-TP-DSE-CS03_CL05-000015, 1MC06-CEK-TP-DSE-CS03_CL05-000016, 1MC06-CEK-TP-DSE-CS03_CL05-000017, and 1MC06-CEK-TP-DSE-CS03_CL05-000018).

Earthworks are proposed to the east of the HS2 line beyond South Heath Cutting. In this area existing levels will be increased by up to 5m with grading out to form a natural slope. The placement of materials in this location is for reasons of sustainability, placing materials in the locality that would be generated by excavations for South Heath Cutting. The placement of the material will create a transitional slackened slope to create a natural appearance in the area surrounding South Heath Cutting. Existing ground levels across this area broadly range from 195 to 200m AOD. Following placement of the material ground levels will range from approximately 195m to 204m AOD. Most of these earthworks fall in the AVDC Package 1 South Heath to Wendover area however within the site, these earthworks will extend from chainage 48+810 to 48+990.

The earthworks to the east of South Heath Cutting are shown on the South Heath Earthworks Cross Sections Sheets 5 and 8 (Drawing Nos. 1MC06-CEK-TP-DSE-CS03_CL05-000015 and 1MC06-CEK-TP-DSE-CS03_CL05-000018).

Earthworks associated with Chiltern Tunnel North Portal and associated Maintenance Access Track

At the landscape bund to the south of the north tunnel portal between chainage 47+150 and 47+270 the ground is at an existing level of 182m AOD sloping up to an existing level of 185m AOD. The proposed earthwork will increase the level to 187m AOD rising above the Chiltern Tunnel North Portal. The gradients of the outward slope will be 1 in 10 whilst the inner slope gradient will be 1 in 5.

To access the Chiltern Tunnel North Portal an access track is required from chainage 47+085, at an existing level of 188m AOD, to 47+610 at an existing level of 190m AOD ground level. At chainage 47+085 the proposed level will remain at 188m AOD and at chainage 48+610 the level will be reduced 11.0m to 179m AOD.

The earthworks design for the Chiltern Tunnel North Portal and associated access is shown on the Proposed Landform Plan Sheet 2 of 2 (Drawing No. 1MC06-CEK-TP-DPL-CS03_CL05-00036).

This submission does not include for approval details of the Chiltern Tunnel North Portal or the associated North Portal Building and Compound. These elements will be submitted under a separate Schedule 17 submission.

In consultation with BC Council, it was requested that a noise assessment for the North Portal building is included in the Noise Demonstration Report to fully present the noise effects at South Heath.

3.1.2 South Heath to Wendover

The proposed earthworks are shown on the following drawings for approval. Landform Plans and Earthwork Cross Sections have been provided to indicate the existing and proposed ground levels.

- **Work No. 2/14** - A railway (8.3 kilometres in length) partly in tunnel and partly on viaduct commencing by a junction with Work No. 2/1, at its termination, continuing north-westwards, and terminating at a point 240 metres north-west of the roundabout joining the A413 London Road with Small Dean Lane; Work No. 2/14 includes a viaduct over the A413 London Road, the Marylebone to Aylesbury Line and Small Dean Lane.

- Work No. 2/21 - An accommodation access road, being a realignment of a track to Cottage Farm, commencing on that track at a point 665 metres south-west of the junction of that road with King's Lane and terminating on that track at a point 159 metres south-west of that junction. Work No. 2/21 includes a bridge over Work No. 2/14.

- Work No. 2/22 - A footbridge over Work No. 2/14, being a realignment of footpaths WEN/38/1 and TLE/2/2 commencing on footpath WEN/38/1 at a point 494 metres south-west of the junction of King's Lane with Bowood Lane and terminating on footpath TLE/2/2 at a point 12 metres west of its junction with King's Lane;

- Work No. 2/23 - A realignment of Bowood Lane commencing on that road at a point 487 metres west of its junction with King's Lane and terminating on that road at a point 201 metres west of that junction. Work No. 2/23 includes a bridge over Work No. 2/14.

The location and appearance of the structures for approval are shown on the following drawings for approval:

- South Heath to Wendover Dean General Arrangement Plan – For Approval - 1MC06-CEK-TP-DGA-CS03_CL05-000020
- Bowood Lane Overbridge – Plan on Deck – 1MC06-CEK-TP-DPL-CS03_CL05-000095
- Bowood Lane Overbridge – Longitudinal Section and Elevation – 1MC06-CEK-TP-DSE-CS03_CL05-000054
- Bowood Lane Overbridge – Cross Section and Parapet Details – 1MC06-CEK-TP-DDE-CS03_CL05-000026
- Cottage Farm Overbridge – Plan on Deck For Approval - 1MC06-CEK-TP-DPL-CS03_CL05-000099
- Cottage Farm Overbridge – Cross Section and Parapet Details -1MC06-CEK-TP-DDE-CS03_CL05-000030
- Cottage Farm Overbridge – Longitudinal Section and Elevation -1MC06-CEK-TP-DSE-CS03_CL05-000058
- Grim's Ditch Retaining Wall — Plan and Cross Sections For Approval - 1MC06-CEK-TP-DPL-CS03_CL05-000103
- Bowood Lane Drop Inlet Culvert –1MC06-CEK-TP-DPL-CS03_CL05-000002
- TLE/2 Accommodation Overbridge – Plan on Deck - 1MC06-CEK-TP-DPL-CS03_CL05-000097
- TLE/2 Accommodation Overbridge– Cross Section and Parapet Detail – 1MC06-CEK-TP-DDE-CS03_CL05-000028
- TLE/2 Accommodation Overbridge - – Longitudinal Section and Elevation For Approval – 1MC06-CEK-TP-DSE-CS03_CL05-000056

Proposed Permanent Earthworks For Approval

The proposed earthworks are shown on the following drawings for approval. Landform Plans and Earthwork Cross Sections have been provided to indicate the existing and proposed ground levels.

- South Heath to Wendover Dean General Arrangement Plan – For Approval - 1MC06-CEK-TP-DGA-CS03_CL05-000020
- South Heath to Wendover Dean Proposed Landform Plan - 1MC06-CEK-TP-DPL-CS03_CL05-000083
- South Heath to Wendover Dean Earthworks Cross Sections Sheet 1 of 6 - 1MC06-CEK-TP-DSE-CS03_CL05-000020
- South Heath to Wendover Dean Earthworks Cross Sections Sheet 2 of 6 - 1MC06-CEK-TP-DSE-CS03_CL05-000021
- South Heath to Wendover Dean Earthworks Cross Sections Sheet 3 of 6 - 1MC06-CEK-TP-DSE-CS03_CL05-000022
- South Heath to Wendover Dean Earthworks Cross Sections Sheet 4 of 6 - 1MC06-CEK-TP-DSE-CS03_CL05-000023
- South Heath to Wendover Dean Earthworks Cross Sections Sheet 5 of 6 - 1MC06-CEK-TP-DSE-CS03_CL05-000024
- South Heath to Wendover Dean Earthworks Cross Sections Sheet 6 of 6 - 1MC06-CEK-TP-DSE-CS03_CL05-000025
- South Heath to Wendover Dean Pond Details and Sections - 1MC06-CEK-TP-DDE-CS03_CL05-000020
- South Heath to Wendover Dean Drainage Plan - 1MC06-CEK-TP-DPL-CS03_CL05-000081

South Heath Cutting (Part of)

South Heath Cutting within the site will extend from chainage 49+000 to 50+400 and will be approximately 1.4km in length. The total length of the cutting extends beyond the site and is approximately 3,160m long. South Heath cutting will be up to 18m depth.

The existing ground level ranges from 180m to 198m AOD. The gradients of the engineered profile of the cutting slopes range from 1:2 to 1:4.

The interface between the crest of the cutting slopes will be locally regraded to provide a smooth transition between the two.

The landscape earthworks design for South Heath Cutting are shown on the Earthworks Cross Section Drawing Sheets 1 to 6 (Drawing No. 1MC06-CEK-TP-DSE-CS03_CL05-000020, 1MC06-CEK-TP-DSE-CS03_CL05-000021, 1MC06-CEK-TP-DSE-CS03_CL05-000022, 1MC06-CEK-TP-DSE-CS03_CL05-000023, 1MC06-CEK-TP-DSE-CS03_CL05-000024, and 1MC06-CEK-TP-DSE-CS03_CL05-000025).

Earthworks are proposed to the east of the HS2 line beyond South Heath Cutting. In this area existing levels will be increased by up to 5m with grading out to form a natural slope. The placement of materials in this location is for reasons of sustainability, placing materials in the locality that would be generated by excavations for South Heath Cutting. The placement of the material will create a transitional slackened slope to create a natural appearance in the area surrounding South Heath Cutting as described at paragraph

Existing ground levels across this area broadly range from 195 to 200m AOD. Following placement of the material ground levels will range from approximately 195m to 204m AOD. A small part of these earthworks falls in the CDC Package 1 South Heath Cutting area.

The earthworks to the east of South Heath Cutting are shown on the Earthworks Cross Section Drawing Sheets 1 to 4 (Drawing No. 1MC06-CEK-TP-DSE-CS03_CL05-000020, 1MC06-CEK-TP-DSE-CS03_CL05-000021, 1MC06-CEK-TP-DSE-CS03_CL05-000022, 1MC06-CEK-TP-DSE-CS03_CL05-000023). Earthworks associated with the realignment of Bowood Lane (WEN/37/1) and associated Maintenance Access Track.

The Proposed Scheme includes ground level changes associated with the proposed realignment of Bowood Lane on the approach to the Bowood Lane Overbridge at chainage 50+100. To the west of the HS2 line, the existing ground levels rise from 185m AOD rising to 194m AOD and these levels will be maintained following the realignment, with ground levels raised either side of the highway by approximately 3m thereby recreating the Holloway.

To the east of the HS2 line, the existing ground levels along Bowood Lane rise from approximately 198m to 201m AOD and these levels will be maintained following the realignment, with ground levels raised to the south of the highway by approx. 1m.

The landscape earthworks design for the realignment of Bowood Lane are shown on the Earthworks Cross Section Sheet 5 (Drawing No. 1MC06-CEK-TP-DSE-CS03_CL05-000024).

3.1.3 Stationary Systems

The assessment of the Chiltern Tunnel North Portal building has been based on the ALIGN detailed design of the building structure and the latest information from HS2 Rail Systems.

3.2 Scheme Wide Design Updates

Scheme wide design updates that have been considered in the noise modelling are set out below and are based on a track alignment which incorporates the reduction of track centres from 5m to 4.7m.

The reduction of the track centres and narrowing of the track corridor serve to bring the mitigation in the form of earthworks closer to the track alignment, thereby providing improved screening provision over the Phase 1 ES assumptions for comparable mitigation.

Key design changes to the South Heath Cutting since the Phase 1 ES include:

The tunnel portal has been moved a further 48m to the north. The ALIGN tunnel design has allowed for the narrowing of the track corridor to start within the tunnel and the reduction in platform width has continued into South Heath Cutting.

At Chainage 47+500 the ES track spacing was 22m as opposed to the Design spacing of 8m. The substantial narrowing of the track corridor was facilitated by the Align design of the Chiltern Tunnel, which allowed for narrowing of the track corridor within the tunnel. This 14m reduction serves to bring the earthworks closer to the track alignment and provide improved screening.

The acoustic benefit of the reduction in track width was partially offset by the reduction in earthworks and slackening of slopes compared to the ES design. Geotechnical investigations indicated the soil type was predominantly chalk as opposed to clay assumed in the ES and as a result of the material type the slopes had to be slackened. The slopes of the track facing earthworks are presented in Image 4 (South Heath Cutting Earthworks Cross Sections sheet 2 of 8 1MC06-CEK-TP-DSE-CS03_CL05-000012) and Image 5. (South Heath Cutting Earthworks Cross Sections sheet 4 of 8 1MC06-CEK-TP-DSE-CS03_CL05-000014)

Image 4 shows slopes on the east side of 1 in 3.25. with a height of approximately 16m above ToR at Ch 47400, decreasing in height above ToR progressing northwards to a height of 12m at Ch48200.

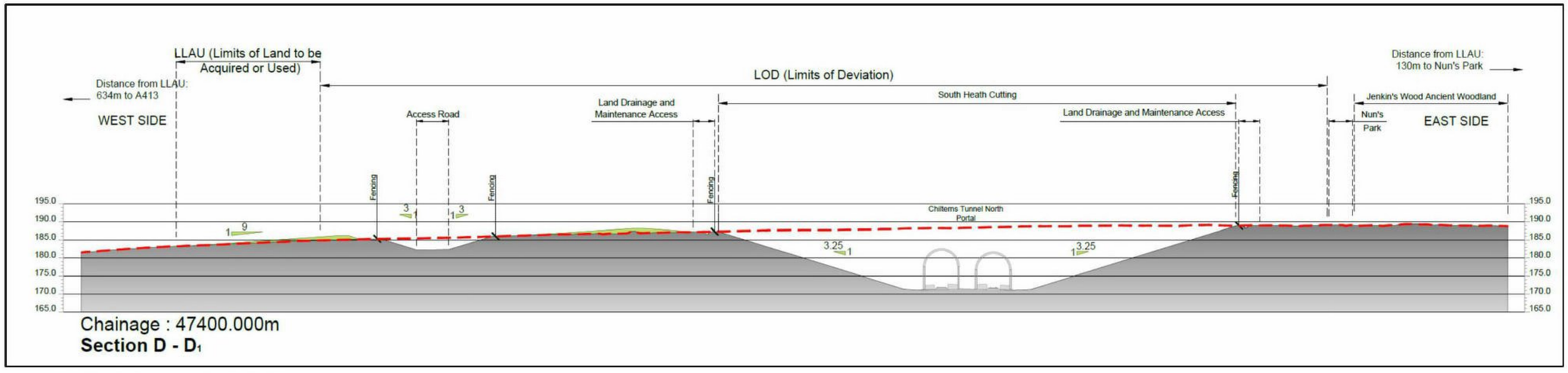


Image 4 Earthworks Cross section Ch 47400

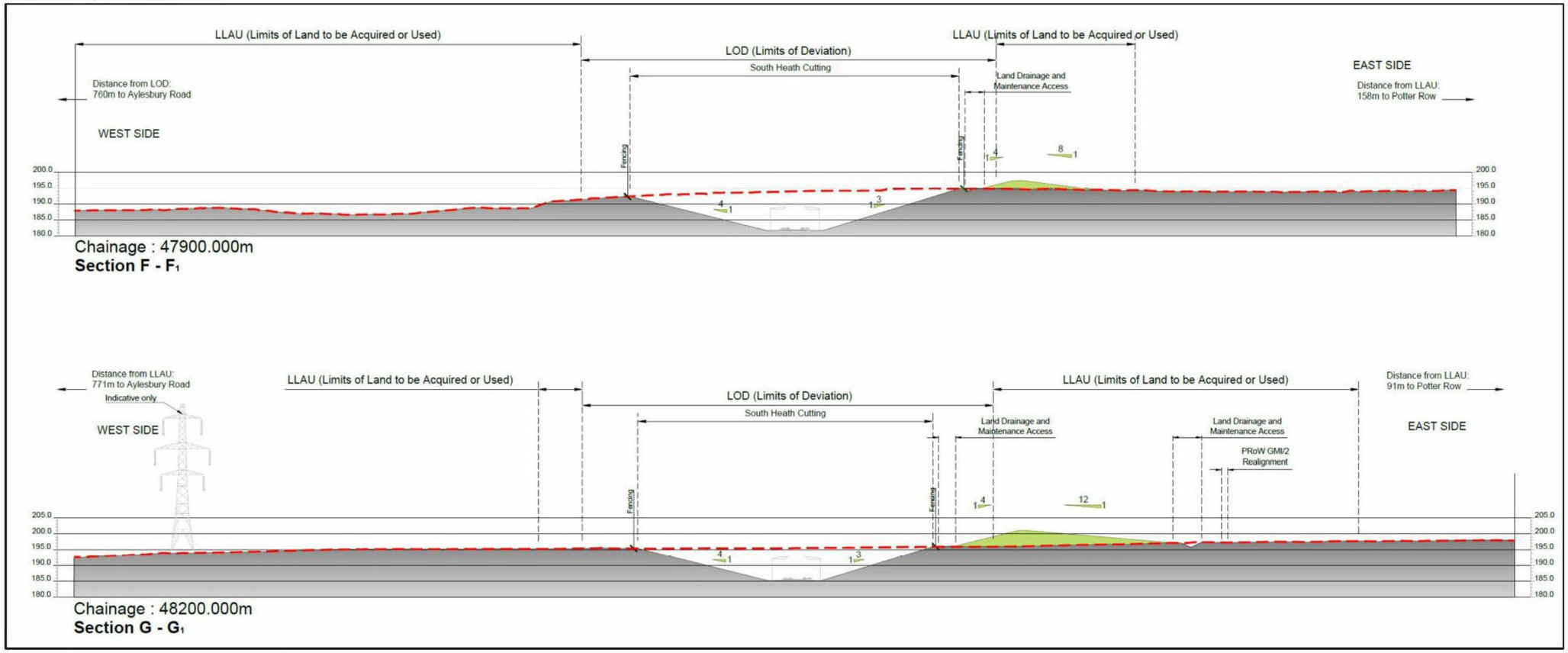


Image 5 Earthworks Cross section Ch 47900 and 48200

As part of the design process, an earthwork bund located the East of the HS2 alignment was removed from the design to preserve a hedgerow. The retention of the hedgerow resulted in insufficient space for the footing of the proposed earthwork. The location of the earthwork removed from the design is shown in Image 6 and lies between Ch 47+630 and Ch47+820.

The noise modelling has considered commensurate mitigation in the form of a noise barrier to compensate for the removal of the earthwork bund.

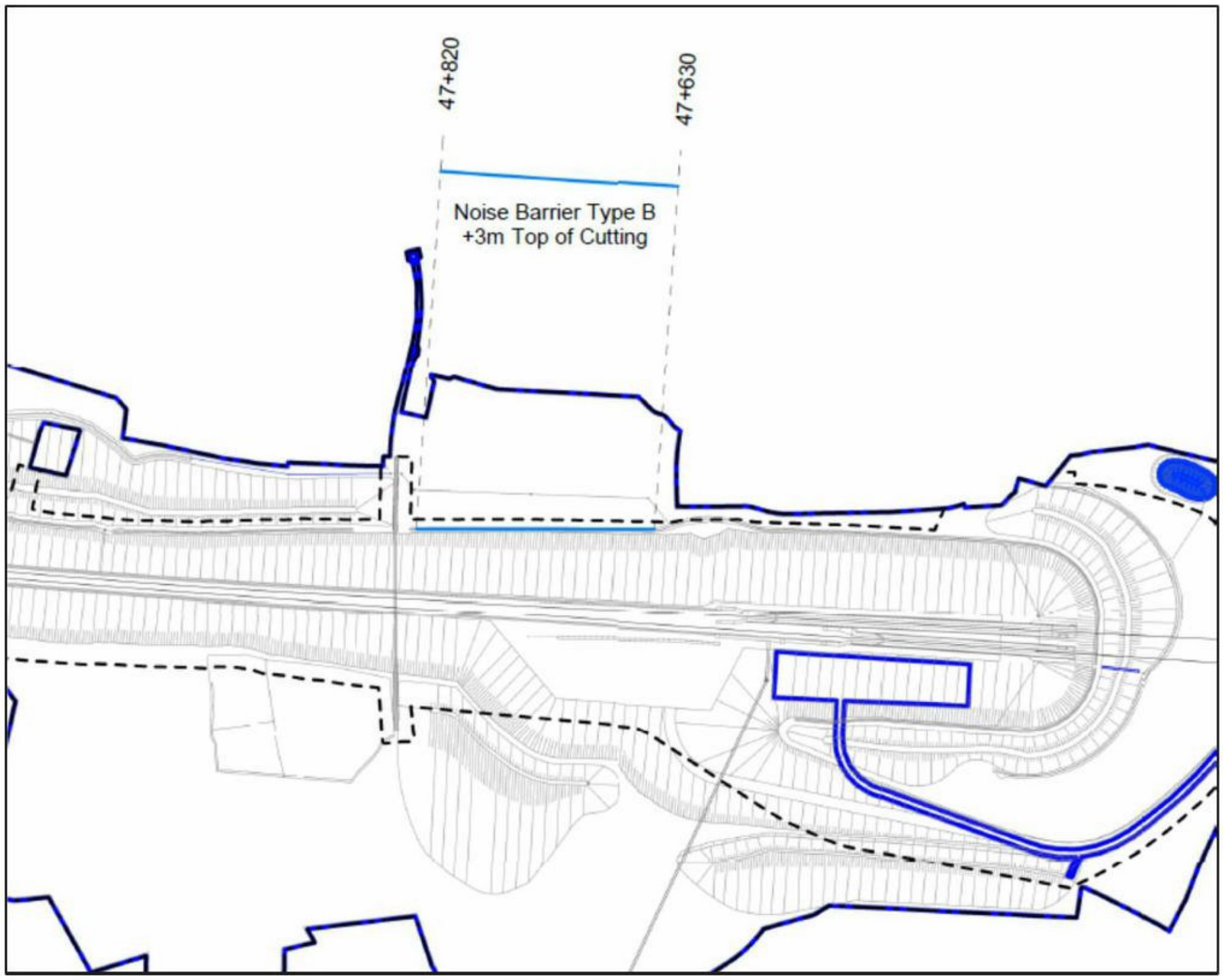


Image 6 Location of Noise barrier to compensate for Earthworks removed from Design

The track support system has been revised to track slab for the HS2 main lines compared to a ballasted system adopted in the Phase 1 ES.

The changes in noise source levels implemented in the design considerations, from those used in the Phase 1 ES, are presented in Appendix C; the revised noise source terms include the removal of TSI compliant trains.

4 Noise Mitigation Design Options and Mitigation Scenarios

Mitigation options have been evaluated against a range of criteria including the acoustic effects; landscape and visual effects; engineering practicability, value for money and stakeholder engagement.

4.1 South Heath

The options are listed below and detailed within Table 1.

- **Base Case Design Option**: no additional noise barrier but inclusion of the earth bund designs;
- **Mitigation Design Option 1**: Trackside Noise Barrier 2m above ToR; lineside 4.6m from outside rail. Option considers earthworks design with bund shown in Image 6 removed from the mitigation.
- **Mitigation Design Option 2**: Trackside Noise Barrier 3m above ToR; lineside 4.6m from outside rail. Option considers earthworks design with bund shown in Image 6 removed from the mitigation.
- **Mitigation Design Option 3**: Barrier 3m above ground on top of embankment to compensate for removal of the earthwork bund as shown on Image 6.

Table 1 below presents a summary of the outcome of the overall appraisal. The proposed design is highlighted in green.

The change in acoustic performance, visual impact and value for money are compared to the baseline ES (as amended) design. Stakeholder engagement and preference throughout the Schedule 17 submission has also been taken into account to ensure the “as far as reasonably practicable” criteria are met.

Case	Description	Acoustic	Visual	Value for money	Engineering Constraints	Consultation
ES Noise Barriers **[Comparison Design]**	Noise fence barriers approximately 3m high and 1.4km long at the top of the cutting on the eastern side of the route, extending from the new tunnel portal to Leather Lane	-	-	-	-	-
Base Case - Mitigation in the form of earthworks	*Mitigation in the form of earthworks design only,*	✗	- ✓	✓	N	N
Option 1 - Lineside Noise Barrier 2m above ToR on East (Up) side.	*Barrier 2m absorptive above ToR east (up)*	✗	✓	N	N	N
Option 2 - Lineside Noise Barrier 3m above ToR on East (Up) side.	*Barrier 3m absorptive above ToR east (up)*	✗	- ✓	N	N	N
Option 3 3m Noise Barrier on embankment to compensate for removal of earthwork bund.	*Barrier 3m absorptive barrier on top of embankment east (up)*	N	N	N	- N	✓

✗ ✗ Materially worse *(Using EIA methodologies)*

✗ Worse

- Neutral, N/A – no change or not applicable

✓ Beneficial

✓ ✓ Materially beneficial *(Using EIA methodologies)*

Value for money compared to the ES: B – Better, W – Worse, N - Neutral

Table 1 – Summary appraisal table, proposed mitigation scenarios, operational airborne noise

In summary;

Base Case: Option with no noise barrier (but inclusion of mitigation in the form of the earth bund designs) shows an increase in the number of moderate and minor impacts compared to the HS2 Phase 1 ES, with an increase to 4 moderate impacts for daytime from 3 moderate impacts in the ES and an increase to 3 moderate impacts for night-time from 1 moderate impact reported in the ES.

This option results in fewer L_{max} exceedances above LOAEL as the ES design, which is attributed to the removal of the TSI trains from the fleet and the proposed design that moves the tunnel portal 48m to the north and the narrowing of the track corridor.

	Design Option		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	4	3	3	1
Minor impact	3	2	3	3
Negligible impact	0	3	0	1
No. above LOAEL L_{Aeq}	**7**	8	6	5
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	82		138	

Table 2 – Baseline Case and ES for South Heath: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

Visual effects: The earthworks option with no barrier would remove any visual effects associated with the ES noise barrier design. would have a noticeable landscape and visual benefit.

Design Option 1: Lineside noise barrier 2m above ToR shows an increase in the number of moderate and minor impacts compared to the HS2 Phase 1 ES. Option 1shows an increase to 4 moderate impacts for daytime from 3 moderate impacts in the ES and an increase to 3 moderate impacts for night-time from 1 moderate impact reported in the ES.

This option results in fewer L_{max} exceedances above LOAEL as the ES design, which is attributed to the removal of the TSI trains from the fleet and the proposed design that moves the tunnel portal 48m to the north and the narrowing of the track corridor.

	Design Option		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	4	3	3	1
Minor impact	3	2	3	3
Negligible impact	0	3	0	1
No. above LOAEL L_{Aeq}	7	8	6	5
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	82		138	

Table 3 – Option 1 and ES for South Heath: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

Design Option 1 presents with a low value for money from a cost to noise benefit perspective.

Visual effects: A 2m barrier above TOR located at the toe of the South Heath cutting when compared to the ES assessed 3m barrier above ground at the cutting crest, would have a noticeable landscape and visual benefit. The 2m barrier would not be visible form adjacent visual receptors other than in glimpses on the approach to the two adjacent overbridges and footbridge which straddle the cutting at this location. Although the barrier would continue to form a linear feature in the landscape its relative position would be relatively inconspicuous, being contained by the engineered earthworks of the cutting.

Design Option 2: Lineside noise barrier 3m above ToR shows an increase in the number of moderate and minor impacts compared to the HS2 Phase 1 ES. Option 1shows an increase to 4 moderate impacts for daytime from 3 moderate impacts in the ES and an increase to 3 moderate impacts for night-time from 1 moderate impact reported in the ES.This option results in fewer L_{max} exceedances above LOAEL as the ES design, which is attributed to the removal of the TSI trains from the fleet and the proposed design that moves the tunnel portal 48m to the north and the narrowing of the track corridor.

	Design Option		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	4	3	3	1
Minor impact	3	1	3	3
Negligible impact	0	3	0	1
No. above LOAEL L_{Aeq}	7	7	6	5
No. above SOAEL L_{Aeq}			0	0
No. above LOAEL L_{Amax}	82		138	

Table 4 – Option 2 and ES for South Heath: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

Design Option 2 presents with a low value for money from a cost to noise benefit perspective.

Visual effects: A 3m barrier above TOR located at the toe of the South Heath cutting when compared to the ES assessed 3m barrier above ground at the cutting crest, would have a noticeable landscape and visual benefit. The barrier would not be visible form adjacent visual receptors other than in glimpses on the approach to the two adjacent overbridges and footbridge which straddle the cutting at this location. Although the barrier would continue to form a linear feature in the landscape its relative position would be relatively inconspicuous, being contained by the engineered earthworks of the cutting.

Design Option 3: noise barrier 3m above earthworks as shown on Image 6 shows the same number of moderate impacts compared to the HS2 Phase 1 ES and a reduction of 1 minor impact at night. The acoustic benefit is minimal and therefore considered neutral.

This option results in fewer L_{max} exceedances above LOAEL as the ES design, which is attributed to the removal of the TSI trains from the fleet and the proposed design that moves the tunnel portal 48m to the north and the narrowing of the track corridor.

	Design Option		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	3	1	3	1
Minor impact	3	3	3	3
Negligible impact	0	0	0	1
No. above LOAEL L_{Aeq}	**6**	4	6	5
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	82		138	

Table 5 – Option 3 and ES for South Heath: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

Design Option 3 presents with a low value for money and would therefore not normally be considered a viable option from a cost to noise benefit perspective. Cost has however not been used as a deciding factor in the selection of Option 3 as this Option ensures that the number of moderate impacts is no greater than that reported in the ES (as amended).

Visual effects: A 190m long 3m barrier above ground level located at the crest of the cutting when compared to the ES assessed 1.4km long 3m barrier at the cutting crest would have noticeable local landscape and visual benefit for the sections where it has been removed. However, for its 190m long section the barrier would have no adjacent earth mound, in contrast to the ES assessed barrier which had a 2m high earth screen bund immediately adjacent to it. The barrier would therefore form a local linear landscape feature, albeit shielded in views by the adjacent retained mature boundary hedgerow on its east side and overtime screened by a combination of the existing hedgerow and the proposed planting. This screening would result in a similar landscape and visual effect as reported in the ES for the same section of barrier with an associated screen bund.

A modified earthworks option in lieu of the 190m noise barrier was considered and proposed to BC during consultation. BC indicated that the noise barrier would be preferable as this would allow the land to be available for future agricultural use. Option 3 was therefore agreed to be the preferred option during stakeholder engagement.

Design Option 3 (mitigation in the form of a 3m barrier on top of the earthworks) is considered the appropriate mitigation option as this option is acoustically neutral compared to the ES (as amended) and presents one less L_{Aeq} impact above LOAEL than the ES and fewer L_{Amax} impacts above LOAEL than the ES. The visual effects are considered neutral and provides other local benefits in terms of land use. As a consequence, this barrier option is preferred as a result of consultation with BC.

From here on this option is referred to as the **Proposed Design**.

4.2 South Heath to Wendover

Only one option has been considered for this area in the form of the earthworks design. It was not considered necessary or appropriate to consider fence noise barriers because of the rural nature of the surrounding area and the low-level impact of the scheme in this area i.e. the absence of any minor, moderate or major impacts.

Table 6 below presents a summary of the outcome of the overall appraisal. The proposed design is highlighted in green.

The change in acoustic performance, visual impact and value for money are compared to the baseline ES (as amended) design. Stakeholder engagement and preference throughout the Schedule 17 submission has also been taken into account to ensure the “as far as reasonably practicable” criteria are met.

Case	Description	Acoustic	Visual	Value for money	Engineering Constraints	Consultation
ES Noise Barriers **[Comparison Design]**	Noise mitigation in the form of earthworks	-	-	-	-	-
Base Case - Mitigation in the form of earthworks	*Mitigation in the form of earthworks design only,*	N	- N	N	N	N
✗✗ Materially worse *(Using EIA methodologies)*						
✗ Worse						
- Neutral, N/A – no change or not applicable						
✓ Beneficial						
✓✓ Materially beneficial *(Using EIA methodologies)*						
Value for money compared to the ES: B – Better, W – Worse, N - Neutral						

Table 6 – Summary appraisal table, proposed mitigation scenarios, operational airborne noise

In summary;

- **Base Case:** Option with no noise barrier (but inclusion of mitigation in the form of the earthworks designs) shows there are no adverse noise impacts in accordance with the Environmental Impact Assessment methodology. Neither are there any exceedances of the L_{Aeq} LOAEL values. The only exceedances are against the L_{Amax} LOAEL values at night. There is no change in the exceedances against the L_{Amax} LOAEL values at night compared to the ES. Any exceedances in the L_{Amax} LOAEL values at night must also be considered in the context of the receiver environment. Therefore, in overall terms this represent no impact or a very low level of impact.

	Design Option		ES Design Scheme	
	Day	**Night**	**Day**	**Night**
Major impact	0	0	0	0
Moderate impact	0	0	0	0
Minor impact	0	0	0	0
Negligible impact	0	0	0	0
No. above LOAEL L_{Aeq}	0	0	0	0
No. above SOAEL L_{Aeq}	0	0	0	0
No. above LOAEL L_{Amax}	20		20	

Table 7 – Baseline Case and ES for South Heath to Wendover: Number of dwellings identifying impacts (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Aeq}) and SOAEL (L_{Aeq}), Number of dwellings exceeding LOAEL (L_{Amax}) and SOAEL (L_{Amax})

Visual effects: An earthworks design was proposed in the ES and therefore the visual effects are neutral.

From here on the Design Option (mitigation in the form of earthworks) is referred to as the **Proposed Design**.

5 Methodology

5.1 Calculation Method

Airborne noise from the operational railway has been assessed according to the required HS2 methodology which requires predictions of noise emission from five discrete sources at different heights above the rail to represent the source of noise associated with High-Speed Rail. The total noise emission from the train is calculated from the summation of the contributions of each of these distinct elements of the train, individually corrected for propagation to the assessment location.

The methodology includes corrections to account for future rolling stock being quieter than TSI-compliant trains and the representation of an individual track to better allow for divergence of the up and down tracks.

Appendix D sets out in detail the technical methodology for the prediction of airborne noise from operational trains.

5.2 Airborne noise from altered roads

Airborne noise from altered roads has been assessed in accordance with the methodology in Appendix D.

Airborne noise from altered roads has been assessed in accordance with the methodology set out in the *Calculation of Road Traffic Noise* (CRTN) and the updated procedure in the *Design Manual for Roads and Bridges HD213-11 Rev1* (DMRB)[6].

5.3 Assessment Methodology

In accordance with Information Papers E20 and E21 and the HS2 Phase 1 ES methodology, the impact of each Mitigation Design Option is considered and assessed against the following criteria:

- The number of residential properties with impacts predicted to exceed LOAEL;
- The number of residential properties with impacts predicted to exceed SOAEL;
- The number of residential properties with predicted noise impacts; and
- The number of properties predicted to be eligible for noise insulation.

[6] DMRB HD213-11 Rev1 as referenced in the HS2 Guidance has been revised (LA 111 Noise and Vibration) but does not alter the criteria for considering road traffic noise.

6 Assumptions

The study is based upon the available information at this stage of the design. For the operational railway the assumed train service patterns, track form, rolling stock parameters and noise sources, and planned operational train speeds are as provided by HS2 and are presented within Appendix D.

Stationary Systems

The Chiltern Tunnel North Portal site and compound will include earthworks and associated landscaping to incorporate the North Portal Building and site access. The Stationary System noise model input data for the North Portal is included in Table 8.

The assessment assumptions represent a reasonable worst-case assessment. It is considered that any uncertainty in the study does not affect the assessment outcomes presented in this report (refer to Appendix E).

Item	Details
Site landscape topography	Landscape design drawings provided by EKFB
North Portal Building	Building layout design drawings provided by ALIGN.
Plant noise data and operating conditions	Robust indicative transformer (non-traction and auto-transformer) sound power level details were derived in collaboration between ALIGN and HS2 Rail Systems. All other acoustic specifications were provided by ALIGN M&E team. Data relating to this is presented in Appendix E.

Table 8 – Stationary Systems input data

The stationary systems items associated with the Chiltern Tunnel North Portal building are listed as follows:

- Air Handling Units (AHU);
- Non traction transformers;
- Computer Room Air Cooling (CRAC) units;
- Extract fans;
- Pumps; and
- Condensing units.

Stationary systems sound levels

Sound power levels associated with the stationary systems are presented in Appendix E. The location of all sound sources assessed at the North Portal building are presented in Appendix E.

All plant associated with the Chiltern Tunnel North Portal building is assumed to be 100% operational, as a conservative approach.

6.1 Uncertainties and Limitations

The Train Noise Prediction Method (TNPM) used within the assessment was originally validated against a large number of high-speed train noise measurements covering a broad range of scenarios, including propagation over flat ground up to distances of 800m from the railway, effects of screening (including reflective and absorptive barriers) and varying angles of view. The overall regression analyses gave a standard error, for the goodness of fit between predicated and measured levels, of approximately 3dB(A) for SEL and L_{pAFmax}. This means that the difference between predicted and measured sound levels is typically within a margin of error of ±3dB(A). Consistent with the Hybrid Bill Scheme the mean levels predicted with TNPM are presented in this report

Any source of noise that could occur, or any mitigation that is installed or constructed to control noise and/or vibration; but is not subject to an acoustic specification / standard requires an assumption. Such assumptions are defined when taking into consideration the likely application of existing technology with reference to the probability of the noise and/or vibration occurring. This includes reference to sensitivity tests and regression analysis between predicted and measured levels such as those presented in Appendix SV-001-000: Annex D2 of the HS2 Phase 1 ES and set out in the methodology section of this report. Assumptions in all reasonably foreseeable circumstances are taken on a reasonable worst case. As such, under the majority of operating conditions, lower noise levels than those predicted in this assessment would be expected.

7 Results

The results of the noise assessment for the proposed design are presented in more detail below.

Receptor locations are shaded in red where a LOAEL value is predicted to be exceeded.

7.1 Airborne Rail Noise

The noise modelling results presented below are based upon the methodology set out in Section 4 and the assumptions detailed within both Section 5 and Appendix D.

The Receptor Identity (ID) Numbers correspond directly with those used in the Phase 1 ES (as amended) study, to allow for direct comparison. This is the case for receptor identities that represent individual receptor locations as well as groups of receptors.

7.1.1 South Heath

The noise predictions at each receptor for the Phase 1 SES (AP4-009-001) Design, and the **Proposed Design** (mitigation in the form of 3m barrier on top of earthworks) are presented in Tables 9 and 10. The tables presents a comparison for the predicted rail noise only. A full set of data for the combined future baseline and road traffic noise is included in Appendix F. Receptor locations are shaded in red where the LOAEL value is exceeded.

ID	Area Represented	No of Impacts Represented	Do Nothing (Opening Year baseline)		ES Design LAeq dB		Proposed Design 3m barrier on earthwork LAeq dB	
			Day	Night	Day	Night	Day	Night
355409	Hunts Green, The Lee	1	54	53	42	33	42	33
355417	Hunts Green, The Lee	1	54	53	43	34	43	33
355448	Hunts Green, The Lee	6	46	39	40	31	40	31
376704	Kings Lane, South Heath	10	47	41	35	25	22	13
376750	Kings Lane, South Heath	9	48	41	35	25	30	20
377005	Wood Lane, South Heath	9	47	40	35	25	19	9
377084	Lappetts Lane, South Heath	20	47	40	35	25	29	19
377405	Wood Lane, South Heath	16	46	41	35	25	20	10
377718	Ballinger Road, South Heath	14	51	41	35	25	30	20
377770	Ballinger Road, South Heath	15	51	41	35	25	27	18
377793	Marriotts Avenue, South Heath	17	46	39	35	26	27	18
377835	Marriotts Avenue, South Heath	18	46	39	35	25	26	17
378065	Ballinger Road, South Heath	22	51	41	35	25	25	16
374262	Meadow Lane, South Heath	6	47	40	35	27	30	20
375067	Lappetts Lane, South Heath	5	48	41	36	29	28	19
700360	Potter Row, Great Missenden	1	44	39	48	39	49	39
355317	Potter Row, Great Missenden	1	46	43	49	40	49	40
355352	Potter Row, Great Missenden	2	46	39	51	42	51	42
374188	Ballinger Road, South Heath	13	51	41	35	26	31	22
374775	Sibleys Rise, South Heath	19	47	40	42	35	23	14
374806	Kings Lane, South Heath	8	47	41	43	36	31	21
374849	Bayleys Hatch, South Heath	6	50	41	46	38	38	28
374914	Sibleys Rise, South Heath	25	47	40	41	33	32	23
375025	Kings Lane, South Heath	8	48	41	37	30	34	24
375134	Kings Lane, South Heath	10	47	41	40	33	34	25
375214	Bayleys Hatch, South Heath	10	48	44	41	33	38	28
375322	Potter Row, Great Missenden	5	44	39	43	35	43	34
375417	Potter Row, Great Missenden	6	48	41	38	30	36	27
375440	Potter Row, Great Missenden	1	46	36	41	32	41	32
375451	Potter Row, Great Missenden	1	46	36	40	31	40	30
375485	Potter Row, Great Missenden	3	50	45	51	42	52	43
375495	Potter Row, Great Missenden	1	44	39	49	40	50	41
375508	Potter Row, Great Missenden	3	46	36	47	37	48	38
375545	Potter Row, Great Missenden	1	46	36	45	36	46	36
375619	Potter Row, Great Missenden	2	44	39	44	35	45	36
375630	Potter Row, Great Missenden	1	44	39	51	42	52	43
375648	Potter Row, Great Missenden	4	46	36	48	38	49	39
375669	Potter Row, Great Missenden	5	51	50	47	38	47	38

Table 9 – Operational airborne noise, Design Option compared to HS2 Phase 1 ES Design

	Observed Adverse Effect Level	Total Day	Total Night
Proposed Design	Number of dwellings exceeding lowest observed adverse effects level (LOAEL) for Rail Noise	6	4
ES (as amended)		6	5

Table 10 – Number of dwellings exceeding LOAEL in the Design and ES (as amended) (LAeq)

The information presented within Tables 9 and 10 show that there is one fewer night-time impact above LOAEL for **the Proposed Design** (3m noise barriers on top of embankment) when compared to the Phase 1 ES (AP4-009-001).

Table 11 shows that the **Proposed Design** (3m noise barrier on top of embankment) presents the same number of moderate and minor impacts as reported in the Phase 1 ES (as amended). The assessment shown in Table 11 does not represent a likely significant effect on a community basis.

	Major Impacts		Moderate Impacts		Minor Impacts	
	Day	Night	Day	Night	Day	Night
The Proposed Design	0	0	3	1	3	3
ES	0	0	3	1	3	3

Table 11 – Number of receptors identifying impacts in the Design and ES (as amended) (LAeq)

The L_{max} levels for the **Proposed Design** have been compared against the Phase 1 ES (as amended) and are presented in Table 12 below.

Receptor ID	Area Represented	No. of Impacts	Proposed Design Option Lmax	HS2 Phase 1 ES (as amended) Lmax
355409	Hunts Green, The Lee	1	54	55/58
355417	Hunts Green, The Lee	1	55	56/59
355448	Hunts Green, The Lee	6	52	52/55
376704	Kings Lane, South Heath	10	51	54/57
376750	Kings Lane, South Heath	9	53	53/56
377005	Wood Lane, South Heath	9	44	44/47
377084	Lappetts Lane, South Heath	20	50	51/53
377405	Wood Lane, South Heath	16	48	51/54
377718	Ballinger Road, South Heath	14	47	47/50
377770	Ballinger Road, South Heath	15	44	44/47
377793	Marriotts Avenue, South Heath	17	46	47/50
377835	Marriotts Avenue, South Heath	18	44	44/47
378065	Ballinger Road, South Heath	22	42	42/45
374262	Meadow Lane, South Heath	6	49	50/53
375067	Lappetts Lane, South Heath	5	49	50/52
700360	Potter Row, Great Missenden	1	62	62/65
355317	Potter Row, Great Missenden	1	63	64/67
355352	Potter Row, Great Missenden	2	64	63/66
374188	Ballinger Road, South Heath	13	50	51/54
374775	Sibleys Rise, South Heath	19	56	61/63
374806	Kings Lane, South Heath	8	54	56/59
374849	Bayleys Hatch, South Heath	6	60	64/66
374914	Sibleys Rise, South Heath	25	59	63/66
375025	Kings Lane, South Heath	8	54	55/58
375134	Kings Lane, South Heath	10	56	57/59
375214	Bayleys Hatch, South Heath	10	58	59/61
375322	Potter Row, Great Missenden	5	60	59/61
375417	Potter Row, Great Missenden	6	55	56/58
375440	Potter Row, Great Missenden	1	54	54/56
375451	Potter Row, Great Missenden	1	53	53/55
375485	Potter Row, Great Missenden	3	64	65/67
375495	Potter Row, Great Missenden	1	62	61/64
375508	Potter Row, Great Missenden	3	59	59/62
375545	Potter Row, Great Missenden	1	57	58/60
375619	Potter Row, Great Missenden	2	57	57/60
375630	Potter Row, Great Missenden	1	65	63/65
375648	Potter Row, Great Missenden	4	61	59/62

Table 12 – Operational Lmax noise levels compared against ES receptors

The exceedances above the LOAEL are summarised in Table 13.

Mitigation Design Option	Observed Adverse Effect Level	Total Night
Proposed Design	Number of dwellings exceeding lowest observed adverse effects level (LOAEL)	82
ES		138

Table 13 – Number of dwellings exceeding LOAEL in the Design and ES for Lmax

Table 13 shows fewer L_{max} exceedances above the LOAEL (82) when compared with the HS2 Phase 1 ES (AP4-009-001) (138), indicating the acoustic benefit of the Proposed Design and the removal of the TSI trains from the fleet.

7.1.2 South Heath to Wendover

The noise predictions at each receptor for the Phase 1 ES Design, and the proposed design (mitigation in the form of earthworks) are presented in Tables 14 and 15. The table presents a comparison for the predicted rail noise only. A full set of data for the combined future baseline and road traffic noise is included in Appendix G. Receptor locations are shaded in red where the LOAEL value is exceeded.

ID	Area Represented	No of Impacts Represented	Do Nothing (Opening Year baseline)		ES Design LAeq dB		Proposed Design (3m barrier on embankment) LAeq dB	
			Day	Night	Day	Night	Day	Night
375669	Potter Row, Great Missenden	5	51	50	47	38	47	38
355498	The Lee, Great Missenden	5	46	39	35	26	35	26
350579	London Road Wendover	2	57	52	45	35	44	35
351596	Aylesbury Road Great Missenden	9	63	57	42	33	42	32
351644	Aylesbury Road Great Missenden	2	69	63	43	34	43	33
351671	London Road Wendover	1	66	60	47	38	47	38
351934	Kings Lane Wendover	1	52	49	49	39	48	39

Table 14 – Operational railway noise, Design Option compared to HS2 Phase 1 ES Design

	Observed Adverse Effect Level	Total Day	Total Night
Proposed Design	Number of dwellings exceeding lowest observed adverse effects level (LOAEL) for Rail Noise	0	0
ES (as amended)		0	0

Table 15 – Number of dwellings exceeding LOAEL in the Design and ES (as amended) (LAeq)

The information presented within Tables 14 and 15 show that there are no rail noise levels above LOAEL for the Proposed Design or the ES.

Table 16 shows that **Proposed Option** (earthworks design) shows there are no adverse noise impacts whatsoever in accordance with the EIA methodology. This result is the same as that for the ES (as amended).

	Major Impacts		Moderate Impacts		Minor Impacts	
	Day	Night	Day	Night	Day	Night
The Proposed Design	0	0	0	0	0	0
ES	0	0	0	0	0	0

Table 16 – Number of receptors identifying impacts in the Design and ES (as amended) (LAeq)

The L_{max} levels for **Proposed Option** have been compared against the Phase 1 ES and are presented in Table 17 below.

Receptor ID	Area Represented	No. of Impacts	Proposed Option Lmax	HS2 Phase 1 ES (as amended) Lmax
375669	Potter Row, Great Missenden	5	62	61/64
355498	The Lee, Great Missenden	5	48	45/48
350579	London Road Wendover	2	64	62/65
351596	Aylesbury Road Great Missenden	9	60	58/61
351644	Aylesbury Road Great Missenden	2	61	58/61
351671	London Road Wendover	1	66	64/67
351934	Kings Lane Wendover	1	63	61/64

Table 17 – Operational Lmax noise levels compared against ES receptors

The exceedances above the LOAEL are summarised in Table 8.

Mitigation Design Option	Observed Adverse Effect Level	Total Night
Proposed Design	Number of dwellings exceeding lowest observed adverse effects level (LOAEL)	20
ES		20

Table 18 – Number of dwellings exceeding LOAEL in the Design and ES for Lmax

The **Proposed Design** shows the same exceedances of the L_{max} LOAEL values (20) as the HS2 Phase 1 ES (20).

These exceedances do not necessarily mean that there will be adverse impacts at night. Impacts can only be assessed comparing the railway noise event levels against the ambient L_{max} levels. Examination of the ambient baseline noise levels would suggest that receptors in this area are already routinely exposed to L_{max} levels exceeding the LOAEL value.

7.2 Stationary Systems

Portal buildings, which will house items of plant for cooling and ventilation of the portal building, are proposed as part of the scheme tunnel portal buildings are plant buildings serving the green tunnels. For the majority of the time these buildings are unmanned.

These are relatively small items of plant with relatively low noise emission ratings. The portal buildings have been designed with sufficient space to provide silencers if necessary. Terminations and openings will be designed to minimise sound transfer to nearby sensitive premises. During detailed design, the walls, floors and doors to the buildings will be designed such that the noise breakout will be negligible compared to noise emitted from any terminations and openings. The measures that will be incorporated into the detailed design will ensure that there will be no adverse noise impacts from the stationary systems located inside the portal buildings.

Jet fans will also be provided inside the tunnels. HS2 Rail Operations have further investigated ventilation options for the tunnel, and it is indicated that jet fans will not be needed for normal operation. Congestion ventilation will be provided by two ventilation shaft fans that do not form part of this application. Jet fan noise control remains contractually required, as far as reasonably practicable. Testing of jet fans will take place 6 time annually during the daytime only, programmed to occur at the less sensitive times of day. Jet fan noise is therefore not considered part of the Schedule 17 application. It is expected that:

- jet fans will also be expected to operate in tunnels for testing purposes. Jet fans will be tested regularly but infrequently. It is expected that this would be required six times annually, which would take place between 1000 and 1600.

- jet fan operation would occasionally be needed to enable rail grinding and maintenance activities maintenance activities, which is not expected to take place more than twice annually;

The noise impact, if any, arising from jet fans, is expected to be low on the basis that:

- They will be located inside the tunnels which will mitigate the effects of any fan noise, similar to the mitigation the tunnels will provide for operational railway noise; and

- The fans will only operate infrequently and not during normal train operations.

The jet fans will be located inside the tunnels and will not be visible. No specific measures are proposed as part of the civil works design to mitigate noise from the jet fans. HS2 is placing contract requirements on the rail systems contractor so that the fans will be designed and specified so as to minimise noise emissions.

Based on design information to date, an assessment has been carried out for the portal building at the north tunnel portal

Table 19 presents the predicted free field specific sound levels (Ls) at the closest noise sensitive properties as a result of the operation of the tunnel portal building.

Receptor ID	Assessment Location	Predicted Specific Sound Level (First Floor)
375322	Potter Row, Great Missenden	19
375485	Potter Row, Great Missenden	17
375619	Potter Row, Great Missenden	13

Table 19 – Predicted plant noise levels at assessment locations

The reasonable worst-case the assessment considers the potential noise impact from the North Portal building during the night-time hours when background noise levels are lowest. Table 20 presents the BS 4142:2014 night-time plant sound assessment at the sensitive receptors closest to the North Portal.

Results	Assessment Location			Relevant BS4142:2014 Clause	Commentary
	ID 375322 Potters Row	ID 375485 Potters Row	ID 375619 Potters Row		
Background sound level $L_{A90,1\text{-}hr}$	26	26	26	8	As per Table 4 and Section 5 of this report.
Specific Level (Ls)	19	17	13	7.3	Ls predicted from 3D SoundPLAN environmental noise model as presented in Table 9.
Rating level ($L_{Ar,Tr}$) $L_{Aeq,T}$	19	17	13	9.2	Plant likely to be masked by background sound
Excess of rating level over background sound level	**-7**	**-9**	**-13**	11	Rating levels at the receptors are predicted to be greater than 5 dB below prevailing background sound levels.

Table 20 – BS4142-2014 Assessment Summary – Night-time (2300-0700)

Table 20 shows that the predicted rating level is between -7 and -13 dB(A) below the prevailing background sound level of the area. Therefore, the assessment indicates that the design objectives set out in Information Paper E22 will be achieved and that noise from stationary systems can be controlled so that there are no adverse noise impacts.

This assessment will need to be revised as the design is developed further. Specifically, data for non-traction transformers will need to be revisited by HS2 Rail Systems Contractors once appointed. At this stage in the design process, the results of the assessment demonstrate that we can be confident that the portal building and associated plant can be designed to avoid any adverse impacts.

8 Conclusions

The report demonstrates how all reasonable steps have been taken to reduce the combined airborne sound from altered roads and operational railways, predicted in all reasonably foreseeable circumstances, in order not to exceed defined values for LOAEL from the Phase 1 ES. Where it has not been reasonably practicable to achieve this objective, the report shows how airborne sound has been reduced AFARP.

The proposed design has been developed using an optioneering process, where options have been evaluated against a range of criteria including the acoustic effects; landscape and visual effects; engineering practicality, consultation with the Council. This process has been used to optimise the design and reduce the noise impacts as far as reasonably practicable.

Key design changes to the South Heath Cutting, since the Phase 1 ES, include: a) the relocation of the tunnel portal north by 48 meters and b) narrowing of the track corridor to start within the tunnel and the reduction in platform width, which has continued into South Heath Cutting. The substantial narrowing of the track spacing from 22m to 8m serves to bring the earthworks closer to the track alignment and provide improved screening. This has allowed for the replacement of the 1.4km long 3m barrier on top of the cutting described in the ES with a 190m long barrier at 3m above the embankment.

For **South Heath** the assessment shows:

- The **Proposed Design** has the same minor and moderate L_{Aeq} impacts levels above LOAEL as reported in the Phase 1 ES and one fewer negligible impact above LOAEL than the ES.

  The **Proposed Design** has fewer LOAEL for L_{max} noise levels than presented within the Phase 1 ES, which is attributed to the removal of the TSI trains from the rolling stock, the shifting of the tunnel portal 48m to the north and the narrowing of the track corridor. Overall, the acoustic performance of the Proposed Design is similar to that reported in the ES (as amended).

  Visually, a 190m long barrier 3m above ground level located at the crest of the cutting when compared to the ES assessed 1.4km long 3m barrier at the cutting crest would have noticeable local landscape and visual benefit for the sections where it has been removed. However, for its 190m long section the barrier would have no adjacent earth mound, in contrast to the ES assessed barrier which had a 2m high earth screen bund immediately adjacent to it. The barrier would therefore form a local linear landscape feature, albeit shielded in views by the adjacent retained mature boundary hedgerow on its east side and overtime screened by a combination of the existing hedgerow and the proposed planting. This screening would result in a similar landscape and visual effect as reported in the ES for the same section of barrier with an associated screen bund.

  A modified earthworks option in lieu of the 190m noise barrier was considered and proposed to BC during consultation. BC indicated that the noise barrier would be preferable as this would allow the land to be available for future agricultural use. Option 3 was therefore agreed to be the preferred option during stakeholder engagement.

For **South Heath to Wendover** the assessment shows:

- The **Proposed Design** results in no adverse impacts whatsoever, in accordance with the EIA methodology.

The **Proposed Design** has the same number of L_{max} noise levels above LOAEL as presented within the Phase 1 ES.
Visual effects: An earthworks design was proposed in the ES and therefore the visual effects are neutral.

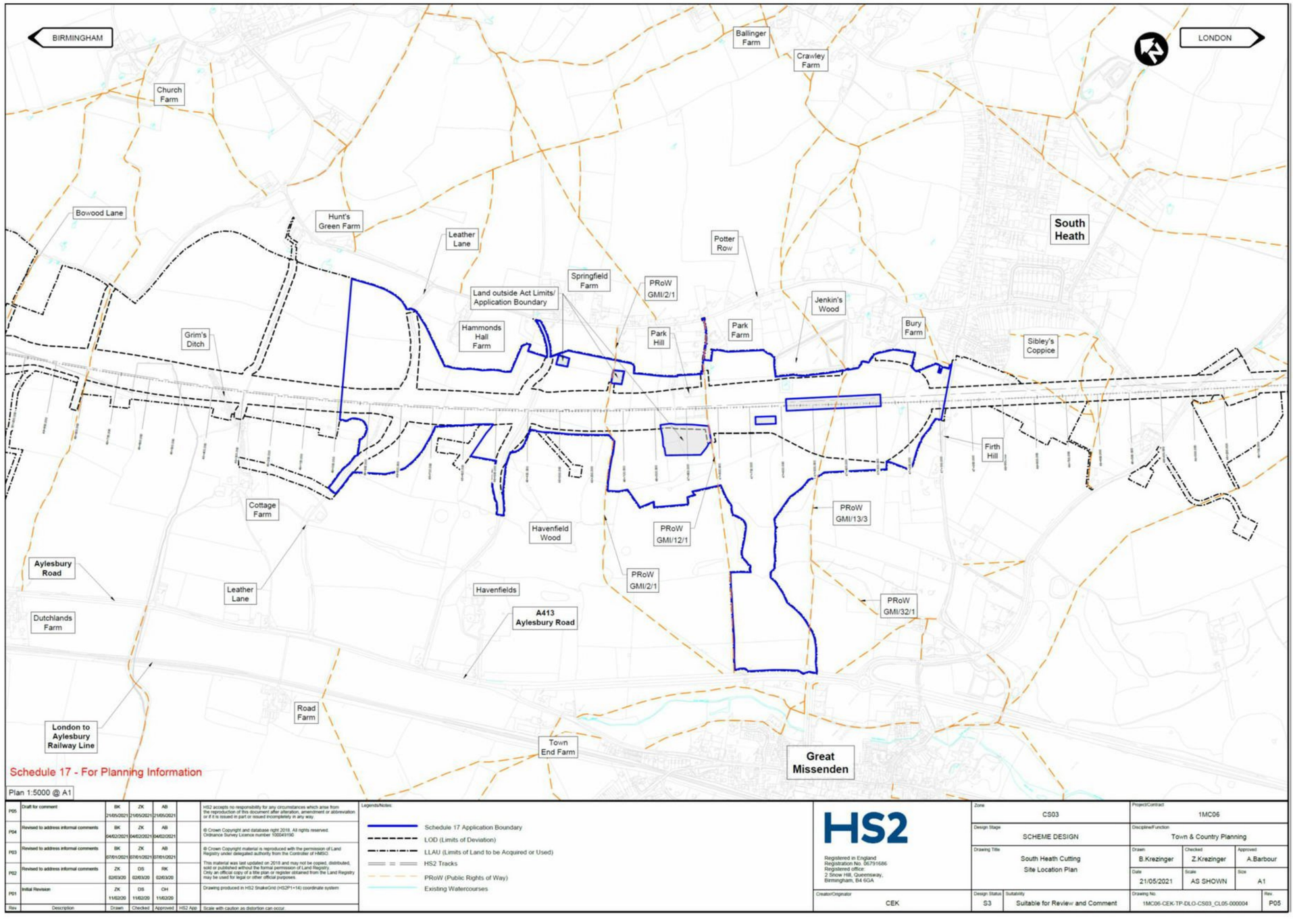
Stationary Systems

The tunnel portal and portal building are part of a separate Schedule 17 Application. The noise effects associated with the tunnel portal building have however been presented in this report at the request of the EHO for BC. The assessment indicates that the design objectives set out in Information Paper E22 will be achieved and that noise from stationary systems can be controlled so that there are no adverse noise impacts.

APPENDIX A

Schedule 17 Application Boundary

Number of Pages: 2



Rev	Description	Drawn	Checked	Approved	HS2 App	Scale with caution as distortion can occur
P05	Draft for comment	BK 21/05/2021	ZK 21/05/2021	AB 21/05/2021		HS2 accepts no responsibility for any circumstances which arise from the reproduction of this document after alteration, amendment or abbreviation or if it is issued in part or issued incompletely in any way.
P04	Revised to address informal comments	BK 04/02/2021	ZK 04/02/2021	AB 04/02/2021		© Crown Copyright and database right 2018. All rights reserved. Ordnance Survey Licence number 100049196
P03	Revised to address informal comments	BK 07/01/2021	ZK 07/01/2021	AB 07/01/2021		© Crown Copyright material is reproduced with the permission of Land Registry under delegated authority from the Controller of HMSO. This material was last updated on 2018 and may not be copied, distributed, sold or published without the formal permission of Land Registry. Only an official copy of a title plan or register obtained from the Land Registry may be used for legal or other official purposes.
P02	Revised to address informal comments	ZK 02/03/20	OS 02/03/20	RK 02/03/20		
P01	Initial Revision	ZK 11/02/20	OS 11/02/20	OH 11/02/20		Drawing produced in HS2 SnakeGrid (HS2P1+14) coordinate system

Legends/Notes:
- Schedule 17 Application Boundary
- LOD (Limits of Deviation)
- LLAU (Limits of Land to be Acquired or Used)
- HS2 Tracks
- PRoW (Public Rights of Way)
- Existing Watercourses

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Registered office:
2 Snow Hill, Queensway,
Birmingham, B4 6GA

Zone: CS03		Project/Contract: 1MC06	
Design Stage: SCHEME DESIGN		Discipline/Function: Town & Country Planning	
Drawing Title: South Heath Cutting Site Location Plan		Drawn: B.Krezinger	Checked: Z.Krezinger / Approved: A.Barbour
		Date: 21/05/2021	Scale: AS SHOWN / Size: A1
Creator/Originator: CEK	Design Status: S3 / Suitability: Suitable for Review and Comment	Drawing No.: 1MC06-CEK-TP-DLO-CS03_CL05-000004	Rev: P05

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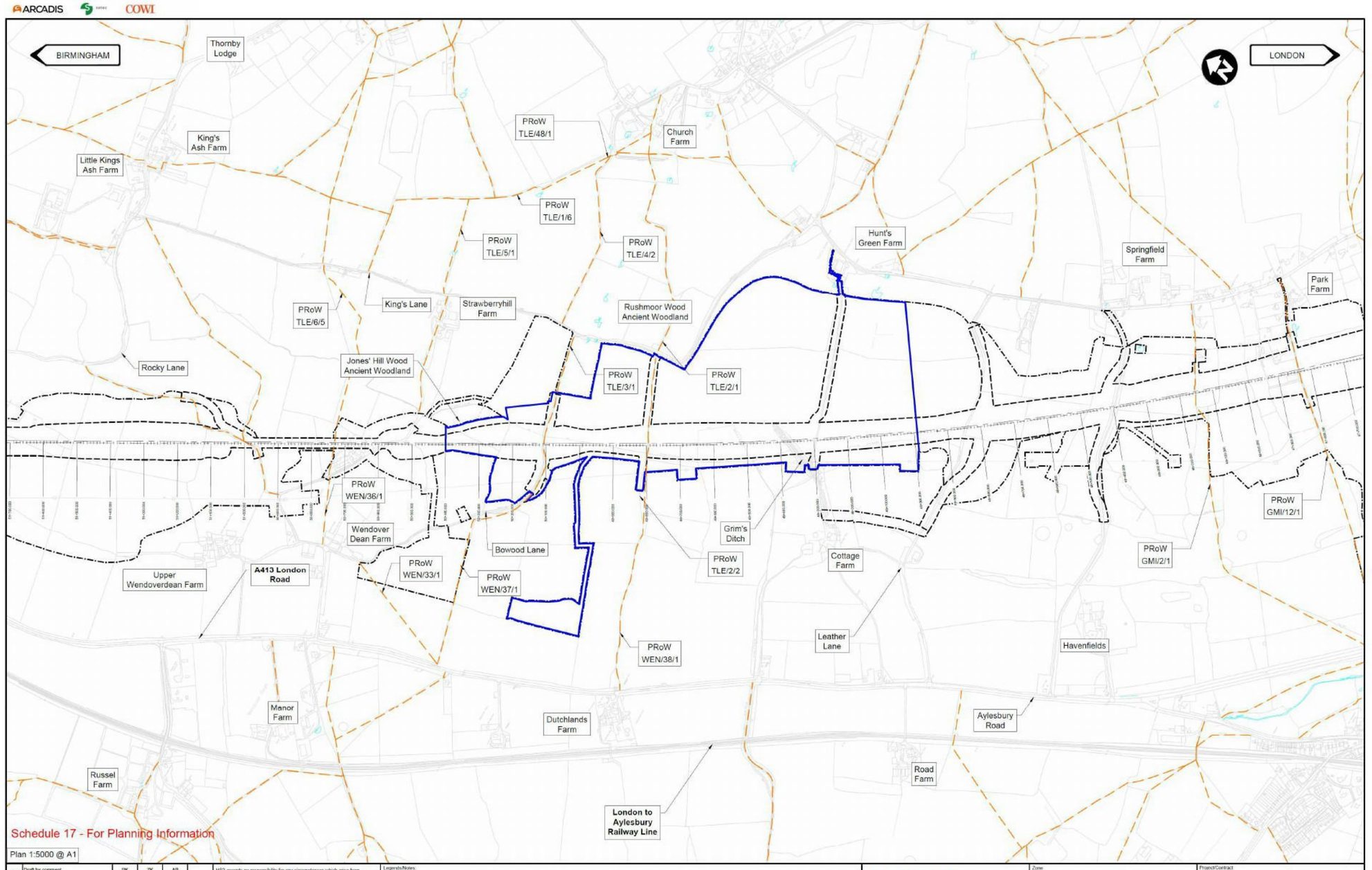
High Speed 2 - 1MC06 - Stage One C2 - MWCC –
North Portal of Chiltern Tunnels to Brackley
1MC07-CEK-TP-REP-CS03_CL05-000003



Rev	Description	Drawn	Checked	Approved	HS2 Appr
P03	Draft for comment	BK 21/05/2021	ZK 21/05/2021	AB 21/05/2021	
P02	Draft for comment	BK 04/02/2021	ZK 04/02/2021	AB 04/02/2021	
P01	First Issue	BK 07/01/2021	ZK 07/01/2021	AB 07/01/2021	

Drawing produced in HS2 SnakeGrid (HS2P1+14) coordinate system

Scale with caution as distortion can occur

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Zone: CS03		Project/Contract: 1MC06	
Design Stage: SCHEME DESIGN		Discipline/Function: Town & Country Planning	
Drawing Title: South Heath to Wendover Dean Site Location Plan		Drawn: B.Krezinger	Checked: Z.Krezinger / Approved: A.Barbour
		Date: 21/05/2021	Scale: AS SHOWN / Size: A1
Creator/Originator: CEK	Design Status: S3 / Suitability: Suitable for Review and Comment	Drawing No: 1MC06-CEK-TP-DPL-CS03_CL05-000074	Rev: P03

APPENDIX B

LOAEL and SOAEL Values from Information Paper E20 and E21

Number of Pages: 2

Time of day	Lowest Observed Adverse Effect Level (dB)	Significant Observed Adverse Effect Level (dB)
Day (0700 – 2300)	50 $L_{pAeq, 16hr}$	65 $L_{pAeq, 16hr}$
Night (2300 – 0700)	40 $L_{pAeq, 8hr}$	55 $L_{pAeq, 8hr}$
Night (2300 – 0700)	60 L_{pAFMax} (at the façade, from any nightly noise event)	80 L_{pAFMax} (at the façade, from more than 20 nightly train passbys), or 85 L_{pAFMax} (at the façade, from 20 or fewer nightly train passbys)

Table B1 - Noise effect levels for permanent residential buildings

Ground-borne noise	Lowest Observed Adverse Effect Level	L_{pASMax} [dB]	35
	Significant Observed Adverse Effect Level	L_{pASMax} [dB]	45
Vibration	Lowest Observed Adverse Effect Level	VDVday[$ms^{-1.75}$]	0.2
		VDVnight[ms-1.75]	0.1
	Significant Observed Adverse Effect Level	VDVday[$ms^{-1.75}$]	0.8
		VDVnight[$ms^{-1.75}$]	0.4

Table B2 - Ground-borne noise and vibration effect levels for permanent residential buildings

Examples	L_{pASMax} [dB]
Large auditoria; and concert halls	25
Sound recording & broadcast studios; theatres, and small auditoria	30
Places of meeting for religious worship; courts; cinemas; lecture theatres; museums; and small auditoria or halls	35
Offices; schools; colleges, hospitals; hotels; and libraries	40

Table B3 - Ground-borne noise impact levels for non-residential buildings

Examples	VDVday [ms-1.75]	VDVnight [ms-1.75]
Hotels; hospital wards; and education dormitories	0.2	0.1
Offices; Schools; and Places of Worship	0.4	n/a
Workshops	0.8	n/a
Vibration sensitive research and manufacturing (e.g. computer chip manufacture); hospitals with vibration sensitive equipment / operations; universities with vibration sensitive research equipment / operations	Risk assessment will be undertaken based on the information currently available for the relevant equipment /process, or where information provided by the building owner or equipment manufacturer.	

Table B4 - Ground-borne vibration impact levels for non-residential buildings

APPENDIX C

Detailed Technical Methodology

Number of Pages: 2

Airborne Rail Noise

Rail noise modelling has been undertaken using the NoiseMap software package. This implements the airborne noise calculation methodology (commonly referred to as the Train Noise Prediction Model (TNPM)). This validated methodology has been used for the HS2 ES and, prior to that, the detailed design of the Channel Tunnel Rail Link (HS1). The method to predict airborne sound from operation has modelled the propagation including the following effects: topography, ground type, reflections, shielding by barriers and buildings, air absorption, and meteorology.

The TNPM methodology allows for sources of varying heights to be put onto the same track segments. Image D1 shows the heights of the five sources defined as distances above rail. The source terms which have been used for each of these source contributions are set out in Appendix E.

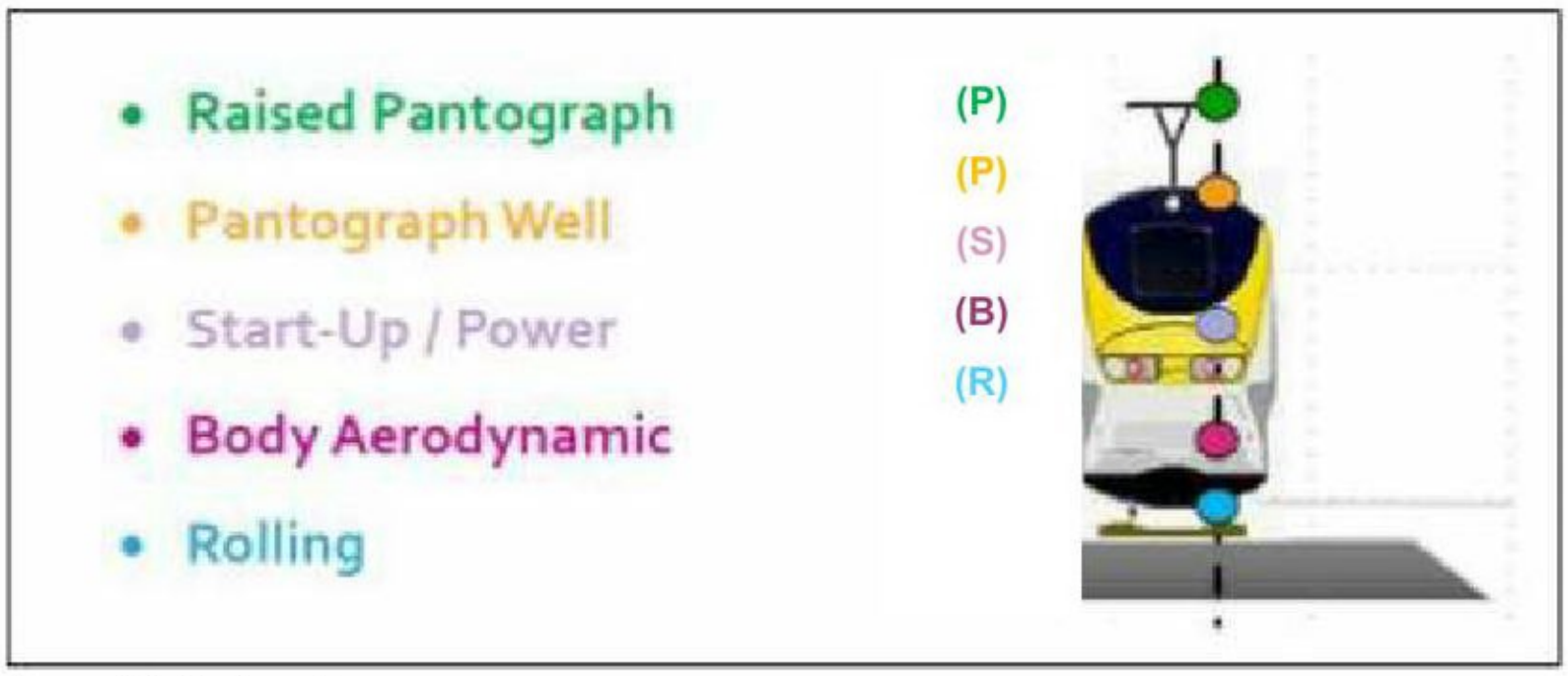

Image D1: Train noise sources

- *In the predictions of airborne noise from HS2 trains, the speed dependence relationships for each of these sources, in terms of SEL shall be:*
  - R_{SEL} *+ 20log10V for rolling sound;*
  - B_{SEL} *+ 60log10V for body aerodynamic sound;*
  - S_{SEL} *- 10log10V for starting sound (V < 250 kph); and*
  - P_{SEL} *+ 60log10V for pantograph and pantograph recess sound.*

  where R_{SEL} is the source term for rolling sound, B_{SEL} is the source term for body aerodynamic sound, S_{SEL} is the source term for starting sound and P_{SEL} is the source term for pantograph and pantograph recess sound and V is the train speed in kph. S_{SEL} shall not be included for predictions of airborne noise when train speeds are 250 kph or above.

- *The corresponding speed dependence relationships for each of these sources, in terms of L_{pAFmax}, which shall be assumed in the prediction of airborne noise for each of these sources are:*
  - $R_{LpAF,max}$ *+ 30log10V for rolling sound;*
  - $B_{LpAF,max}$ *+ 70log10V for body aerodynamic sound;*

- $S_{LpAF,max}$ for starting sound; and
- $P_{LpAF,max}$ + 70log10V for pantograph and pantograph recess sound.

- *Where $R_{LpAF,max}$ is the source term for rolling maximum sound, $B_{LpAF,max}$ is the source term for body aerodynamic maximum sound, $S_{LpAF,max}$ is the source term for starting sound and PLpAF,max is the source term for pantograph and pantograph recess maximum sound and V is the train speed in kph.*

- *The method to predict airborne sound from operation shall model the propagation in order to consider, but not limited to, the following effects: topography, ground type, reflections, shielding by barriers and buildings, air absorption and meteorology.*

- *The total pass-by L_{pAFmax} is computed using the following equation:*

$$L_{pAFmax} = MAX\ [\ (R_{LpAF,max} \oplus B_{LpAF,max} \oplus S_{LpAF,max})\ ,\ (R_{LpAF,max} \oplus P_{LpAF,max} \oplus S_{LpAF,max})]$$

- *To account for the differing source heights resulting in different distance attenuation, ground absorption and shielding etc. the calculations for propagation from source to receptors will be undertaken for each source individually for both $L_{pAeq,T}$ and $L_{pAF,max}$ calculations. $L_{pAeq,T}$ will be logarithmically summed at the receptor location to provide a single figure value and $L_{pAF,max}$ will be summed in accordance with equation above at the receptor location to provide a single figure value.*

Predictions of airborne sound take into account the acoustic performance of civil engineering assets, trackwork and trains throughout the life of the operational railway with a maintenance programme agreed with HS2 and thereby account for all reasonably foreseeable circumstances in accordance with HS2 Information Paper E20.

Predictions of airborne sound from existing conventional railways unaltered by the proposed scheme and construction railways have been made in accordance with the technical memorandum the Calculation of Railway Noise (CRN), the CRN Supplement 1 and the AEAT supplementary sources terms. This will include source terms and rolling noise corrections as specified by the CRN methodology.

Airborne Noise from Altered Roads

Airborne noise from altered roads has been assessed in accordance with the methodology set out in the Calculation of Road Traffic Noise (CRTN) and the updated procedure in the Design Manual for Roads and Bridges (DMRB) HD213-11 Rev1.

Where there has been no significant changes since the ES, results from road noise calculations from roads altered by the scheme presented for the ES have been utilised. This data will be updated as further information comes available.

APPENDIX D

Assumptions

Number of Pages: 1

Rail Modelling Assumptions

The HS2 rolling stock and service pattern is made up of two train fleets:

- Phase 1 fleet will be made up of Conventional Compatible (CC) trains that can run on both the High Speed and the classic rail network, and,
- Phase 2b fleet will be made up of Captive (CP) trains that are dedicated to the High Speed network.

Train service pattern data is summarised in Table D1, normalised to 200m long trains and the noise source terms are presented in Table D2.

	Route Section	200m trains per section	400m trains per section	Total rains per section	Equivalent 200m trains per section	One-way train flow assumptions (equivalent 200m trains)								
						05.30-06.00	06-07.00	Standard hour	21-22.00	22-23.00	23-00.00	Total (24hr)	**Total Day (16hr)**	**Total Night (8hr)**
London to Birmingham / The North	3	6.0	12.0	**18.0**	30.0	5	20	30	25	15	5	490	460	30
└---> Conventional Compatible (Catch-Up)	3A	1.5	0.0	**1.5**	1.5	0	1	2	1	0	0	23	22	1
└---> Conventional Compatible (330)	3B	4.5	4.0	**8.5**	12.5	2	8	13	10	6	2	203	191	12
└---> Captive (Catch-Up)	3C	0.0	0.8	**0.8**	1.5	0	1	2	1	0	0	23	22	1
└---> Captive (330)	3D	0.0	7.3	**7.3**	14.5	2	9	15	12	7	2	235	222	13

Table D1 – Train flow data

Source	SEL dB at 25m		LpAF,max dB at 25m	
	Conventional Compatible train	Captive train	Conventional Compatible train	Captive train
Rolling	92	92	89	89
Body Aerodynamic	92	90	89	87
Start-up / Power	74	74	73	73
Pantograph Well	n/a	n/a	n/a	n/a
Raised Pantograph	76	76	78	78

Note: Sound emissions from each train running at 320kph on assumed HS2 infrastructure, expressed in terms of the SEL and L_{pAFmax} 25 m from nearest track and 3.5m above ground

Table D2 – Train source data

APPENDIX E

Stationary Systems

Number of Pages: 2

Stationary systems noise modelling inputs and uncertainties

Noise source levels

The sound power levels for the North Portal Building fixed plant are provided in Table E1. This acoustic data is based on a mature detailed design developed by ALIGN and whilst the ultimate suppliers and specific models will be subject to procurement, the equipment selected will be similar in design intent. The plant listed in Table E1 are assumed to operate at all times.

Location	Sound Source	No. of units		Octave Band Sound Power Level dB in stated frequency band (Hz)								
		Duty	Stand-by	63	125	250	500	1k	2k	4k	8k	dBA
Condensing Units	Airedale CR30 CRAC condensing units	4	3	82	87	74	74	73	70	63	62	78
	Daikin RZAG71NY1 condensing units	2	2	-	-	-	65	-	-	-	-	62
Heat Pump	Daikin RXM42N9 - Outdoor VRF wall mounted	1	2	56	59	58	55	50	44	38	30	56
Mechanical Room - AHU	Supply Inlet	1	1	67	73	72	68	60	58	51	43	77
	Extract Outlet			72	80	79	78	78	76	76	68	86
	AHU Casing Breakout			56	66	61	58	58	54	44	32	69
Extract fans	Extract Fan CBT-80N LG270VE	1		45	56	67	77	79	75	66	56	82
Extract Fans for Battery Rooms	Fan TD-1300/250 ECOWATT	1	1	36	51	66	70	73	68	58	48	76
	Fan TD-800/200 ECOWATT	1	1	30	42	60	64	64	61	53	43	69

- Octave Band Centre Frequency sound power level not available

Table E1 – North Portal building Plant

Two non-traction transformers will be located within the North Portal Building (transformer room A and transformer room B). As specific transformer models are yet to be determined, a robust indicative sound power level was derived in collaboration between ALIGN and HS2 Rail Systems, in accordance with BS EN 60076-10:2016. This may be subject to change on appointment of the HS2 Rail Systems Contractor. Table E2 presents the transformer sound power levels for the transformers, which are assumed to operate at all times.

Location	Sound Source	Octave Band Sound Power Level dB in stated frequency band									
		31.5	63	125	250	500	1k	2k	4k	8k	dBA
Transformer Room A and B within North Portal building	Indicative non traction transformer (2.5m x 1.9m x 2.2m height)	64	73	75	75	73	64	56	51	44	72

Table E2 – Sound Power Level for ATS Transformer

Building Elements and Noise Controls

The rooms in the North Portal building are assumed to be of standard block work construction. Intake and extract louvres at the North Portal building and the external walls for the transformer rooms are to be standard performance profile weather louvres and are assumed to be Colt 2UL universal fixed metal ventilation louvre systems.

Table E3 presents the sound reduction index which has been considered in the noise modelling predictions for all surfaces.

Location	Louvre/surface type	Sound Reduction Index dB in stated frequency band								
		63	125	250	500	1k	2k	4k	8k	Rw
Intake and extract louvres and external walls of transformer rooms	Colt 2UL universal fixed metal ventilation louvre systems (*manufacturer data not provided. Conservative assumptions applied)	2*	5	4	3	3	5	7	7*	4
All remaining surfaces	Solid breeze or clinker blocks, un-plastered	12	17	18	20	24	30	38	41	25

Table E3 – Sound Reduction Index for Louvres and other Surfaces

APPENDIX F

Overall Operational Noise for Design compared to ES – South Heath

Number of Pages: 1

ID	Area Represented	No of Impacts Represented	Do Nothing (Opening Year baseline)		ES Design Scheme noise only LAeq dB		ES Design Opening Year Baseline +Year 15 Traffic LAeq dB		Proposed Scheme Only No Barrier		No Barrier Opening Year Baseline +Year 15 Traffic LAeq dB		Proposed Scheme Only 2m Barrier Lineside		Design Option 2m Barrier Opening Year Baseline +Year 15 Traffic LAeq dB		Proposed Scheme Only 3m Barrier Lineside		Design Option 3m Barrier Opening Year Baseline +Year 15 Traffic LAeq dB		Proposed Scheme Only 3m barrier on earthwork		Design Option 3m barrier on EarthworkOpening Year Baseline +Year 15 Traffic LAeq dB	
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
355409	Hunts Green, The Lee	1	54	53	42	33	54	53	42	33	54	53	42	33	54	53	42	33	54	53	42	33	54	53
355417	Hunts Green, The Lee	1	54	53	43	34	54	53	43	33	54	53	43	33	54	53	43	33	54	53	43	33	54	53
355448	Hunts Green, The Lee	6	46	39	40	31	47	40	40	31	47	40	40	31	47	40	40	31	47	40	40	31	47	40
376704	Kings Lane, South Heath	10	47	41	35	25	47	41	22	13	47	41	22	13	47	41	22	13	47	41	22	13	47	41
376750	Kings Lane, South Heath	9	48	41	35	25	48	41	30	20	48	41	30	20	48	41	30	20	48	41	30	20	48	41
377005	Wood Lane, South Heath	9	47	40	35	25	47	40	19	9	47	40	19	9	47	40	19	9	47	40	19	9	47	40
377084	Lappetts Lane, South Heath	20	47	40	35	25	47	40	29	19	47	40	29	19	47	40	29	19	47	40	29	19	47	40
377405	Wood Lane, South Heath	16	46	41	35	25	46	41	20	10	46	41	20	10	46	41	20	10	46	41	20	10	46	41
377718	Ballinger Road, South Heath	14	51	41	35	25	51	41	30	20	51	41	30	20	51	41	30	20	51	41	30	20	51	41
377770	Ballinger Road, South Heath	15	51	41	35	25	51	41	27	18	51	41	27	18	51	41	27	18	51	41	27	18	51	41
377793	Marriotts Avenue, South Heath	17	46	39	35	26	46	39	27	18	46	39	27	18	46	39	27	18	46	39	27	18	46	39
377835	Marriotts Avenue, South Heath	18	46	39	35	25	46	39	26	17	46	39	26	17	46	39	26	17	46	39	26	17	46	39
378065	Ballinger Road, South Heath	22	51	41	35	25	51	41	25	16	51	41	25	16	51	41	25	16	51	41	25	16	51	41
374262	Meadow Lane, South Heath	6	47	40	35	27	46	40	30	20	47	40	30	20	47	40	30	20	47	40	30	20	47	40
375067	Lappetts Lane, South Heath	5	48	41	36	29	48	41	28	19	48	41	28	19	48	41	28	19	48	41	28	19	48	41
700360	Potter Row, Great Missenden	1	44	39	48	39	50	42	49	40	51	43	49	40	51	43	49	40	51	43	49	39	50	42
355317	Potter Row, Great Missenden	1	46	43	49	40	51	45	49	40	51	45	49	40	51	45	49	40	51	45	49	40	51	45
355352	Potter Row, Great Missenden	2	46	39	51	42	52	44	51	42	52	43	51	42	52	43	51	42	52	43	51	42	52	44
374188	Ballinger Road, South Heath	13	51	41	35	26	51	41	31	22	51	41	31	22	51	41	31	22	51	41	31	22	51	41
374775	Sibleys Rise, South Heath	19	47	40	42	35	46	40	23	14	47	40	23	14	47	40	23	14	47	40	23	14	47	40
374806	Kings Lane, South Heath	8	47	41	43	36	47	41	31	21	47	41	31	21	47	41	31	21	47	41	31	21	47	41
374849	Bayleys Hatch, South Heath	6	50	41	46	38	50	41	38	28	50	41	38	28	50	41	37	28	50	41	38	28	50	41
374914	Sibleys Rise, South Heath	25	47	40	41	33	47	40	32	23	47	40	32	23	47	40	32	23	47	40	32	23	47	40
375025	Kings Lane, South Heath	8	48	41	37	30	48	41	34	24	48	41	34	24	48	41	34	24	48	41	34	24	48	41
375134	Kings Lane, South Heath	10	47	41	40	33	47	41	34	25	47	41	34	25	47	41	34	25	47	41	34	25	47	41
375214	Bayleys Hatch, South Heath	10	48	44	41	33	48	44	38	28	48	44	38	28	48	44	37	28	48	44	38	28	48	44
375322	Potter Row, Great Missenden	5	44	39	43	35	46	40	43	34	47	40	43	34	47	40	43	34	47	40	43	34	47	40
375417	Potter Row, Great Missenden	6	48	41	38	30	48	41	36	27	48	41	36	27	48	41	36	27	48	41	36	27	48	41
375440	Potter Row, Great Missenden	1	46	36	41	32	47	37	41	32	47	38	41	32	47	38	41	32	47	38	41	32	47	38
375451	Potter Row, Great Missenden	1	46	36	40	31	47	37	40	30	47	37	40	30	47	37	40	30	47	37	40	30	47	37
375485	Potter Row, Great Missenden	3	50	45	51	42	54	47	53	43	55	47	53	43	55	47	52	43	54	47	52	43	54	47
375495	Potter Row, Great Missenden	1	44	39	49	40	50	42	50	41	51	43	50	41	51	43	50	41	51	43	50	41	51	43
375508	Potter Row, Great Missenden	3	46	36	47	37	49	40	48	38	50	40	48	38	50	40	48	38	50	40	48	38	50	40
375545	Potter Row, Great Missenden	1	46	36	45	36	48	39	46	36	49	39	46	36	49	39	46	36	49	39	46	36	49	39
375619	Potter Row, Great Missenden	2	44	39	44	35	47	40	45	36	48	41	45	36	48	41	45	36	48	41	45	36	48	41
375630	Potter Row, Great Missenden	1	44	39	51	42	52	44	52	43	53	45	52	43	53	45	52	43	53	44	52	43	53	45
375648	Potter Row, Great Missenden	4	46	36	48	38	50	40	49	39	50	41	49	39	50	41	48	39	50	41	49	39	50	41
375669	Potter Row, Great Missenden	5	51	50	47	38	52	51	47	38	53	50	47	38	53	50	47	38	53	50	47	38	53	50

APPENDIX G

Overall Operational Noise for Design compared to ES – South Heath to Wendover

Number of Pages: 1

ID	Area Represented	No of Impacts Represented	Do Nothing (Opening Year baseline)		ES Design Scheme noise only LAeq dB		ES Design Opening Year Baseline +Year 15 Traffic LAeq dB		Proposed Scheme Only No Barrier		No Barrier Opening Year Baseline +Year 15 Traffic LAeq dB	
			Day	Night	Day	Night	Day	Night	Day	Night	Day	Night
375669	Potter Row, Great Missenden	5	51	50	47	38	52	51	47	38	53	50
355498	The Lee, Great Missenden	5	46	39	35	26	46	39	35	26	46	39
350579	London Road Wendover	2	57	52	45	35	58	52	44	35	57	52
351596	Aylesbury Road Great Missenden	9	63	57	42	33	63	57	42	32	63	57
351644	Aylesbury Road Great Missenden	2	69	63	43	34	69	63	43	33	69	63
351671	London Road Wendover	1	66	60	47	38	66	60	47	38	66	60
351934	Kings Lane Wendover	1	52	49	49	39	54	49	48	39	54	49